

**IRRIGATION COSTS AND PRICES:
AN INSTITUTIONAL ECONOMIC ANALYSIS OF PRICING STRATEGIES IN
THE *OFFICE DU NIGER* AND SMALL PUMP-IRRIGATED VILLAGE
PERIMETERS IN MALI**

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ABSTRACT

IRRIGATION COSTS AND PRICES: AN INSTITUTIONAL ECONOMIC ANALYSIS OF PRICING STRATEGIES IN *OFFICE DU NIGER* AND SMALL PUMP-IRRIGATED VILLAGE PERIMETERS IN MALI

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This paper explores the link between cost and price in two irrigation schemes in Mali - the *Office du Niger* (ON), a large-scale gravity irrigation authority, and a number of small pump-irrigated fields at village perimeters along the Niger River (*Petits Perimetres d'Irrigation Villagois*). I argue that the effectiveness of cost-recovery pricing strategies for improving the long-run financial sustainability of irrigation systems and advancing national development objectives is a function of decision-making processes, which influence the distribution *and absolute levels* of cost and benefit flows. Participants' willingness and capacity to invest in problem solving play an important part in irrigation system viability by increasing the rate of technological and institutional change, which can increase benefits and decrease costs of production. Understanding formal and informal relationships between service users and service providers can help reveal institution-based sources of incentives and disincentives for parties to invest in producing effort and solving problems. The paper examines the price strategies in two case studies and the relationships among stakeholders in the design and implementation of each system's price strategies. Institutional theory suggests ways to align individual incentives with the objectives of the pricing strategy; targeted investments may be needed to provide participants with the means to act on institutionally designed incentives.

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LIST OF ACRONYMS AND ABBREVIATIONS

AFAR	<i>Action pour la Formation et l'Autopromotion Rurale</i> – Action for rural training and self-promotion
AVD	<i>Association des Volontaires pour le Developpement du Delta</i> – Association of Volunteers for the Development of the Delta
CPGF	<i>Comité Paritaire de Gestion des Fonds d'Entretien du Réseau Hydraulique Secondaire</i> - Secondary Canal Committees for the Management of Maintenance Funds
CPGT	<i>Comité Paritaire de Gestion des Terres</i> - Secondary Committee for Land Management
CP	<i>Contrat-Plan</i> – Contract-Plan (<i>Office du Niger</i>)
CPR	Common Pool Resources
DNAER	National Directorate for Rural Works and Equipment
DRAER	Regional Directorate for Rural Works and Equipment
GMP	<i>Group Motopompe</i> – Diesel Motor Pump
GOM	Government of Mali
HEC	High exclusion cost goods
IMF	International Monetary Fund
IMT	Irrigation management transfer
MAEP	<i>Ministere de l'agriculture, de l'elevage, et de la peche</i> – Minister of Agriculture, livestock and fisheries (formerly MDRE and MDR)
OERT	Organizations for Maintenance of Tertiary Networks
O & M	Operations and Maintenance
ON	<i>Office du Niger</i> , Niger Valley Authority
ORM	<i>Office Riz Mopti</i> , Mopti Rice Authority
NGO	Non-governmental organization
PIM	Participatory Irrigation Management
PNIR	National Rural Infrastructure Program
PPIV	<i>Petits Perimetres d'Irrigation Villagois</i> - Small Irrigated Village Perimeters
SEXAGON	<i>Syndicat des Exploitants Agricoles de l'Office du Niger</i> – ON Farmer Union
SNDI	National Irrigation Development Strategy
SYNADEC	<i>Syndicat Agriculteurs du Delta Central</i> – Union of farmers of the inner delta
USAID	United States Agency of International Development
VRES	<i>Valorisation des ressources en eau de surface</i> – Valuation of surface water
WB	World Bank

1 INTRODUCTION

This paper provides an institutional economic description and analysis of two irrigation-pricing cases in Mali. The first case is the *Office du Niger* (ON), a large-scale gravity irrigation authority. The second is the case of a number of small pump-irrigated fields at village perimeters, primarily in the Mopti region, that receive governmental or non-governmental subsidization; these irrigation schemes are collectively referred to as *Petits Perimetres d'Irrigation Villagois* (PPIVs). Both schemes are principally used for flooded rice production.

In both cases, formal irrigation pricing institutions (pricing policies) are primarily designed as tactics to recover the financial costs of the irrigation scheme.¹ Irrigation-pricing institutions are analyzed with respect to their ability to promote objectives outlined by the National Sub-Sector Strategy for Irrigation Development (SNDI) - to increase sustainable agricultural productivity in support of national strategies for development. Relevant national development strategies include the National Poverty Reduction Strategy, the National Environmental Action Plan, the National Economic Growth Strategy, and the National Food Security Strategy. These strategies are designed to promote a vision for Mali of reduced poverty and increased sustainable development.

In the paper I explore the link between cost and price in the two irrigation cases reviewed. I argue that the effectiveness of cost-recovery pricing strategies for improving

¹ Irrigation pricing can be broadly defined as the formal and informal rules for exchanging responsibilities for rights to irrigation services. In both cases reviewed, designed pricing strategies or policies serve as a primary formal institutional link between the *provision* or allocation of common-property resources (CPR) rights to the user (the good being sold - access to the irrigation service, the water and the irrigated parcel of land) and the *appropriation* of CPR responsibilities from users (the price of the good - work, cash payment, crop share, etc.). In Mali, all land and water are owned by the State. Irrigation infrastructure is owned by the State in the *Office du Niger* (ON) and is owned collectively by users' associations in the Small Scale Irrigated Village Perimeters (*Petits Perimetres d'Irrigation Villagois* - PPIVs). The allocation of usufruct rights is shaped by ownership of equipment, family size (labor), and power (relationships to land management committees).

the long-run financial sustainability of irrigation systems and advancing development objectives is a function of the design of decision-making and accountability institutions which influence the distribution *and absolute levels* of cost and benefit flows based on resulting institution-based incentives.

This argument rests on two simple but important observations. The first is that the rate of technological change is influenced by both endogenous and exogenous factors. Second, the distribution of transaction costs between irrigation service users and irrigation service providers, including information, contracting, monitoring and enforcement costs, is persistently asymmetrical. Making these observations, I further argue that a system's long-run financial viability and level of productivity are a function of participants' willingness to invest in problem solving and interest in directing that effort toward generating technological and institutional ingenuity that reduces the costs of irrigation service provision. Understanding formal and informal relationships between service users and service providers can help reveal sources of incentives and disincentives for parties to invest in producing effort and creative problem solving or ingenuity and can help trace the target of its application. Institutions can be designed to align individual incentives with the objectives of the pricing strategy so that ingenuity is generated and is applied to advancing personal and national objectives rather than to personal gain at the expense of the common goals; investments may be necessary to provide participants with the means to act on incentives (e.g. training, information, oversight).

This research is dually motivated by 1) the literature gap in irrigation pricing research in Africa, particularly in West Africa and by 2) the limited success of irrigation projects in Mali despite significant (though declining) donor and government investment.

The bulk of irrigation pricing literature is based on research conducted in Asia, the Middle East, and Europe – all regions with significantly different irrigation histories and contexts than Sub-Saharan Africa. Research on irrigation in West Africa is largely limited to organization and government reports, which are often restricted to financial analyses and have limited circulation. Furthermore, irrigation research and reform efforts in Mali tend to focus on either technological cost-reducing remedies or project-financing institutions – both with the objective of increasing the productivity, sustainability and hectare coverage of irrigation systems. That *physical* transformation costs are affected by governance structures, social relationships, learning, and history is rarely acknowledged.

Designs, in the sense of their being practical ideas applied to solve problems, are both inputs to and outputs of the economic process. They demonstrate cumulative causation and path dependency, and they can change the distribution and level of production costs. The relationship between price strategies and participants' (farmers and irrigation system managers) means and incentives for developing and applying ideas creatively is largely overlooked in irrigation literature.

Donor and governmental funding for large physical infrastructure projects is declining in Africa and the financing approaches for remaining projects are fundamentally changing (Anyemedu, 2003). Growth rates of area under irrigation in West Africa declined dramatically over the past 25 years, and investments are increasingly made as loans and/or short-term start-up subsidies conditioned on

implementation of cost-recovery pricing strategies and irrigation management transfer (Rosegrant and Perez, 1997). While average yields per hectare have increased, unfortunately, irrigation projects continue to scale back or close, require significant operational subsidies, redistribute income away from the poorest, and/or have high rates of farmer turn-over from eviction due to non-payment of irrigation fees.²

Based on food trade and production projections made by the Institute for Water Management Institute, if Mali were to increase the total land area served by productive irrigation systems by 33% before 2020 (the most optimistic scenario modeled), it would still be unable to meet food security goals. Specific policy attention would be needed to direct the benefits of the expanded production toward meeting food security and poverty alleviation goals (Rosegrant and Perez, 1997).

The two cases reviewed share four significant characteristics that warrant their joint review in this paper. First, international donors are seeking to expand irrigation projects in both areas of Mali with the objective of advancing rural development; financial cost recovery is a key tactical objective this strategy. Second, both projects are implemented on government-owned land; farmers have usufruct rights conditioned on irrigation-fee payment. Third, both projects rely on representational organizations to design projects' pricing strategies. Fourth, both systems are plagued by high eviction rates of farmers who are unable to pay required irrigation fees, often affecting the poorest/highest risk farmers in the community.

² Despite these problems, significant private and international investments are still being made in the Office du Niger; the Schaeffer sugar cane project at Markala and targeted Millennium Challenge Account funds are among them.

The case studies are based on a series of structured and unstructured interviews with farmers, researchers, donors, and organizational leaders (government and user organizations) and review of various research and government reports. The interviews were conducted as part of an effort to inform the development of survey questions to be used for a review of West African irrigation-pricing strategies.

Interviews helped to identify critical pricing issues that needed to be addressed by the survey. Initial interview questions were largely influenced by Ostrom (1992), Chambers (1980), and Johansson (2000) among others. From interview to interview, the guide changed to reflect issues raised by prior interviewees. A final list of suggested survey questions is in Appendix I. It is intended to be an interview guide only and not a questionnaire to be followed verbatim.

Interviews were limited by language and opportunities to conduct fieldwork. As a result, there is bias due to the fact that (with very few exceptions) I interviewed people who spoke French and who were selected as representatives by a donor, research, or government agency. In the paper I identify illiteracy, innumeracy, and lack of French language skills as contributing factors to farmers' relative disadvantage in bargaining, contracting and enforcement. I was unable to discuss directly with non-francophone farmers some of the strategies they may have developed to overcome these obstacles.

The interview guide was designed to engage three types of stakeholders for each project being studied – farmers, irrigation system administrators, and farmers organizations. I was able to interview at least two subjects in each category for each case study.

In the ON, I conducted formal interviews and was also able to attend otherwise-organized meetings intended to collect opinions and feedback from various stakeholders about the *Office* pricing strategy.

PPIV systems are not organized as clearly as the ON along the lines of administrators, users, and organizations. Formal interviews were conducted with three government officials from the *Office du Riz Mopti (ORM)* and one ORM PPIV farmer who was also the president of his village PPIV advisory committee. I was also able to conduct three panel interviews – one with agricultural extensionists and farmers who were also elected farmer representatives (*Valorisation des Ressources en Eau de Surface - VRES*); one with donor agency professionals (*Action pour la Formation et l'Autopromotion Rurale – AFAR, VRES*); and one with diesel motor pump mechanics and extensionists (*Association des Volontaires pour le Developpement du Delta - AVD*). Additional individual interviews were conducted with irrigation sector professionals including two interviews and a field visit/farmer interview with the director and founder of AVD, a mechanic from a private garage that services the region's motorpumps, and a Malian economist working on irrigation research.

In both cases, farmers were the most difficult to schedule for interviews; government officials were easiest to access – another source of informational bias. In most cases, I was able to informally pose many of the interview guide questions to farmers, researchers, and irrigation professionals in other organizational meetings or during casual conversations. Verifying and background information was attained from government, donor, and organization reports and professionals.

Section 2 summarizes relevant economic concepts and theory. It begins with a basic description of irrigation-pricing strategy components, objectives, and contextual considerations (2.1). It then provides a review of the institutional economic theory used to analyze the two cases (2.2). In section three, a general description of irrigated agriculture in Mali, including national strategic objectives is reviewed. This is followed by the description and analysis of each of the case studies, first the *Office du Niger* and then the *PPIVs*. Finally, the argument is reevaluated in light of the two cases and questions for further research are raised.

2 IRRIGATION PRICING AND THEORETICAL LITERATURE REVIEW

2.1 Irrigation Pricing

Water pricing is a general term that is often used to describe the pricing of water delivery services - household or agricultural. When applied to irrigation, water pricing generally refers to the pricing of two economic goods: 1) water delivery services (timing, location, and quality of delivery service); and 2) the water being delivered, usually by quantity, but sometimes in terms of water quality also.³ In this paper, because Mali does not charge fees for extraction, diversion or pollution of water resources, the term *irrigation pricing* is used rather than *water pricing* to avoid misconceptions about what goods are being priced.⁴ Prices may be paid in cash, labor, percentage or fixed value of crop production, and/or any combination of these goods.

An irrigation-pricing policy can be considered a *strategy* designed to advance certain policy objectives. The strategy has three interrelated components. They are the *price structure*, the *price level*, and the *sanction system*. *Price structure* determines the bases on which fees are assessed to users (e.g., per hectare of land irrigated, per cubic meter of water used, according to crop type, etc.). The *price level* refers to the price set

³ The two goods are complementary in agriculture. The financial value water is higher if delivery service is reliable and meets demand, and where water is scarce, reliable irrigation services have higher value. The values of delivery services and water can also be related to the value of the crops being irrigated, other related production costs (such as land and fertilizer), and the relative demand for water in other sectors or in downstream regions.

⁴ The Malian water law changed in 2002 to generally require permission and payment for water extraction, diversion, and pollution, but no implementation plan has been designed or implemented. I did not find anyone outside the Ministry of Water Resources who was even aware of the law change. I was able to identify only one case in West Africa of pricing water resources. The Government of Senegal charges SAUR, a private company with a contract to supply drinking water services to a number of cities in the country, for the quantity of fresh water that is piped into the Dakar area. Fees paid by consumers cover both the cost of water and the cost agriculture in and around Dakar. Mali is still working on surveying its existing water resources and developing international agreements regarding shared river basins, which would help establish the quantity of water supply each country has a right to use/sell. Moving forward at the international/regional levels may be a useful precursor to promoting water resource pricing at local levels.

after the criteria or units of consumption are established. Often price structures are relatively fixed over time while price levels vary with changing costs and/or political tides.

A third component of water pricing strategies is the design of *sanctions* for behaviors that violate the pricing strategy. Sanctions can be formal and/or informal. Fines, fees, loss of rights are examples of formal sanctions of non-payment. Public criticism, boycott, and withholding cooperation, are examples of informal sanctioning by farmers who pay fees but do not receive the agreed-upon service (Ostrom, et al. 1994). In both cases reviewed, formal pricing-policy sanctions are downwardly applied to ensure user compliance with payment policy through threat of eviction for non-payment. No sanctions exist to ensure management compliance with service-provision responsibilities; compliance measures are limited to institutions that promote transparency, coupled only with electoral pressure in some cases.

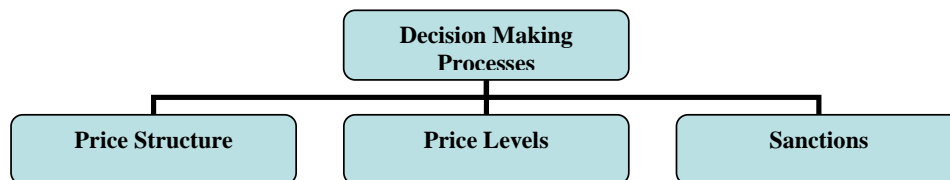


Figure 1: Components of a Price Strategy

Each component of the strategy is an institution that is defined by *decision-making institutions* or rules. Ostrom (1994) identifies three levels of rule formation through decision making, as follows: *operational rules* affect day-to-day decisions made by participants; *collective-choice rules* affect operational activities in by determining who

is eligible to participate in operational rule-making and how operational rules are made; *constitutional choice rules* determine eligibility and procedures for collective choice rule-making.

The objectives of pricing policies are also established through a decision-making process. Objectives are likely to include *cost recovery*, *demand management*, *allocative efficiency*, and/or *income distribution* (Johansson, 2001).

Cost recovery refers to users' payment of the financial costs⁵ of water delivery services and, where relevant, financial costs associated with water extraction or diversion rights. Decisions are made explicitly or implicitly to determine which/whose financial costs will count in the cost-recovery accounting. For example, the cost of building livestock access points is increasingly accepted as part of the price of building irrigation canals and is not passed onto herdsmen.⁶ Pesticide application may damage natural fisheries at the expense of fishermen. Total costs and their distribution may vary based on trade-offs between the level of fixed costs and level of O&M costs – important particularly when different groups are paying for different costs. Finally, there can also be a tradeoff between management and organizational development costs and costs of physical construction and O&M.

Demand management occurs if users are encouraged to invest in water and/or land conservation efforts in order to lower the irrigation price they pay. If irrigation services

⁵ There are usually additional economic costs associated with irrigation systems that have not been internalized into the financial cost structure of the irrigation system. Farmers may still pay these costs, however. For example, increased health problems may be associated with irrigation techniques. Farmers and their families may pay related costs in terms of increased health care but this cost is not internalized into the financial cost of the water.

⁶ Livestock degrade canal walls when being watered. Designing specific access points decreases overall damage from livestock and localizes the damage to fewer places, improving system managers' ability to keep track of degradation and rehabilitate as necessary, lowering damages and O&M costs. Similarly, villagers use canal water for washing, bathing, water collection etc. Steep earthen canal walls quickly erode under the heavy traffic and cause degradation of the entire canal system. Building concrete stairs provides a safer and less damaging means of access to canal water. In both cases, enforcement costs of managing access to irrigation water would be more costly than investing in access point construction.

are priced by cubic meter of water delivered, water-saving practices may be implemented. If services are priced by hectare, increased efforts to intensify production per hectare may result (which would likely reduce infrastructure costs and water used per unit of output). Demand-management pricing is complemented by extension services that provide farmers with training to evaluate alternative water-saving production strategies.

Allocative efficiency usually refers to prices that vary with the dynamic value of the good being allocated so that buyers make use decisions in reaction to changing values. Inability to rent land and obstacles to crop diversification can limit farmers' ability to respond to irrigation price signals.

An *efficient* allocation is defined in relation to the objective sought and by how property rights (the rules of exchange) are allocated. Food security, poverty reduction and economic development are part of Mali's objective function. Allocations that generate high financial returns but detract from other objectives may not be efficient with respect to advancing identified objectives.

Income distribution impacts can be analyzed at various levels: among farmers in an irrigated perimeter, among farmers in a watershed, and among multiple/diverse water resource users in a region. A variety of factors influence cost distribution. Choice of costs to be recovered, criteria upon which prices are based (per hectare, per unit of water delivered, etc.), and design of sanctioning systems could each affect income distribution. In tiered or block pricing, the definition of user classifications or blocks can influence income distribution.

The objectives listed above are not mutually exclusive; strategies may aim to meet combinations of objectives depending on a region's development and political priorities.

An irrigation-pricing strategy should be tailored for system-specific characteristics of variables including: *water supply* (water quality, accessibility of water – depth and distance to site of use, variability of flow or precipitation by season or year, effects of upstream water use practices); *distribution systems* (systems have different infrastructure and human resource management needs and capacities); and *user and management demographics and organization* (diversity of farmer capacities, holding size variability, cash/credit and labor availability, technical and managerial capacities, history of cooperative management or corruption, etc.). Best practices for irrigation pricing irrigation will vary by situation and over time. As a result, decision makers' ability to assess and respond to changing situational conditions at all levels is paramount to irrigation system sustainability.

How decisions are made and who is included in those decisions determines how the issues listed above are reflected in the pricing strategy. The decision-making process defines whose interests are considered in the objective function. The process also influences the degree of stakeholder buy-in to the rules produced, the degree to which stakeholders have been able to contribute information and opinion, and the degree to which innovative solutions have been applied to existing problems. Decisions shape and are shaped by formal and informal institutions which frame the relationships between/among various decision makers. This, in turn, affects how stakeholders respond to, invest in, and comply with formal rules or institutions.

2.2 Institutional Economic Theory: Prices, Costs, and Decision-Making

Both irrigation-pricing strategies described in the following section are designed to be tactics to achieve irrigation system cost recovery and financial sustainability. The nature of a pricing strategy's treatment of cost recovery can be addressed by exploring three questions: 1) What are the costs of production? 2) Which costs of production are internalized into the formal price? 3) How are those costs distributed?

This section reviews institutional theory that regards costs as a function of endogenous factors including ingenuity and organizational learning. It supports the argument that decision-making processes influence the distribution *and absolute levels* of cost and benefit flows in the medium and long-run. The second part of this section considers the relationship between decision-making processes and cost. It explores how formal and informal relationships between service users and service providers define incentives and disincentives for parties to invest in producing effort and creative problem solving or ingenuity. It also addresses the problem of ingenuity being applied by different parties to achieve conflicting goals and how institutions can be designed to realign incentives to serve common goals despite parties' opposing interests.

2.2.1 Costs: Samuels and Schmid (1997) explain that a notion of real costs - broadly referring to the costs of production - is misleading. The authors explain that costs of physical factors of production (in irrigated rice production - fertilizer, equipment, delivered water, labor, seeds, etc.) are actually a function of technology, and that technology, in turn, is a function of "creative imagination, invention, and application." Institutions affect which physical costs are internalized into the market as "real costs" of production; they influence the price levels of physical costs as a result of

the ways in which contracting, information, and enforcement alter the price of acquiring a set of goods and services, and finally physical costs of transformation can be reduced if decision-makers are inspired to think creatively about how to solve problems and reduce costs. Institutions can increase investment in creative problem solving through the design of financial or social incentives.

Paul Romer examines the role of knowledge as an endogenous factor of economic growth, the level of which partially determines an economy's steady state. "Ideas are the designs that allow us to make limited physical resources ever more valuable (Romer, 1990, Romer, 1994)."⁷ He emphasizes the non-rival and non-excludable characteristics of knowledge, a key factor of production that fuels technological change, and suggests that institutions must be designed to increase incentives for its production and application.⁸

Thomas Homer-Dixon (1995) considers the contribution of technology to productivity and clarifies that ideas do not have to be new, just practical. He defines *ingenuity* as the ability of people *and organizations* to develop and apply ideas, solutions, and institutions to problem solving. Homer-Dixon (1994) notes, "Just as important are ideas about social organization, especially about reforming and building institutions." Where technical ingenuity can reduce physical transformation costs and problems, social ingenuity can change the costs and benefits associated with specific institutions. The two

⁷ It is worth noting that good designs can also make limited *financial* resources ever more valuable – incredibly important for those attempting to irrigate with a decreasing availability of investment funds. Purchase prices of physical inputs can be reduced depending on the effort or ingenuity used to acquire them (whether each person purchases inputs separately, can organize purchasing cooperatives, can bargain and contract effectively, can buy when supply is high vs. low, etc.).

⁸ In *Rules, Games and Common-Pool Resources*, Ostrom also characterizes rules as public goods – high exclusion costs goods for which improvement requires high fixed costs and often results in free riding. (Ostrom, et al., 1994).

factors are inseparably produced and consumed. For example, production of technological ingenuity in communications can facilitate social ingenuity through the expanded exchange of ideas and information, which can in turn generate additional technological ideas and designs.

Resource scarcity can increase the severity and complexity of technological and social problems; this accordingly increases the demand for ingenuity.⁹ Homer-Dixon, notes four situations that constrain supply in response to increased demand: market failure, capital shortages in particular, social friction, and constraints on science.

- *Market failure* occurs when the scarcity value of a good and other associated costs of use are not reflected in market prices due to poorly defined property rights, time lags, lack of information and uncertainty, etc. Ingenuity may be further underprovided because of its non-rival, high exclusion cost nature, which requires institutional measures to rearrange incentives (e.g., *administrative solutions* – public provision and taxation; *status* – receiving public recognition or learning to value achievements outside of markets; *contracts* – designing contractual incentives to produce and apply ideas, such as patents (Schmid, 2004)).
- *Capital shortages* are one type of market constraint that disrupts economic agents' ability to make rational decisions about the allocation of resources. Capital shortages can promote short-term planning and temporary immediate solution-oriented thinking rather than long-term adaptive planning for resource management.

⁹ Homer-Dixon focuses primarily on natural resource scarcity. He further specifies that renewable resource scarcity requires more ingenuity than non-renewable scarcity due to the complex problems of non-convexities, sudden shocks, tipping points, interactive effects within ecological systems, and uncertainty. In the case of irrigation in Mali, food scarcity, labor scarcity, and investment and finance scarcity also become complex problems that require social ingenuity. Similar analyses in which institutional factors and knowledge production are endogenous to economic systems include cumulative-causation analysis and path dependency including Myrdal, North, and Hodgson among others.

- *Social friction* occurs when small interest groups organize themselves to influence institutions to redistribute wealth and property rights rather than to increase wealth and economic growth (Olson, 1982). Scarcity and changes in relative prices can increase incentives to change institutions in ways that allow them to reassign the distribution of costs and benefits (North, 1990). Homer-Dixon regards this as a shortfall of ingenuity. Special interests, however, also rely on ingenuity to solve problems through institutional reform, but benefits sought are often redistributive and not necessarily growth-oriented.
- *Science is constrained* when there is a limited capacity to understand, apply, and build upon existing ideas. This can occur when capital shortages and institutions result in constrained investment in education and research, if resource scarcity exacerbates the quantity and complexity of problems, or if social conflict moves discussion and investment away from science in order to advance special interests.

Outside organizations can play a particularly important role when resource scarcity constrains the supply of ingenuity as a result of the above factors.

Geoffrey Hodgson (1999) argues, “Production costs cannot be independent of social relations.” In 1998, he explained, “prices are social conventions, reinforced by habits embedded in specific institutions... theories of price must be in part, a theory of ideas, expectations, habits, and institutions involving routines and processes of valuation” (Hodgson, 1998). Ingenuity is not only a good stored by individuals but also accumulated and directed by governing organizations. The capacity of organizations to encourage and guide ingenuity toward commonly-defined goals of productivity and problem solving is greater than the sum of their members’ contributions, and benefits are greater than simply reduced transaction costs.

Geoffrey Hodgson (1999) emphasizes the role of collective learning. “Learning is more than the acquisition of information; it is the development of the modes and means of calculation and assessment... the skills of workers and managers are enlarged as they learn.” He quotes Winter (1988) as saying, “the learning experience is a shared experience of organizational members... thus even if the contents of the organization are stored only in the form of memory traces in the memories of individual members, it is still an organizational knowledge in the sense that the fragment stored by each individual member is not fully meaningful or effective except in the context provided by the fragments of the other members.”

Costs are also influenced by how culture or informal institutions of an organization shape members preferences, beliefs and values for productivity and collaboration – particularly where formal institutions are weak. Lam (2001) identifies a culture of trust and social cohesion as the distinguishing factor in Taiwanese irrigation organizations’ successful adaptation to rapid change in the 1990s. Organizations amended institutions in order to eliminate perverse incentives and to align individual and collective interests despite the high fixed and high exclusion cost nature of investment in rule reform. (Lam does not make recommendations for developing trust as the *status quo* where it does not yet exist.)

Just as ingenuity can be used by special interests to alter institutions for redistributive gain in ways that reduce or slow growth, learning can also be counterproductive to achieving identified goals. Groups can learn disempowerment or entitlement. Similarly, where there is a learned expectation of continued government or NGO provision of services, financial independence may not be prioritized. Decisions to

make cost-saving long-run investments can be hampered by the perception that a project will be discontinued or changed unexpectedly or if expectations of retaining land access are uncertain.

Particularly in situations where change is occurring quickly and unpredictably, prioritizing investment in physical factors of production for prescriptive technological solutions over or without adequate attention to investment in the development of ingenuity could increase long-run costs and sacrifice system productivity and flexibility. Research is needed to understand better the role of social and technological ingenuity as complementary and sometimes substitute goods for financial investment in physical factors of production. Research is also needed to understand/design decision-making and price institutions that provide better incentives for the development of ingenuity at an individual *and* organizational level.

2.2.2 Decision Making: The second and third cost questions - what and whose costs are recovered by prices and how those costs will be distributed – are determined by who is included in decision-making arrangements and how. The design of the decision-making process in pricing strategies can have significant implications for total cost and benefit levels and can influence whether cost-recovery tactics undermine or advance the greater national objectives of poverty alleviation.

Samuels and Schmid (1997) write, “The economy is a decision-making or choice process...Power is the effective participation in decision making to make one’s interests count when they conflict with others.” The interaction between formal and informal institutions, particularly at the collective-choice level, determines the nature of different stakeholders’ participation in decision-making, and it is the nature of their involvement

that shapes the outcomes of decisions – in particular, which costs will be recovered by prices and how those costs will be distributed among beneficiaries of services. The authors explain that stakeholders function together in an economic system with the following four elements:

1. *Opportunity Sets*: available alternatives lines of action or choices, open to an individual, each with a relative opportunity cost.
2. *Power*: effective participation in decision making to make one's interests count when they conflict with those of others; the means or capacity with which to exercise choice.
3. *Coercion*: impact of the behavior and choices of others upon the content of one's opportunity set.
4. *Working rules*: rules of law, custom, morality, and so on, governing access to and use of power (formal and informal).

The authors add that, “culture and power influence individual preferences, organizational preferences, and the creative activity that is either encouraged or prohibited.” An analysis of how Malian cultural institutions influence pricing institutions is well beyond the scope of this paper, but many incentives and disincentives can be teased out of the pricing strategies by examining stakeholders relationships to one another.

Non-cooperation or lack of creative effort can increase transaction costs and increase rates of resource depletion, deterioration, and misuse, thereby increasing physical transformation costs. Baland and Platteau (1999) apply game theory to a series of regulated and unregulated common pool resource cases. They find that as inequality increases, the cost to regulatory agencies to implement and enforce appropriation and

provision rules increases. They note that exclusion of stakeholder groups can undermine the effectiveness of administrative and regulatory agencies, particularly if the marginalized groups are expected to cooperate with established rules and invest effort into common productivity goals.

Meinzen-Dick et al. (2002) note that inadequate participation can increase project costs when nominal representation is used to pass on responsibilities without decision-making rights or buy-in; also costs can increase when rights and responsibilities are devolved insufficient implementation capacity – this may be insufficient financial, informational or enforcement capacity.

Participation in a decision-making process can be costly; results of participation can be positive, absent, or negative. Rules can be designed to incentivize participation and protect participants from potential negative ramifications (even if the negative is simply the cost of participation measured against low prospects for positive gain). Finally rules can sometimes be designed to align competing interests' to work toward the same goals. In this case, participation of all parties is particularly encouraged and often necessary for the rule structure to result in the desired performance of all parties.

In both irrigation cases reviewed, certain aspects of the decision-making processes that determine costs and prices can be framed as principal-agent games in which there is a situation of necessary interdependence between a principal (or resource owner) and an agent (resource manager) who have objectives that are in conflict with one another. Well-designed operational and procedural institutions can result in both principal and agent working toward the same goal to maximize their own gain (a perfect example of this is in the rule structure of the *Garage Moderne* in the second case study of

PPIVs). In situations of significantly asymmetrical power, rule design may have to be combined with sufficient support (one-time or continuous) for disadvantaged parties to be able to act on rule-based incentives. To properly design institutions and support programs, the sources and implications of asymmetrical power must be identified.

Increasing agricultural productivity is a priority for advancing economic growth in rural-based economies like Mali. Poverty reduction is largely assumed to result from rural economic growth (via trickle-down multiplier effects) or through targeted projects and safety-net policies and programs (Jayne et al. 2003). Others authors argue that economic growth is a necessary but insufficient condition for poverty reduction, and that all stakeholders' participation must be effectively mainstreamed into project design if poverty alleviation and fairness are to be institutionalized and result in long-run sustainable economic growth (Lam, 2001, van Koppen, 1998).

Beck and Nesmith (2001) examine the relationship between vulnerable populations within communities and access to common pool resources (CPRs). Vulnerable populations are often most reliant on CPRs for their livelihoods, and they often have the least access to effective participation in making decisions. Marginalization can occur intentionally in an effort to redistribute rights and wealth or unintentionally due to bias; vulnerable groups can be marginalized because they lack specific skills (e.g., literacy and having colonial language skills) or because their knowledge, experiences and opinions are not respected.¹⁰

¹⁰ Bina Agarwal (2001) finds that inadequate participation of women increases depletion of resources, increases costs of resource protection and rule enforcement, and reduces fairness or perceived fairness of rules. Agarwal identifies factors that affected inequity as social perceptions and norms, rules of entry, and personal or household attributes and endowments. She stresses that disempowering perceptions and beliefs held by the women and by those who excluded them were not always well founded, but that lack of

Jayne et al. (2001) find that community-driven approaches to development require serious attention to distribution of resources. Their attempts to explain landholding size in five African countries using variables such as household size and assets - the formal criteria on which agricultural land is often distributed - did not demonstrate consistently strong explanatory power. The authors identify local-level kinship ties and power relationships to be important factors in local governance decisions missed by their model. They note that such factors have implications for decentralization strategies that aim to reduce poverty and suggest transparency as an important area of focus.

Institutions to promote transparency, however, may be insufficient if marginalized groups cannot use available information for purposes of upward accountability. Illiteracy, disempowerment, and lack of support from outside a locally corrupt system can all undermine effective use of available information. Reversing this trend requires that development initiatives identify, target, and mainstream these marginalized groups to develop their assets, negotiation skills, and enforcement/accountability options.

interactive participation opportunities reinforced such beliefs. She finds that mandated inclusion of vulnerable groups through constitutional rules is an important but insufficient step.

3 OVERVIEW OF IRRIGATION IN MALI

Section three provides a description the state of irrigation in Mali. The section also identifies the national laws and policies that define objectives for public involvement in the agriculture sector and promotion of irrigated agriculture specifically. This section is followed by the two Malian case studies, the *Office du Niger*, in section four and the case of small, irrigated village perimeters (PPIVs) in section five. A description of price strategy components – price levels, price structure, and sanctions – is provided for each case along with analysis of relevant cost and decision related issues

Mali is rich in water resources and economically dependent on agriculture production. Benefiting from both the Senegal and Niger River Basins, a 1982 UNDP statistic is often cited indicating that 2.2 million hectares of land could be irrigated if the proper infrastructure were developed.

This figure is misleading. The true potential of land and water resources is unknown and would vary depending on the type of irrigation system used, on other land and water-use demands in Mali and in up and downstream countries, and on the agricultural practices applied. The UNDP figure does not account for growing water demands in countries upstream and downstream from Mali or for minimum flows needed to maintain ecological services such as pollutant dilution and eutrophication prevention. As seasonal floods of the Niger crest later and lower each year, increasing productivity of diversions becomes more important and requires increased water control (ARD, 2002).

It is generally agreed, however, that the estimated 418,313 currently-irrigated hectares in Mali represent only a fraction of the country's irrigation potential. Additionally, agriculture on much of the land currently irrigated could be intensified to

increase yield per drop, yield per CFA franc (the regional currency), and yield per hectare.

Mali is divided into four climatic zones and has three main approaches to water control. The four climatic zones slice the country laterally, moving from the greatest rainfall in the south (two southern zones combined represent 18% of Mali's land and have growing seasons of 160 days) to the least rainfall in the desert north (51% of Mali's land, growing season less than 15 days).¹¹ The interior zone, which includes the inland delta of the River Niger, makes up 26% of the land in Mali and has a highly variable growing season (15 to 100 days). The *Office du Niger* lies in the inland delta; the small, irrigated village perimeters (PPIVs) are located primarily along the Niger River in Mopti, Gao, and Tombouctou.

Water-control technologies are classified by degree into four categories. Both cases in this paper are considered total water control. Total water control is one of the two priority approaches in the National Irrigation Development Strategy (SNDI) based on *potential* to deliver maximum increases in yield per hectare, yield per m³ of water diverted, and poverty-reduction benefits.

Irrigation has not been the anticipated productivity panacea, unfortunately. The National Sub-Sector Strategy for Irrigation Development (1999) reports 60,000 of 418,313 hectares of land with irrigation infrastructure have been abandoned due to deteriorated soils or infrastructure. In 2004, nearly 16% of the smallest, most vulnerable landholders in the *Office du Niger* were permanently evicted from their parcels after a

¹¹ Soudano Guinean, 6%, 1200 millimeters rain/year, growing season 160 days, rainfed agriculture; Soudanian, 12%, 600-1200 millimeters of rain/year, growing season 100-160, rainfed with irrigated supplementary agriculture; Sahelian, 26%, 200-600 millimeters rain/year, growing season 15-100 days, irrigation primary, rainfed supplementary; Saharan, 51%, less than 200 millimeters, growing season less than 15 days, irrigation necessary.

single uncharacteristically bad season. Of approximately 1,600 hectares of land developed into PPIVs under a European Union/World Bank project, only 52% are currently operational; this project continues, nonetheless, to develop new perimeters to meet its 2007 goal of at least developing irrigation systems on 2,500 hectares.

A nation's development plans can be analyzed at three levels – the vision, the strategies to achieve the vision, and the tactics to implement the strategy (Staatz, 1994). The National Sub-Sector Strategy for Irrigation Development (SNDI), written in April 1999, is intended to “develop a coherent sub-sector strategy to guide national irrigation policy specifically and the use of water resources in general... in a manner compliant with national strategies for rural and agriculture development, accelerated economic growth, and poverty reduction” (p 5). Specific implementation tactics are to be guided by the visions and strategies of sector development plans - the Rural Infrastructure Development Plan (2000), the Food Security Plan (2003), the National Environmental Plan (1998), and the Decentralization Mission (1993) specifically.

SNDI strategic objectives are summarized as follows:

- The promotion of food security through increased sustainable irrigated agricultural production, particularly in the North, where rainfed production is not an option;
- Improvement of nutritional status of vulnerable populations, particularly women and children;
- Promotion of a rural economy oriented toward reducing agricultural imports and increasing agricultural exports;
- Rural income growth;
- Reduction of internal migration and emigration patterns.

The SNDI and World Bank/Government of Mali National Rural Infrastructure Program (PNIR), published in 2000, specifically address the issue of irrigation pricing. The SNDI indirectly mandates financial cost-recovery pricing of system operations and maintenance by limiting the State's investment role to one of supporting initial infrastructure investments where such investments surpass communes' or irrigation users' ability to pay (pp. 35-36). Fees (at a minimum) are to recover operation and maintenance financial costs, and collection efforts are to be improved.

SNDI Annex III cites an FAO study indicating that PPIVs are sufficiently profitable to allow 100% recovery of initial investments through irrigation fees; the same analysis shows ON farmers to have the financial capacity to pay 61-93% of land development or rehabilitation costs (it is not specified, but assumed that this refers to secondary and tertiary canal investment and land leveling costs).

The SNDI details a plan for a system of "New Irrigation Fees." Fees are suggested to be 20% of the estimated minimum gross income per hectare for various perimeters throughout the country. Fees are to be adjusted periodically according to changes in average yields and average paddy prices.¹² Line-item accounting for use of collected funds is encouraged but not mandated.

The New Irrigation Fees are presented as a guideline for maximum fees chargeable based on ability to pay rather than cost of delivery. Each perimeter is encouraged to negotiate actual fees applied. When compared with fees being charged in existing perimeters, New Irrigation Fee guidelines all exceed current irrigation fee rates

¹² This is based on the fact that the majority of irrigated land in Mali was used for rice production at the time the SNDI was drafted. Crop diversification is an objective of the ON, and land there and in other perimeters is increasingly being used for crops including sugarcane, tomatoes, and onions.

(in the ON, suggested fees were 80,000 CFAF/ha and actual fees were 43,000 CFAF/ha in 1999). No guidance is provided for situations in which costs exceed 20% of the minimum gross income per hectare.

According to the SNDI, irrigation fees for PPIVs are to remain below 100,000 CFAF/ha (in 1999 CFAF). This figure was estimated to be the limit of farmers' ability to pay and sufficient to cover all diesel motor pumps (*groupe motopompe* – GMPs, used to pump water from the Niger into river-side rice fields) and associated irrigation costs. It was noted that PPIVs' fees per season are easier to link to itemized costs per hectare and should therefore be set at the perimeter level.

The PNIR targets irrigation investments toward the ON and PPIVs (through the National and Regional Directorates for Rural Works and Equipment - DNAER, DRAER). With respect to pricing in the ON, the program mandates a shift of responsibility for primary infrastructure O&M costs from the State to ON farmers. Half of these additional costs to farmers are to be recovered through higher irrigation fees and the other 50% through new fees collected from expanded perimeters. Small-scale ON farmers are expected to pay for tertiary development costs and any necessary pump equipment (primarily used in the dry season by vegetable farmers); medium and large-scale investors are to cover secondary and tertiary canal development costs – requiring an estimated 12% increase in productivity per hectare.

PNIR Phase I did not outline explicit pricing guidelines for PPIVs. Partner NGOs were to establish pilot cost-recovery based pricing along with capacity /institution-building programs for local irrigation decision makers.

4 CASE 1: THE OFFICE DU NIGER

The *Office du Niger* (ON), or Niger River Authority, is located in central Mali's inner delta, a large alluvial flood plain of the Niger River. When originally planned, in 1929, the project was to irrigate over a million hectares. Today, conservative estimates put the upper limit closer to 200,000 hectares. Currently, the canals of the *Office* irrigate 70,682 hectares during the growing season (2004).

In the late 1980s, the Government of Mali and international donors embarked on a mission to take the colonial-era parastatal in disarray and transform it into a proverbial ricebasket for West Africa. At the time, yields per hectare were steadily falling and farmers were abandoning salinized and otherwise degraded parcels.

During the Structural Adjustment-era reforms, donors insisted on 100% cost-recovery pricing for the costs of O&M on primary and secondary canals and land administration, with at least 98% collection rates. Farmers' exchanged acceptance of rate increases for increased transparency regarding management's use of collected fees (Aw and Diemer, unpublished). Farmers gained the right to participate in certain maintenance decisions and gained greater tenure security; officially, only non-payment of irrigation fees or non-cultivation of the plot results in eviction.

The Government of Mali (GOM) relinquished total control over the ON, developing it into a quasi-independent administrative authority to be governed by a State-ON-farmer contract-plan (CP) that governs the water pricing strategy among other rules.

A number of factors contributed to production increases of 200-300% per hectare in many zones (zones are the administrative districts of the ON; there are six). Among them were extensive institutional reforms in the ON and financing of network

expansion and rehabilitation launched in the 1980s. Rice marketing reforms and the 1994 devaluation both contributed to an increased profitability of production, which generated incentives to intensify production. Average parcel size declined dramatically, falling from 4 to 2 ha between 1995-2002 as the population nearly doubled in the same seven years; in 2002, 34% of farmers held less than 2 hectares, and increasingly parcels of less than .5 hectare are being distributed (Fall, et al. 2004).¹³ Intensification and double cropping (growing in both the rainy and dry seasons) have counteracted some income effects of the shrinking average parcel sizes.

Current objectives of the *Office du Niger* include intensification of production per hectare, extension of the network, diversification of production – currently dominated by rice – poverty reduction, increased dry-season production, and increased private investment according to the ON *Etude du Schema Directeur* (2002).

4.1 Pricing Objective

The *Office du Niger* charges all farmers on ON land a *redevance eau*, translated as the water fee. Although it is called the water fee, payment buys access to land, water, and water delivery.¹⁴ The primary *objective* of the ON irrigation fee is to recover select financial costs of the irrigation system. Bi-annual reports on the fee continually identify the need to implement demand management incentives. Excessive water use can reduce crop productivity, increases O&M costs, and limits potential expansion of the network, resulting in higher price levels per hectare.

¹³ Even given these small parcel sizes, distribution of land is based on criteria that are intended to distribute land to farmers with the greatest means for production such as family size and productive assets.

¹⁴ For consistency with the rest of the paper, it is referred to as the irrigation fee.

4.2 Price level

Total fees collected must equal total costs to be recovered. Total costs are divided among farmers using the price structure (3.3.3). A reassessment of costs to be recovered is conducted before the renewal of each two-year Contract-Plan. Financial costs to be recovered by the irrigation *redevance* include the costs of operation and maintenance (O&M) of primary and secondary canals, certain pest control costs, certain administration costs, and other costs as determined by ON-Farmer Joint Committees for the Management of Funds for Secondary Canal Maintenance (CPGFE - receives and manages 50% of collected funds). O&M for certain primary structures such as the main Markala Dam are excluded because of their large capacity relative to the actual number of hectares served. Fixed costs and infrastructure depreciation are excluded from the irrigation fee to avoid farmers' claim to ownership of the system the implications of which would complicate parcel evictions.¹⁵ Depreciation of machinery purchased for maintenance work is included.

In 2004, the highest fee per hectare was worth approximately 0.4 tons of rice. Irrigated yields were approximately 6 t/ha; without irrigation, average yields were 3 t/ha. By these rough figures, the value added from using irrigation services *on average*

¹⁵ Land tenure arrangements are usufruct rights granted for one, 30, 50, or an indeterminate number of years. Plots can be inherited or divided by user, but cannot be *legally* leased or sold. Eviction is allowed on the basis of non-payment of irrigation fees or non-cultivation. Problems with non-maintenance of tertiary canals are to be dealt with by organizing tertiary canal committees. The contract states that non-contribution to these committees will be dealt with by eviction, but this is a debated policy since most benefits would be from improved drainage but even these effects would be limited since secondary drainage is not well maintained. No land use fees are paid to the ON distinctly from irrigation fees. Rights to ON housing are permanent even if evicted from plot. Illegal land leasing takes place fairly openly. Because the scarcity value of the land and the value of negative externalities resulting from intensification are not included in the water use fee, demand for plots exceeds supply (it is worth noting that the scarcity value of land in part a function of the price of access to land, which is related to the *redevance* itself in this case.

surpasses the price of irrigation services (by 2.6 tons/ha). The cost-benefit margins vary by farmer and by land and irrigation service quality. They also vary by year, as input costs and output prices change significantly from year to year depending on ON and farmer coop marketing and purchasing practices, transportation issues, farmer's access to credit and storage, and world/regional prices. Farmers who have access to credit, storage, education, and better land will consistently have an advantage over those whose access is limited.¹⁶

Variation notwithstanding, consultant, donor, and state research shows the irrigation price levels above to be feasible in terms of average ability-to-pay and in terms of cost recovery (ECOFOR-SARL, 2004, 1999, 2002, 2004, Gaddis, 2002, Francois, 2004, Fall, et al. 2004). There is no crop risk insurance or well-defined emergency system for events of below-average productivity. Bills are distributed at the end of the growing season, and payment, in cash, is due within six months.

4.3 Price structure

The structure of the ON irrigation fee determines the distribution of total costs among different classifications services provided. The ON fee is a function of certain O&M costs, season (rainy or dry, reflecting water scarcity), the crop cultivated (rice or other, reflecting estimated consumptive water use), the class of land irrigated as determined by its level of network rehabilitation (I-III, reflecting value added). Fees do not vary by distance from road, by zone, by soil/land quality, or by quantity of water used. Starting in 2005, class I growing season fees will be the base fee (100%) and fees for all others classifications will be set as a relative percentage.

¹⁶ That there is a waiting list for distribution of all classes of land and that farmers are willing to farm informally out of network (where there is abandoned or no network yet) indicates potential profitability of parcels.

$$\text{Fee} = f(\text{Costs, Season, Crop, Land Class})$$

As a result, there are seven fees paid per hectare. Below are these fees for the years 2001-2007.

Table 1 Irrigation Fees (CFAF/Hectare) ¹⁷

Fee Classification	2001-2002	2002-2003	2003-2005	2005-07
Class I (rehabilitated network)				
Rice Growing Season	63 500	65 300	65 300	67 000
Vegetable Growing Season	63 500	56 700	56 700	56 950
Class II (partially rehabilitated network)				
Rice Growing Season	54 500	56 700	56 700	56 950
Vegetable Growing Season	54 500	44 500	44 500	37 520
Class III (non-rehabilitated & land out of canal network 'hors casier')				
Rice Growing Season	44 500	44 500	44 500	46 900
Vegetable Growing Season	44 500	35 600	35 600	37 520
Off Season Fee (all classes, all crops)	6 350	6 350	6 350	6 700

Although water stays in the canal system all year, only 20-30% of farmers are guaranteed enough water to gravity irrigate in the dry season. These farmers must pay the '*contre saison*' or dry-season fee. Other farmers may be notified at the last minute that they will receive off-season irrigation services; they pay only if they elect to plant. In the rest of the network, dry season canal water levels remain too low to irrigate by gravity (Coulibaly, 2004). Women and children often use a portion of men's land to bucket-irrigate small vegetable patches during the dry season. Fees for small off-season vegetable gardens are often not assessed or collected due to high information costs. Vegetable gardens that are formally maintained year-round (usually by women's associations) are charged by prices in the table above. There is exceptional confusion

¹⁷ Contat-Plan, Etat/Office du Niger/Exploitants Agricoles, 2002/2004. Office du Niger. Contract-Plan 2005-2007 had not been approved at the time of research for this paper. Figures here are those suggested by consultant in October 2004.

among users and officials regarding who has to pay dry-season fees and under what conditions; the implementation of these rules may also vary from zone to zone.¹⁸

4.4 Sanctions

The formal sanctioning system is fairly straightforward on paper. Farmers can be evicted from their land under three conditions. The first is for failure to produce. This does not refer to a poor production year but rather to farmers who do not cultivate their land. The second is in the event of illegal land leasing or sale. This rule is not enforced uniformly; leasing is widely and openly practiced, for the most part, with impunity.¹⁹ The third way to be evicted is through failure to pay the *redevance*. This has recently been expanded to include failure to pay tertiary fees as defined by organizations for tertiary network users (OERTs); tertiary-fee sanctions have not yet been implemented.

Enforcement of sanctions is not uniform. Monitoring and collection (enforcement) costs are high for farmers on the smallest parcels and those out of the canal network (*hors casiers*) but required to pay for access to canal water (Bolly, 2004, Coulibaly, 2004, Ly, 2004).²⁰ At the same time, enforcement of other rules, particularly

¹⁸ Everyone I spoke with had a different reason for why dry season production was low, including poorly developed markets for non-rice outputs, misunderstandings about what fees would have to be paid, lack of resources/skills to produce non-rice crops, market constraints for non-rice inputs, etc.

¹⁹ The Chinese company COVEC has a formal but illegal system of leasing land, which includes issuance of written contracts. It is tolerated by the ON administration. Individual farmers, particularly unionists, face greater risks of eviction from leasing.

²⁰ The ON defines users as those having formal permission to farm on ON canal-served lands. A number of users do not have formal land use rights but irrigate impromptu fields on undeveloped lands near secondary drainage canals, “pirating” water to their informal networks. The improper land development accelerates soil degradation and can have negative impacts on legally connected perimeters from blocked drainage canals. By developing a new class of users called *‘hors casiers’*, or the ‘out of network’ user category, the ON has attempted to mitigate two problems. Users gained some level of land security, giving them an increased incentive to maintain the soils and invest in the development of tertiary canals and drainage. Second, the ON is able to exact a fee from the new class of users, which brings them under control of official ON rules and regulations, helps to pay O&M costs, and cover some planning expenses. Farmers pay fees in anticipation of maintaining usufruct rights in the event of canal extension.

the national law prohibiting land leasing and rental, is not applied to large-holder investors.²¹

Graduated sanctions do not exist. If a farmer pays only part of the irrigation fees owed, he or she is evicted from the entire holding. If it is the first year of non-or partial-payment in ten years, total eviction still holds. Formal credit markets are largely non-existent for small holders (land cannot be used as collateral), and renting land is illegal. A single bad year can easily result in eviction. As a result, the poorest farmers are at the highest risk in the event of household or perimeter-level shocks (they are often the least able to recover from or adapt to them because of limited skills and assets).

Comment: I changed the wording because the previous wording implied that land cannot be used as collateral because formal credit markets are non-existent. It is likely that one of the reasons the formal credit markets don't exist is precisely because there is no way to use land as collateral. Thus, the causality runs the opposite direction as that implied in the original wording.

Farmers' unions put forth two proposals for alternate graduated sanction institutions for the Contract-Plan 2005-2007 that would also guard against financial losses for the *Office* (SEXAGON, 2004). No changes were made, but it was agreed that a study would be conducted on the general problem of evictions (ECOFOR-SARL, 2004).

Criteria for exactly what constitutes an emergency or exception to fee payments are not standardized. Defining such criteria could reduce the role of power and politics in defining solutions at the time of subsequent emergencies and increase farmers' ability to plan for and respond to such events.

While the Contract-Plan assigns rights and responsibilities to each of the three signatories, only farmers are held accountable for fulfillment under threat of sanction.

²¹ COVEC is a Chinese firm established in the ON under agreement between the GOM and the Chinese government. Development of new secondary networks for the project was financed by the GOM and donors as low interest loans. COVEC hands out leasing contracts to renters. This is illegal by national law, but accepted at the headquarters level in the ON and by the GOM. The World Bank is also experimenting with an official land-titling project called Koumana under the PNIR that would result in land purchasing and sale rights for large investors.

No formal system of upward accountability of sanctioning exists for partial or non-fulfillment of State or ON responsibilities.

Post-reform collection rates were reportedly 95-98% of due funds (not of farmers making payment) through the late 1990s (Aw and Diemer, 2002). But in 2002, rates of on-time payment ranged between 83% for growing-season rice fields and 18% for off-season rice production. According to the 2004 study on ON pricing that is used to inform the process of setting new Contrat-Plan *redevance* rates, in some zones, growing-season payments rates were as low as 71% (BRLi, 2004).²² The *Office* unofficially allows time beyond the six-month deadline for payment; but eviction rates are high. In 2001, the ON reclaimed 604 hectares through evictions, in 2002 - 279 hectares, in 2003 – 21 ha, and in 2004 – 5,103 ha were reclaimed through the eviction of 16% or 4,222 of the 26,435 ON farmers in that year alone (Fall, et al. 2004). Considering farmers' families, the number of people affected by evictions could easily have surpassed 50,000. See Appendix II for more information about the eviction situation of 2003-2004.

4.5 Costs and Decision Making

Decision making and decision makers are described at each of three levels of irrigation committee management related to pricing and costs – the bargaining and design of the ON-wide Contract-Plan, the secondary canal network, and the tertiary canal network levels. This is followed by a description of stakeholders and the incentives they face to improve the ON's ability to meet its objectives.

²² Figure represents the percentage of funds collected. The percentage of farmers paying *redevance* is much lower. Those farmers who do not pay are those who hold small plots, and the cost of collecting fees from those who hold only fractions of a hectare has been too high in the past to warrant systematic collection efforts from them. Discussion among ON officials indicates that efforts to collect from or evict farmers with small holdings will be increasing.

Contract-Plan. Decisions regarding what costs are to be recovered by irrigation fees are formally made for the entire ON during negotiations *Contract-Plan* (CP), officially by the Advisory Council. The Advisory Council is formally made up of representatives from the three partner entities, the GOM, the ON administration, and the elected farmers' representatives. Possible changes to the price structure and fee levels are discussed in these negotiations. No structural changes have been made for at least the past two contracts (four years).

The two farmer representatives on the Council are selected from and by the zone-level farmer delegates who are elected by farmers (three delegates per zone). An independent consulting firm studies the situation before each Contract-Plan (2005-2007 will be the fourth CP since reforms) and meets with all stakeholder groups before making suggestions for the following Contract-Plan. Suggestions are to be discussed, bargained, and voted on by the Advisory Council.

Contract-Plan discussions include dozens of non-signatory stakeholders, including representatives from both farmers' union and various donors (World Bank, IMF, USAID, EU, AFD among others). They do not include official representatives from the commercial large-holder business community. Discussions are held in French, for the benefit of visiting donors and the consultants. Translators are not provided for elected farmer representatives. Consultant reports are in French and based on data produced by the ON. No rules exist with respect to the advanced distribution of bargaining materials, such as the consultant's report or that it be translated; this adds to farmer representatives' bargaining disadvantage and increased information costs.

Bargaining is largely shaped by what topics go on the agenda and the content of the consultant reports. Investment alternatives and pricing options are framed by ideas presented in the consultant reports. Using consultants rather than the ON to frame the debate within the report is designed to provide an element of objectivity to the report.

The GOM and farmers can either accept that all discussion is based on the consultant report content or they can challenge how questions are answered by the report and even which questions are asked. Their ability to challenge the report-led agenda shapes the level on which each party is bargaining. One unionist aimed to accomplish this at the C-P meeting when he protested a portion of the *redevance* increase that was to pay for an ON staff pay raise. This was an automatic cost-of-living increase that was not on the agenda for debate. The unionist pointed out, however, that farmers would effectively be taking pay cut to give the ON staff a pay increase. This comment, among others, was made but not discussed or included in 'official' version of meeting notes, which, when compared to the proceedings, seemed to reflect the relative weight of different parties' voices.

A history of adversarial relationships and corruption seems to contribute to extensive mistrust among Advisory Council parties, illustrating how organizational learning can also have negative effects on productivity and functionality of an organization. Hostilities and disrespect were voiced openly and privately between all parties at various times. This is not likely to change until the staff of the ON, most of whom has been with the organization since pre-reform years, turns over. Similarly, union leaders must take on a more proactive rather than defensive role; the ON staff actively opposes this role change for the union, however.

Secondary Canal Networks. At the secondary canal level, Farmer-ON committees for secondary network maintenance funds (*Comité Paritaire de Gestion des Fonds d'Entretien du Réseau Hydraulique Secondaire* - CPGFE) make spending decisions on secondary network O&M costs using 50% of the fees collected from the relevant secondary network. Elected farmers are responsible for working with zone-level administrative officials to bid contracts, prioritize projects, and to ensure expenditure accountability. This committee also proposes evictions (for any reason outside of non-payment of fees) and will evaluate fields in the case of extensive destruction from natural causes (CPGFE is allowed to excuse 1% of fees per season).

The secondary network land management committee (*Comité Paritaire de Gestion des Terres* - CPGT) implements evictions and land distribution at the zone level and has at least one representative from a farmers' organization. Committees for water management (*Comité de Partiteur* - CPE) are to monitor secondary network maintenance implemented by the CPGFE and assure that farmers are conducting sufficient O&M at the tertiary level. The CPE has the official right to propose evictions; again, there is at least one representative from farmers' organizations on this committee.

Tertiary Canal Networks. Maintenance of tertiary canals and land is the responsibility of growers; appropriate maintenance at tertiary level is connected to O&M costs at secondary level. The 2002-2004 ON Contract-Plan mandated the existence of a tertiary network maintenance fee to be collected and managed by *OERTs*, Organizations for Farmers of Tertiary Networks. Nearly 9000 *OERTs* were formally established in 55 villages between the 2003-2004 growing seasons; their level of functionality was

questioned by the BRLi consultants, USAID contractors in the area, and the President of SEXAGON.

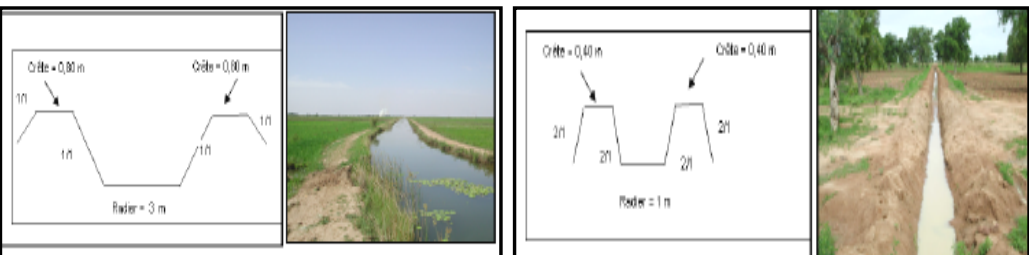
Maintenance of secondary canals affects the costs of tertiary maintenance. Discussion to link the CPGFE farmer representation officially to OERT representatives has been rejected by the ON for the past two CPs, purportedly out of concern that farmers will gain too much control relative to the ON representatives (François, 2004). Additional complications arise because the ON guarantees water delivery to farmers in exchange for fee payment. If tertiary O&M is left completely to farmers, the provision of water to some fields may be blocked by poor tertiary O&M on neighboring fields. It is unclear if the blocked farmer could legally withhold payment of fees to the ON.

Similarly, while it is clear that the ON can charge farmers the cost of tertiary O&M if it is not properly performed, it is not clear that farmers have the right, much less the capacity, to force ON payment when secondary drainage canals result in premature deterioration of tertiary networks, or parcel degradation (primarily as a result of salinization), a problem for most zones. Adding to the complication of assigning various agents' responsibility for maintenance is the fact that the physical relationships among network levels in disrepair in terms of how investment or neglect in one area may physically influence the rate of deterioration of canals in other areas of the network. The level of effort and knowledge applied to maintenance tasks may vary greatly and has short-run and long-run effects on various parts of the irrigation system that may or may not be known, much less measured.

Prices and Costs. The choice of initial infrastructure at each irrigation level has a direct effect on the nature and distribution of long-run O&M costs (Figure 2,

below). For example, initial infrastructure design and building may be costly for one type of canal (paid by the ON, donors, or the GOM), but long-run O&M costs to the user will be lower. In other cases, such as below, fixed costs may actually be lower for canals that also have lower O&M costs. Alternatively, the ON may choose less expensive investments, however, passing on the cost of savings to the farmers in the long run. For example, deciding not to apply expensive laterite coverings to dykes during construction reduces fixed costs but can increase annual O&M costs by 30% according to BRLi research conducted for the 2002-2004 CP. Unofficial payoffs, friendships/past business agreements among contractors and ON officials, and standard operating procedures all weigh into individual decisions incentives when new canals are planned. High costs are associated with changing the status quo and individuals in the ON have no incentive to take on those costs for change.

Figure 2: Comparison of O&M costs of two tertiary canal construction types in the ON with equal water-carrying capacity (water evaporation costs not considered). Canal on the left was machine-dug by a large private contractor; O&M is 286 CFAF/yr/million liters water delivered. Canal on the right was dug by hand with employment benefits accruing to local families; O&M is 170 CFAF/yr/million liters of water delivered. Source: *Etude de l'Entretien des Reseaux Primaires, Secondaires, et Tertiaires et du Calcul du Taux de Redevance*.(BRLingenierie, 2004).



Increased investment in regular O&M can also lower total physical costs by reducing periodic and long-run O&M and rehabilitation costs. Organization of an adequate management system and capacity building for users at secondary and tertiary levels are non-physical but real costs of production that are not addressed or are given secondary priority in the allocation of collected funds. Allocating funds to such intangible management and organization costs is more challenging from a decision-making perspective than spending funds on easily definable physical factors of production. Such decisions are usually made at the ON or zone level largely by ON professionals who face no performance-based incentives and may not see the benefits of irrigation management transfer or more likely be threatened by such decentralization of decision making.

The nature of individuals' participation in the decision-making process is shaped by the incentives they face, their real and perceived choice set, and the means at their disposal to acquire information, bargain effectively and enforce contracts. Below, each of the major participants involved in the design and implementation of the price strategy is analyzed with respect to their relative incentives, perceptions, and means to influence the price strategy. Participants reviewed include ON officials, smallholder farmers, largeholder farmers and private investors, the Government of Mali, and donors.

ON Officials have largely been with the ON since before structural reform – making them a wealth of collective of information but also a repository of ingrained perspectives and opinions about farmers, agriculture, and approaches to development. ON officials view discussion of lower prices or changes in sanction rules as a zero-sum game in which revenues would be lost to the ON and lower productivity condoned. ON

officials are accountable collectively (but not individually) to donors to generate high cost-recovery and productivity-per-hectare statistics; poverty research is not part of annual ON reporting.

The farmer–ON relationship is similar to the principal-agent problem. The ON (agent) retains most of the specialized knowledge about various irrigation system performances and options, it is at an advantage over farmers (principals) who must rely on them to invest effort into irrigation system design. This results in a problem of *moral hazard* in which the quality to which the ON chooses to meet its contractual duties is not readily (or inexpensively) observable by the farmer or the GOM.

Even if this information were available, farmers have no formal institutional means to hold the ON accountable for providing quality services. Furthermore, they have no alternative service provider; the ON has a monopoly on provision of irrigation services to farmers. This results in asymmetrical information and asymmetrical power.

Individual ON officials have an incentive to maintain or increase fees to comply with donor demands of balanced budget, but they have little incentive to invest effort or ingenuity into addressing eviction problems or cost-reduction strategies. Higher costs simply require higher fees. Increasing eviction rates, increasing poverty, and/or increasing farmer organizing, may be among the indicators of when this approach to balancing fees and costs reaches its limits of feasibility. Pushing these limits may also result in making farming feasible only for those producers with the skills and financial capital to significantly increase yields per hectare.²³ External funding for new projects is generally based on assumed or reported project costs, which are estimated by consultants

²³ This, of course, re-introduces the question of how less productive farmers and their families will earn an income since food security requires both production and purchasing power.

or ON officials (as opposed to providing funding based on expected benefits). Accordingly, farmers have no way to ensure that fee increases will result in better service provision or that their own efforts to reduce costs will result in reduced fees rather than be invested in some other system cost (including ON officials' salaries, as was the 2004 proposal).

The principal-agent problem is reversed at the local level, where the ON (principal) must rely on thousands of small farmers (agents) to invest in proper farming, water use, and O&M practices to maintain tertiary canals. In some ways, this reflects moral hazard (the ON cannot ensure that the farmers are maintaining their parcels properly). The OERT system is an attempt to address the moral hazard dilemma and create incentives for farmers to invest adequate effort at the tertiary level to reduce total costs. Alone, however, it may be insufficient if farmers do not also have the means to coordinate properly among themselves and related secondary network efforts, if land rights are perceived to be insecure, or if system-wide cost savings that result are not reflected in fees paid or may be nullified by poor O&M at the secondary level.

Various comments made at the 2004 CP discussion forum indicated that officials believed smallholder farmers to be incapable of making decisions, but were included in the decision-making process only because donors mandated it, and that time and resources spent informing farmers was largely wasted. For example, farmers requested funds (approximately \$50 per zone representative, a total request of \$600) for gas to distribute and discuss CP proposals among farmers in their respective zones (reducing farmers' information disadvantage and increasing representatives' bargaining power in the CP). The idea was discouraged. The Chairwoman responded by explaining that such

funding would require an additional increase in the *redevance* and by following up with the comment that the farmers would not be able to understand the information, so why bother? While she apologized for the comment, such comments indicate an informal institution of marginalizing farmers' contributions to the system. Accordingly, the request was not included in the summary of the meeting.

Smallholder farmers comprise a large diverse group, making a unified vision more difficult to define and advocate and making intra-group communication and decision-making more costly. Part of the heterogeneity is reflected in variable education and wealth levels. Low education levels exacerbate cash poverty by decreasing farmers' ability to identify and evaluate available options, increasing information and bargaining costs. They are an additional bargaining disadvantage because they have no option to exit the system. In the end, they will always have to agree to and follow the contract plan regardless of its design.

Farmer unionization began in response to a history of farmer marginalization and the obstacles to individual effective participation. Currently, there are two farmer unions in the ON: the more independent *Syndicat des Exploitants Agricoles de l'ON* (SEXAGON) and *Syndicat des Agriculteurs du Delta Central* (SYNADEC), which was created in 1998 with the support of the ON, approximately one year after the inception of SEXAGON (Benoît, 2004).

Individual and collective/organizational learning is likely to occur as farmers become more autonomously educated about ON issues and as networks among them develop through union activity. This is occurring through the implementation of the government decentralization plan, through the growth of the unions, and through the

proliferation of radios and cell phones. Each of these events reduces the cost of information but also facilitates learning. As the process advances, farmers are likely to change beliefs about their own rights, responsibilities, and capacities; ON officials may also learn new attitudes if farmers begin to organize effective collectives, and improve their ability to articulate demands to the ON, to newspapers, and to other government offices (Fall, et al. 2004).

Change often involves conflict, however, as power balances shift. This transition can be particularly costly in the short run for the disadvantaged groups gaining power, making it difficult to change the status quo. Conflict has arisen between the ON and primarily SEXAGON (84% of union farmers). SEXAGON is invited to ON meetings occasionally, and efforts are underway to formally limit its rights to organize input or output market services (Atelier, 2004). External support or rules that formally institutionalize the unions' invitation to and participation in meetings and bargaining may reduce the meeting-by-meeting political decisions of if and how SEXAGON should participate, reducing some of the transaction costs to farmer advocates.

High eviction rates can undermine the union's ability to organize by increasing farmers' perceived or actual costs of participation in the union – particularly as eviction rules are enforced by the ON selectively. High eviction rates can reduce individual and organizational learning opportunities. Research is needed to understand the effects of these evictions better – where the evicted farmers go and what they do, what kinds of people are re-allocated the eviction parcels, and if new parcel-holders are more or less productive. Government plans to support private investment in a sugarcane farm and processing plant and a tomato processing and canning plant could provide limited off-

farm employment. For the limited number of farmers who will access to these jobs, the work could provide seasonal income that could reduce eviction rates (if income were to help farmers mitigate seasonal risk) or serve as alternative means of income in the event of eviction.

Largeholder farmers or private investors operating in the ON bargain directly with the ON or through donors and have no formal representation on the Advisory Council. Because the ON, GOM, and donors are interested in promoting private investment and commercial farms, investors have made formal and informal exceptions to operational and collective action rules for their benefit.²⁴ The number of investors is increasing due to external and internal pressures and incentives. No one on the CP committee represented largeholder interests. New institutions are needed to address formally the issues facing smallholder farmers as distinct from those of private investment farming. Transparency in large private investor-ON negotiations is also needed.

The Government of Mali is represented primarily through the Ministry of Agriculture, which is the office responsible for the State's participation in the ON as a CP signatory. To some degree, it faces the same moral hazard problems with the ON as the farmers face. There are important differences between the GOM and the farmers in terms of the effects of the moral hazard in terms its impact on bargaining power and goal achievement. Different from the farmers, the GOM, particularly the Ministry, can speak

²⁴ The World Bank's Koumana project is an example of formal experimentation with allocating land rights to private investors who were willing to invest in the fixed costs of land and irrigation network development. COVEC is doing the same type of experiment in practice but does not have the formal right to lease its land. USAID required that a significant portion of US-funded, newly irrigated parcels be allocated to private investors despite research illustrating private investors' ability to pay for secondary irrigation-infrastructure development (Schema Directeur, 2002).

with a unified voice and does not also incur the cost of organizing and education that farmers face. Furthermore, the Ministry has relatively significant resources at its disposal to read published reports, request statistics from the ON, and while it does not have the option to choose a different service provider, it can make effective threats to budgets and individual employees if need be.

It is not certain that the GOM has much of an incentive to develop an irrigation program with a focus on poverty reduction rather than squarely on revenue generation, however, nor is it certain that the GOM is taking steps to ensure that the two objectives are not competing. Ministry officials are responsible to elected officials (formally) and to large donors (formally and informally). Backed by donors, the government is heavily promoting private investment, particularly foreign private investment, in the ON. Union-Ministry discussions were held to address recent eviction problems, but Ministry officials eventually revoked their support for fee reductions or fee level freezes (Coulibaly, 2004, Keita, 2004, Fall, et al. 2004). Some GOM and ON officials maintain that enforced evictions and prioritization of private investment are acceptable costs to advance long-run objectives of poverty alleviation through non-farm employment growth.

Donors play both an internal and external role in the process of institutional change and in shaping the system performance outcomes of the established operational and collective choice rules. Changes in donor objectives and development project trends affect the demands that donors place on governments explicitly or implicitly. Currently, the trend includes a focus on increasing private investment in the ON as a strategy to increase off-farm labor opportunities (plans for sugarcane and tomato processing plants were both cited frequently as potential large employers), to increase land productivity

through improved application of new technologies, and to decrease government expenditure on canal investments. High eviction rates were not viewed as a priority problem in terms of issues discussed in the CP meeting.

Donors' beliefs about farmers' potential contribution to decision making and capacity to participate interactively in decision making influences how and which projects are designed and implemented. Because donors are not accountable to the ON, GOM, or to Malian public opinion, they have significant political space to demand formal changes that could also promote positive informal change. This would entail advocating policies and programs that improved the balance of power among the three CP signatories in terms of providing appropriate and timely training, education, and information - all of which would improve the bargaining process.

4.6 Office du Niger Conclusions

The ON price strategy is designed for meeting the tactical objective of cost-recovery. It may not be well designed to meet the objectives of advancing the sustainability and productivity of the agriculture sector as a strategy for poverty reduction and food security.

Changing the standard operating procedures for designing, approving, and implementing CP spending and price setting requires a shift in the current established culture of interactions among agents; both formal rules and informal rules of operating need to change. The current status quo is defined by diverse stakeholder groups of different sizes, with different goals, with learned perceptions about rights and responsibilities, and who face power and information asymmetries. As a result, even though entire groups should benefit from seeing improved cost-efficiencies in irrigation

system management, there are weak institutional incentives for the individuals who comprise the groups to take on the costs and responsibilities associated with making the necessary changes in the status quo. Short-term costs of change (learning, risk, information) are high and the payoffs are uncertain and diffuse in the long term (as was made clear by the evictions and arrests in 2004). This is particularly true for small farmers who do not have the option to risk loss of land for political activities that yield uncertain and payoffs. Reforms that come are slow and iterative.

Over the past fifteen years, as small farmers' perceived benefits decreased, as their sense of capacity and entitlement increased, and as attitudes about rights and responsibilities began to change with other reforms taking place in the ON system and in the country, farmers overcame some of the disincentives to organize and initiated a union whose primary role to date seems to be leveraging public opinion and drawing public attention to issues such as price levels and sanctioning institutions. SEXAGON leadership aims to move into a position to serve farmers' physical production needs (bulk purchase of seed, fertilizer, etc.) and be institutionally legitimized by the ON through formally institutionalized recognition in bargaining and advocacy. This would advance its capacity to serve as a farmer advocate within the system, to support voting delegates, and to teach farmers that they have new options (and responsibilities) for voicing their opinions through the union. The union could also serve as another source of information and generate alternative perspectives for framing the CP debates, improving asymmetries of information and power, and improving farmers' bargaining positions overall at the primary, secondary and tertiary levels.

Farmers have the incentive to organize themselves if they perceive that the costs of organizing will pay off in the future. Union members' and active delegates' commitment to invest in change to date seem to be the result of a willingness to incur personal costs of risk for the benefit of group. None of these options, however, address the problem of monopolized service provision.

External agents like donors and journalists can leverage the financial incentives and public opinion to hold the GOM and ON officials accountable for poor performance levels *vis a vis* excess expenditures and inability to advance poverty-reduction goals. They have the opportunity to play an important role in promoting ON investments in rules and line items that specifically address power and information asymmetries and appropriate skills training for farmer delegates. Insisting on rules for the translation of and public comment on important documents is one way. Funding regularly held zone and secondary level farmer information sessions is part of the costs of irrigation service provision. Funding these costs can reduce physical costs of production by improving the choice of investments and by improving farmers' interest in providing feedback and accepting ownership for strategy implementation.

5 CASE 2: SMALL SCALE PUMP-IRRIGATED VILLAGE PERIMETERS

In the late 1980s, when Mali faced a period of drought and heightened food insecurity, international donors and the Government of Mali amplified its efforts to expand the number of small pump-irrigated village perimeters operating in the North, referred to by the acronym in French as PPIVs (*Petits Perimetres Irrigues Villagois*). Pump irrigation was viewed as a way to increase food supply and reduce poverty in the region by increasing control over existing water resources. PPIV rice production was the focus in the regions of Mopti, Tombouctou, and Gao, but PPIVs were also established in Kayes for vegetable production.²⁵

PPIVs primarily refer to irrigation schemes (15-40 hectares) around villages along the Niger River in which diesel motor pumps (*group motopompes* – GMPs) are used to pump river water over a dyke into a network of lined or unlined canals. The European Union leads PPIV efforts in Mali, having funded over 1,300 hectares of PPIVs in Mopti from 1989-2002 through a project called VRES (*Valorisation des Ressources en Eau de Surface*). VRES aims to develop another 1,200 hectares before 2007 in conjunction with the NGO, *Action pour la Formation et l'Autopromotion Rurale* (ONG-AFAR). The governmental *Office Riz Mopti* (ORM) maintains 12 PPIVs and is seeking funds to expand its program as well.

The timeliness of this case review is underscored by two events. First, when originally conceived, high subsidies from donors and the state were considered to be acceptable under the auspices that food security was of national interest (a joint impact good) warranting public subsidy to ensure its production. Extensive funding of GMPs,

²⁵ According to the SNDI, 60-75% of PPIV rice production is consumed by the household.

fuel, and inputs were distributed after the 1984 drought (ARD, 2002). PPIVs developed, yields per hectare and the number of hectares developed for PPIV agriculture increased. Through the late 1990s, development trends started to move toward principles of cost-recovery, and, in irrigation specifically, toward Participatory Irrigation Management (PIM) and Irrigation Management Transfer (IMT); one of the major PPIV donors, VRES, initiated efforts in 2001 to make PPIVs self-sufficient (Goro, 2004). VRES was to stop subsidizing GMP repairs, technical support, and other irregular infusions of financial support. PPIV failure rates increased, and alternatives to improve PPIV financial sustainability were explored (See Appendix III).

The second event was the arrival of a new large donor to the PPIV scene. USAID was interested in funding PPIVs and began by donating three GMPs in 2004. Questions surfaced regarding how, and even if recipients should pay for the GMPs. Related, what price should PPIVs pay donors for a new GMP and should they have to pay at all if they are unable to select the GMP type? Would it better to give the GMP to the farmers' associations, to GMP rental firms, GMP mechanics, or other to other NGOs working in the region? If the original GMP were subsidized completely or in part, what institutional arrangements would improve the quality of GMP repair and renewal? The debate that ensued revealed a lack of research and information used to inform existing donor choices. It also moved away from evaluating pricing as a tactic to support the goals of poverty reduction and food security, defining the issue as one solely of financial cost recovery.

This case study is not a comprehensive quantitative analysis but serves primarily to identify areas for future institutional research based on the limited time and

data that were available to describe the situation. Different approaches to GMP acquisition and service are described below based on how each approach affects the costs and prices of PPIV irrigation, in particular, GMP life expectancy and the related seasonal depreciation costs. PPIVs can lease, rent or purchase GMPs; GMP service arrangements vary accordingly. Some PPIVs hired GMP service technicians for a fixed price per season. Others have servicing costs included in their lease or rental contract. Many simply hire repair services on an as-needed basis. The various approaches and related incentives to provide quality service are described, but data was not available to estimate how each approach may have changed long-run costs based on extended or shortened GMP lifespan.

The *Garage Modern* (private) and *Association des Volontaires pour le Developpement du Delta* (AVD) – Association of Volunteers for the Development of the Delta (NGO)— are two specific service providers reviewed in this report because of how their contractual designs and activities increased different stakeholders’ incentives to invest effort into lowering prices (Section 5.4). The *Garage* primarily leased equipment and would service by season or on an as-needed basis. AVD leased, rented, or sold new and rebuilt GMPs as well as the separated motors and pumps. Leased equipment generally included a service arrangement in which an AVD-trained mechanic lived in the village throughout the season. While the *Garage* was a private business, AVD’s mission was to develop the GMP service and provision sector by increasing price and cost transparency, training new mechanics to improve competition, and to teach PPIVs how to manage GMP contracts.

Reports are mixed with respect to the degree of PPIV successes. Officials from both VRES and ORM PPIV programs cited normal rice yields to fall in the range of five to six tons a hectare. VRES claims at least 400 hectares have been developed into similar schemes without donor or government support due to the demonstrated success of the approach (ARD, 2002). Yet, only 54% of VRES-constructed perimeters were operational in 2002, and that percentage may be declining as the organization moves to reduce free provision of O&M and technical support (SOFRECO, 2003). Those PPIVs that continue to operate are not guaranteed to be financially profitable, even with 100% start-up subsidies.²⁶ Motor pumps are expensive to purchase and operate. Parts, reliable mechanics, information, and village-level financial management skills are all scarce goods and difficult to differentiate with respect to quality of service provision (pervasive adverse selection problems).

ORM PPIVs cultivate one season a year, and contrary to VRES perimeters, 100% of ORM perimeters remain operational. Start-up costs are subsidized 100%, as with VRES perimeters, differing only in that ORM contracts for the machine construction of the canal network and lines canals, whereas VRES projects require farmers to develop their land and canals by hand, often without canal lining. The difference in canal quality results in significant water losses for the unlined canals. Not lining the canals makes them less expensive to construct and builds on the ideal of farmer participation, but it also increases pump operation time and cost, speeding up the rate of depreciation (SOFRECO, 2003).

²⁶ Unpublished calculations done by Alpha Kargne, agricultural economist for USAID production project, PRODEPAM.

A PPIV-VRES institutional relationship is maintained by formal network of PPIV farmer committees and VRES-hired extension agents. Formally, extension agents are only to provide fee-based services after the first year of PPIV operation. Depending on village needs and the agents' willingness, extension agents may end up providing free technical advice and supporting or even conducting day-to-day accounting tasks and input acquisition (Macalou, 2004).

While the ORM officially only offers free crop technical support, ORM administrators admitted to advising on GMP technical problems and acquisitions. ORM holds regular training seminars for all GMP operators to improve routine O&M and reduce GMP depreciation rates. The coordinating committee president (a local farmer) and the ORM PPIV director seemed to have an open, respectful and informed working relationship in the meeting I attended. As well, the ORM's PPIV director seemed to generally respect the PPIV farmers he worked with based on his descriptions of their work and effort levels while recognizing their skill constraints. This was a notable difference after speaking with/listening to ON farmer-administration relations.

Both VRES and ORM have one or more small (1.5 ha) women-operated vegetable PPIVs. Often, GMPs also irrigate small vegetable plots in addition to the rice perimeters, but the women and children who cultivate these plots are not subject to fees and have no official say in the perimeter decision-making process or management. I did not collect information on how usufruct rights were distributed or retained for these plots.

5.1 Price Objective/Level

Irrigation pricing in PPIVs has the sole objective of financial cost recovery. Farmers pay a *redevance* that covers irrigation-related costs plus the costs of inputs such

as seed, fertilizers, pest control, and canal-network maintenance. A PPIV-elected committee of farmers is responsible for all purchasing and payments. The redevance is calculated and assessed at the end of the growing season.

This section discusses what factors contribute to variation among PPIV price levels; section 5.4, Costs and Decision Making, elaborates on why the costs of certain line items can vary significantly. Unfortunately, it does not compare or analyze the range of price levels found in different organizations and areas due to lack of data. VRES and AFAR published average *redevance* costs in 1998 at 176,000 CFAF/ha (field and harvest labor not included; based on a 30-acre perimeter).²⁷ This surpassed the SNDI-based suggested maximum New Irrigation Fee *redevance* for PPIVs of 100,000 CFAF/ha (set in 1999) by 76%. More recent averages were not available during my visits. Future research to collect information on the different *redevance* levels and the perimeter characteristics could provide interesting and important insights into how to make pricing promote sustainable irrigation production.²⁸

²⁷ The budget sheet I was given for an AFAR perimeter (PPIV Diantakaye in 1998, Table 2) shows a redevance of about 150,000 CFAF/ha for a 19.5 ha perimeter, reflecting increasing costs if compared to the 30 ha redevance of 176,000 CFAF/ha provided by the organization as an average for the same year (Table 3). In this case, Diantakaye farmers paid 57% more than the SNDI policy-suggested maximum irrigation fee. GMP costs were more than 60% of the total, 76,316 CFAF/ha; of that depreciation was 26,316 CFAF or about 1/3 of GMP costs and 1/6 of total redevance costs (without labor). The Diatakaye perimeter calculated an average income per ha of 466,259 CFAF (after all non labor-related costs). SOFRECO did not cite its source of data and may have drawn from the same AFAR document with its 1998 averages.

²⁸ Characteristic variables that would be interesting to regress on redevance level might include donor organization, perimeter size, number of years of perimeter operation, type of GMP provision arrangement, and percentage of the redevance that was GMP depreciation and GMP total costs, distance from urban area.

Table 2 AFAR Cost Sheet for PPIV Diantakaye, 1998

Surface (ha).....	19.5
Yield, paddy (t/ha)	5
Price, paddy (CFAF/kg).....	125
Cost of labor (CFAF/day).....	750
Growing seasons per year.....	1
Average plot size (ha).....	0.33

Costs	Dose per ha	Cost per unit	Cost per hectare
Inputs			71,000
Seed (kg)	60	125	7500
DAP (kg)	100	260	26000
Urea (kg)	150	250	37500
Phytosanitary products	0		0
Water Service			49,925
Fuel	80	275	22000
Pump Oil	1.5	1000	1500
GMP maintenance/repair			10000
Perimeter maintenance/repair	15	750	11250
Pump operator salary			5175
COOP management			2,500
Management salaries			
Vehicles/fuel			
Meetings			
Telephone			
Other			
Labor and Services			170250
Soil preparation	3	3000	9000
Sowing seeds (ha*day)	50	750	37500
Maintenance (ha*day)	65	750	48750
Harvest (ha*day)	100	750	75000
Winnowing (ha*day)			
GMP Depreciation			26,316
TOTAL			149,741

According to an engineering firm's study of irrigation costs in Mali, total costs of PPIV operations are dominated by GMP costs (40% of total *redevance*) including pump operators' salaries, fuel, oil, repair parts, servicing, and depreciation (SOFRECO, 2003). A VRES analysis of all the organization's project perimeter budgets in 1998

(Table 3) supported the SOFRECO estimate; average GMP costs amounted to approximately 35% of total costs per hectare, (99,000 CFAF/ha).

Comment: It's not clear where these numbers come from. How do they relate to the figures in the preceding table? When you talk about "GMP costs" --e.g., in this last sentence, are you referring to total costs or total NON-LABOR costs? I think it's the latter. But logically, I would think that lab or for "maintenance" [of the GMP? or the irrigation system?] ought to be included in the GMP costs. I can see why you might want to exclude the other crop production and harvesting costs. In general, you need to make the links between the tables you present and the discussion here in the text clearer.

Table 3 VRES Average costs per ha for all project PPIVs in 1998, based on a 30 ha perimeter (GMP related costs highlighted)

	Quantity	Price per unit in CFAF	Total CFAF
VARIABLE COSTS			
Phosphates	100kg	295	29,500
Urea	100kg	285	28,500
Seed	50 kg	150	7,500
Fuel	120 l	275	33,000
Oil	2 l	1,000	2,000
GMP maintenance and repairs			10,000
Coop operational costs (transportation, phone, fuel, etc.)			5,000
Bagging (75 bags of 80 kg rice to last 3 seasons)	75/3	400	10,000
Sub total 1			125 500
LABOR			
Labor	35 ho/day	700	24,500
Prep, spray, seedlings planted	20 ho/day	700	14,000
Seedlings distributed to fields	80 ho/day	700	56,000
GMP operation, field surveillance	35 ho/day	700	24,500
Weeding	30 ho/day	700	21,000
Harvest	100 ho/day	700	70,000
Sub total 2	300	700	210,000
FIXED COSTS (total cost/expected life)			
Storage building (12,800,000/50 yrs)			8,533
GMP 400 m3 (6,500,000/15 seasons)			14,444
Accessories (9,000,000/20 seasons)			15,000
Fuel storage (2,000,000/30 yrs)			2,222
Perimeter (16,000,000/50 yrs)			10,666
Sub total 3			50,865
GENERAL TOTAL			286,365 CFAF

While it was not feasible to conduct an analysis of the averages and ranges of pump costs for various categories of PPIVs, the scale of variation can be surmised based AVD GMP leasing options alone (Table 4).

AVD leases equipment by the month. Its rental prices, based on GMP type, age, and pumping capacity of the GMP, can vary up to 70% (676,000 to 1,148,000 CFAF/mo; 22,530 to 38,266 CFAF/ha/mo). Furthermore, according to AVD, the rate at which the pump is operated can cause diesel fuel consumption to vary up to 100% (for the budgets sited above, fuel was 22,000-33,000 CFAF/ha, both significant figures if doubled). GMPs must pump at high flow rates if the perimeter is large relative to the pump capacity. If the operator is not well trained, diesel fuel use may increase as well; pumping more hours at lower flow rates may use less diesel fuel and reduce the rate of machine depreciation compared with pumping fewer hours at high flow rates. Similarly, fuel consumption increases if the GMP is poorly maintained or if extra water must be pumped because the canal network was developed with unlined canals and/or if the canals are not maintained well (illustrating the trade-off among costs related to quality canal construction, operator training, GMP diesel fuel, and canal maintenance).

Table 4 AVD-Delta worksheet of the fixed costs of renting a GMP with rebuilt motor and rebuilt pump as compared with the fixed costs of renting a GMP of rebuilt motor and new pump in 2004

Type of GMP	Unit for rebuilt motors	Unit for new motors	For 20 ha PPIV			Savings of new motor & rebuilt pump over new motor & new pump	Savings of using rebuilt motor and pump vs new pump	For 40 ha PPIV			Savings of new motor & rebuilt pump over new motor & new pump	Savings of using rebuilt motor and pump vs new pump
			Rebuilt motor and pump	New motor, rebuilt pump	New pump			Rebuilt pump and motor	New motor, rebuilt pump	New Pump		
			180-250 m ³ /hr	180-250m ³ /hr	TR2			350-450 m ³ /hr	350-450 m ³ /hr	TR3		
Price of GMP purchase	CFAF	CFAF	2,295,100	3,883,250	6,205,650	37%	63%	3,224,100	4,992,000	7,976,100	37%	60%
GMP financing fees per season	2%	2%	45,902	77,665	124,113	37%	63%	64,482	99,840	159,522	37%	60%
Depreciation fees	1/6	1/8	382,517	485,406	775,706	37%	51%	537,350	624,000	997,013	37%	46%
Once-per-season GMP maintenance and upkeep fee (after 4,000 hrs of use)	prorated by age	prorated by age	248,226	248,226	248,226	idem	idem	319,044	305,272	319,044	idem	idem
Total financing fees			676,645	811,297	1,148,045	29%	41%	920,867	1,029,112	1,475,579	30%	38%
Per month of use	5	5	135,329	162,259	229,609	29%	41%	184,175	205,822	295,116	30%	38%

Another challenging aspect of setting a price level is appropriately covering the costs of GMP depreciation with the *redevance*. According to interviews with PPIV employees, beneficiaries, and GMP service providers, early deterioration of GMPs and inability to replace/repair them is a leading cause of PPIV failure (Macalou Mamdou, 2004, Seckou Sogoba, 2004). Organizations' estimates on GMP life expectancy vary from fifteen seasons (AFAR) to as few six (AVD) seasons for new equipment. Based on AVD's sample budget, this difference would more than double the line item for depreciation costs alone in a 30-hectare perimeter's *redevance* (from 10,000 to 26,000 CFAF/ha in 2004). Doubling the depreciation line item in the average 1998 AFAR budget from above would increase the total *redevance* by about 8%.

5.2 Price Structure

Total perimeter input costs are distributed among farmers strictly by proportion of their parcel size relative to the area of the irrigated perimeter. Because farmers purchase inputs collectively, their per unit input costs are equal. Farmers also have little to no control over the amount of water that flows past their parcel, so quantity-based pricing is not feasible. At this time, there is no objective for which prices should be structured in any way other than uniformly, per hectare.

5.3 Sanctions

In both ORM and VRES perimeters, formal rules sanction non-payment of the *redevance* with eviction. Parcel sizes are between .25 and .33 hectares, so partial parcel retention is not a reasonable option for partial fee payment. Late payments are not officially permitted in either scheme, but in both cases user association representatives indicated that late payments were accepted. Fees are still due in the event of eviction due to non-payment but are rarely collected.

Two institutional measures for upward accountability exist for farmers to hold elected committee members accountable for appropriate management of redevance collection and expenditure. The first is in the process of committee elections. The functionality of this sanction depends on the number of farmers within the perimeter who are literate/numerate and can perform the necessary duties of an elected official; it also depends on other power relationships that may be working in the village to discourage accountability. The second level of accountability is the farmers' ability to bring complaints before the coordinating council made up of representatives from a number of PPIVs (described below).

The existence of both of these formal options is an important benefit of participatory irrigation management that does not exist in the ON structure. The effectiveness of the sanctions in discouraging moral hazard problems may vary from perimeter to perimeter based prevailing informal institutions and farmers' means to identify a problem and/or to take action.

5.4 Costs and Decision Making

Most formal rules for PPIVs are handed down from the relevant administrative organization (VRES, AFAR or ORM). Otherwise, the PPIV system generally supports participatory irrigation management practices. In all cases, farmers elect a perimeter management committee from among themselves. Members of the committee are responsible for purchasing perimeter inputs, assessing and collecting fees, enforcing sanctions, and can develop PPIV-level rules.

From among the representatives of each PPIV, a coordinating council is elected to serve as an intermediary between the donor or administrative agency (VRES or ORM)

and the farmers. This coordinating council helps resolve conflict at the perimeter level upon request from farmers or committee members. In both arrangements, elections are to be held every three years.

The village perimeter committee has responsibility for the continued and affordable operation of a diesel motor pump. GMP-related costs are possibly the most variable portion of total seasonal costs. Their level can determine whether a PPIV reduces poverty *or* results in increased farmer debt and closes after a few seasons.

Unfortunately, there is no accurate figure for the average rate of GMP depreciation.²⁹ Furthermore, the difference in GMP life-expectancy estimates between AFAR and AVD are based on estimates but do not reflect calculated differences of how long GMPs tend to last for each organization. AFAR representatives suggested that AVD exaggerated numbers so that it can charge higher depreciation fees. AVD counters that AFAR overestimates the life of GMPs. While the annual *redevance* may be lower for farmers early in a GMPs life, AFAR/VRES PPIVs rarely have sufficient funds for GMP replacement. Replacement funds are used for expensive repairs, or repairs and quality upkeep are not made properly, reducing the life of the GMP to the point that insufficient

²⁹ Depreciation is generally based on the 'average' the life of the GMP by counting number of seasons used. Using this average avoids the important issue of *why* some GMPs last longer than others. Furthermore, the figure is too rough to be useful, since season and off-season depreciation are not the same; GMP depreciation from 12 rainy seasons is not equivalent to 6 years of double cropping. During the rainy season, GMPs may only be used a few times a month, for a few hours each time. During the dry season, pumps run 8-12 hours every day and GMPs depreciate much faster. There is no standard among farmers to practice double cropping or not, so the choice may vary by year. Unfortunately, no organizations have data for the average life of GMPs based on the number of *hours* operated. Using expected life of GMP listed in purchase manuals is also misleading, as conditions of operation in Mali are significantly different from those in Europe. Furthermore, options to invest in GMP renewal versus increasing repair costs of an aging GMP versus renewing only the pump or only the motor separately as necessary would all be evaluated differently depending on the PPIV's skill set and knowledge and the resources of the GMP service and acquisition sector – both of which can be developed to reduce costs. Identifying basic areas of improvement can be done without these data by focusing on the first question above of *why* certain GMPs last longer. Exploring this issue is likely to present better variables on which to base the design of a consequent statistical inquiry.

savings accumulate by the time of GMP exhaustion. The ORM uses estimates provided by the manufacturers - admittedly poor estimates given that the GMP manuals base the estimates on GMP performance in European climates, inputs and servicing schedules.

Even averaging the actual GMP lives for all perimeters would be a misleading guide for pricing. The variation among perimeters is significant but not randomly so. The factors below influence the level of and relationship between GMP acquisition and operational costs.

1. Financial management quality a) among PPIV members and b) between PPIVs and service providers (e.g., literacy, basic knowledge of pump operation and use issues, follow-up with all involved parties, good contracts and agreements, conflict resolution skills, transparency and comprehension of costs and expenditures, etc.)
2. GMP operation quality (e.g., warming up the engine, understanding pump and motor pumping curve, turning off the motor if there are odd noises, coolant leaks, etc. and related, proper canal maintenance so water losses are reduced and less pumping is needed).
3. GMP maintenance quality (e.g., regularly lubricating parts, changing filters, oil, etc.)
4. GMP input quality (e.g., clean and filtered oil and gas, not street-side oil and diesel *mélangé*)
5. GMP repair service and part quality (e.g., taking care of problems immediately when they arise, having a trustworthy mechanic, having timely access to and using correct parts, etc.)
6. Appropriate GMP acquisition (GMP make, capacity, and condition must match the region, perimeter size, and reasonably available repair services and parts.)

PPIVs have different GMP financing problems. Some PPIVs do not charge a high enough annual depreciation rate to cover the cost of GMP replacement. Others use depreciation funds for increasingly costly repairs as the GMP wears out rather than replacing a dying GMP. Depreciation funds may be invested in other projects or lost through intentional or unintentional financial mismanagement by the time a new GMP must be purchased. Just as often, a technical problem related to factors 2-6 above accelerates pump depreciation, making an otherwise financially sustainable project fail. These four technical issues can become problematic if the pump operator is not trained well or if the operator does not have an incentive to invest personal effort into reducing GMP costs at his own personal expense (either increased effort or by using higher quality /more costly products). A list and brief description of creative PPIV approaches to financing new GMPs can be found in Appendix III.

Final decisions on how to acquire, operate, and finance GMPs with irrigation-fee funds are left to the village committees. Currently, most PPIVs aim to own at least one GMP (an operator is hired to run the GMP and provide regular upkeep, but is not a mechanic). Institutional advantages and disadvantages to alternative pump service provision approaches include renting, lease-to-own, and leasing pumping services and village ownership, are evaluated below with respect to implications for long-run cost reduction and cost recovery.

Ownership. Application of basic principal-agent analysis illustrates that pump owners (principals) are at a disadvantage with respect to knowing the true cost and quality of repair services rendered by service providers (agents). Owners face the problem of adverse selection when choosing a GMP service agency. Post-contract, this

develops into a moral hazard problem by not knowing what repairs need to be done or how. With little competition and specialized knowledge, repair-service providers have no incentive to invest effort into quality repair provision. Worse, they face an incentive to provide substandard service in order to gain future work in GMP service calls. Furthermore, GMPs in disrepair may retain value but village committee members rely on service providers – who may also buy and rebuild old GMPs for redistribution - for this assessment. Until competition and accountability in the GMP service and provision sector increases, these asymmetries lead to conflicting objectives.

When donors provided generous financial and technical support to PPIVs for resolving GMP problems, this principal-agent problem had fewer implications for the continued operation of PPIV's as tools of food production and poverty alleviation. As PPIV financial independence came into donor fashion, village-level failure to properly manage GMPs resulted in PPIV failure, which does not promote food security or poverty alleviation. VRES attempted to ameliorate the situation with a revolving loan program. Because the loan program did nothing to change the information problem, PPIVs were still paying for services that were substandard or even exploitative. Not surprisingly, loans were not repaid and the program was suspended after one year (Goro, 2004). VRES would not release the number of operational PPIVs for the 2004 growing season, but agricultural advisors of the organization indicated that perimeter failure rates were increasing, resulting in lost value of organizational learning (Macalou Mamdou, 2004).

The PPIV-service provider principal-agent problem is layered by a similar problem at the village level. Much of the adverse selection problem faced in the ON may be avoided by the small scale communities where most villagers have well-known

reputations for their skills and ethics. The moral hazard problem remains, however. As well, the limited number of literate farmers in the community may limit the options of who can be elected to the perimeter committee – regardless of their reputation for fairness. Farmers, agriculture advisors, and mechanics from both *Garage Moderne* and AVD all acknowledged that village-level *redevance* funds are frequently mismanaged, unintentionally and intentionally. Seasonal costs recorded are too high for goods actually purchased. Depreciation funds disappear. Rules and sanctions are not applied blindly or uniformly. Villagers of status are not expected to pay their *redevance* regularly in some cases (Seckou Sogoba, 2004). Poor quality diesel fuel is purchased from street vendors and money saved is pocketed, etc.

PPIV committees are formally required to maintain seasonal accounting records that are reviewed either by the ORM or VRES/AFAR agricultural advisors; this information is public and can be reviewed by any member of the PPIV. These institutional safeguards should reduce the moral hazard problem. Few farmers in each village, however, may be capable of holding PPIV representatives accountable for the appropriate collection and expenditure of funds due to illiteracy and innumeracy (means) or intra-village hierarchies (power). Literacy skills and position within the village are likely to have been correlated prior to project implementation. Furthermore, the few farmers capable of managing accounting responsibilities (literate and numerate) in each village (agents) are most likely to be voted and re-elected as PPIV leaders by the other farmers (principals). As a result, asymmetrical information and power problems are manifested at the village level as well as between the PPIVs and mechanics or GMP leasing/rental operations.

Part of the AFAR mission is aimed at improving farmer literacy and management skills of the PPIV leaders in each village. Farmers are trained in their local languages to read and write with the aim of improving power balances and management capacity (unfortunately, most accounting notebooks, supply contracts, and mechanics' contracts are in French). Such measures are aimed at improving PPIV management skills (opportunity set) as well as their bargaining and monitoring positions *vis a vis* service and supply providers (power) but cannot be expected to generate immediate results.

Additionally, AFAR targets an initial set of PPIV leaders from each village for training (Cisse, 1998). Those initially selected for leadership positions, if not already in positions of power relative other farmers, will almost inevitably gain relative power. While donors cannot be expected to bring all farmers to functional literacy levels, the potential for exacerbating intra-village inequities needs to be recognized and better understood. If PPIV farmers do not have the means to monitor committee member activities, then election-based upward accountability measures will not serve to reduce the moral hazard problem. External auditing measures for village-level transactions, for example, may be an appropriate/cost-effective complementary option for monitoring village-level accounts.

The current private GMP **rental and lease-to-own** sector is widely believed to take advantage of farmers' limited options by providing questionable services at high prices; again, asymmetrical information leads to adverse selection and moral hazard both. The result is a strong private-sector incentive to apply ingenuity and effort to increase GMP costs. The President of AFAR explained his understanding of the four ways to make money in the private lease-to-own business (Cisse, 2004):

1. Pump owner (agent) has new or used GMP of a quality level that is unknown to the PPIV (principal). He sells GMP to PPIV at a higher price than it was purchased through 3-year post-harvest payment plan (no technical support is given with the pump).
2. Without competition or widespread information about competing providers, the pump owner is able demand payment in paddy at a low fixed price/kilo at the end of the season (e.g., 65 CFAF/kilo, when actual price may be 85 CFAF/kilo).
3. Pump owner can demand payment in paddy during harvest when paddy prices are low, storing paddy and selling it when paddy price rises in February/March (e.g., to 150 CFAF/kilo).
4. Farmers eventually are unable to make a payment; the pump owner confiscates the pump and starts again with another PPIV.

Private rental and repair service providers pose similar problems due to asymmetrical information and lack competition and perverse incentives to provide poor service. Limited competition in the GMP sector, limited communication among PPIVs, and farmers' limited ability to understand if and how a service provider has acted unethically all exacerbate a weak system of using reputations as a tool to reduce both moral hazard and adverse selection. Pump owners do not fear that inappropriate behavior will lead to less business in the future; farmers cannot rely on reputation to help them select quality providers. (AVD and Garage Moderne do have some level of positive reputation as a result of their links to foreign donors but their service capacity is limited.)

In van't Hof's *Lessons Learned* (2002), the author recognizes the need for increased information and training for farmers in GMP-based agriculture in Burkina Faso, Mali, and Niger in order to strengthen the entire sector. He specifically notes the need for identifying locally-available GMP brands, increased user training in GMP use

and maintenance, increased market information about GMP parts supply and demand, and distribution of contact information for official GMP equipment sales and service representatives.

Association des Volontaires pour le Developpement du Delta (AVD-Delta), as described earlier, is an NGO working to develop the GMP distribution and service sector. AVD focuses on leasing pumping services for which users pay for the number of months during which water is delivered to their perimeters. The monthly fee for servicing the entire perimeter is set by AVD at the beginning of season, and payment for the season is put in escrow. The village pays diesel fuel and oil throughout season as needed. An AVD-trained pump mechanic lives in the village and provides pump operation, service, and maintenance as well as providing the village with limited training on how pumps operate most efficiently (e.g., choosing most efficient speed, number of hours, to reduce diesel fuel costs and prolong the life of the GMP).

This leasing system reverses the principal-agent incentive problem of dealing with mechanics because the GMP owner, AVD, is earning a fixed rate for leasing services and must pay repair costs from that fixed rate. The information advantage AVD has over the PPIV does not provide AVD with the opportunity to financially profit from that advantage under the terms of the contract.

Criticism of AVD generally focuses on the level of the rates charged, not the structure of the price strategy.³⁰ AVD explains that the higher rates are what PPIVs

³⁰ It is actually difficult to compare AVD rates to those of other service providers or to pump ownership because of the variety of motors and pumps available. The two components are often sold new as an ensemble, but trained mechanics can replace/repair each component individually. Prices cited in the AVD price comparison (2004) vary depending on whether the PPIV opts for new or reconditioned motor, pump, or both as well as with the horsepower of the motor and capacity of the pump chosen. Various

should charge themselves to guarantee long-term pumping services, and that furthermore, through the AVD arrangement, all of the farmers are guaranteed to receive irrigation services throughout each season across seasons. This guarantee adds the benefit of reduced risk – a significant benefit considering the statistic that 50% of VRES fields are out of service due to GMP disrepair. The problems such as deciding when to continue making GMP repairs, when to renew either the motor, the pump, or both remain in the hands of the mechanic who is trained to make such decisions. In each of the rental or lease scenarios offered by AVD, financial profits per farmer would outweigh production-cost-based fees (when all costs of field labor wages are included). The AVD approach strengthens the GMP service and supply sector in the following ways (AVD Delta, 2004):

1. Increasing competition among the few existing private GMP service providers;
2. Increasing transparency of prices, reducing information costs (all AVD prices and options are in writing and fixed so that farmers can evaluate various options with AVD. This provides farmers with a point of reference that can be used in negotiations with other private service providers to help reduce the adverse selection problem);
3. Decreasing risk to crops by reducing breakdown frequency and duration by having mechanic on hand and back-up GMPs available (risk and cost reduction);

combinations are suggested for different PPIV sizes (usually 20, 30, and 40 ha PPIVs) and different options have different implications for O&M costs and depreciation rates.

4. Increasing quality of service to farmers by training farmers on the appropriate and efficient use of pumps for irrigation;³¹
5. Immediately investing payment for depreciation into purchase of more pumps for the organization rather than having depreciation funds be ‘kept’ by village for use of purchasing next village pump (avoiding the problem villages face of ‘lost’ depreciation fund savings resulting in inability to purchase new GMP, forcing the perimeter to rely on increasingly unavailable donor funds for GMP renewal);
6. Reducing inefficiency in the sector from having reparable village-owned motorpumps remain out of operation unnecessarily because village does not have financial resources for repairs (according to AVD extensionists, in 2004, 30-50% of GMPs at Lake Debo were in disrepair, accounting for 40% of existing perimeters);
7. Hiring mechanics (non-farm rural employment) to live in villages renting pump services where they can diversify their activities in areas such as cooling facilities, dehulling services, etc. Business ethics is an integral part of training AVD mechanics (using *status/value* as an institution to align individual and collective interests that may otherwise be in conflict).

The goal of AVD is to change the structure of the entire GMP sector so that eventually, costs to the PPIVs for GMP provision will fall relative to the benefits.

³¹AVD mechanics can rebuild old motors and match new motors to old pumps so that the entire motor pump group does not need to be purchased every time the motor dies. They are also able to use old car motors and use the GMPs for additional community projects such as small electrification and cooling projects. One VRES farmer reported that some of the villages in his area have started rebuilding motors and matching old pumps to new motors after learning of the AVD approach. AVD Delta (2004).

Imboden, the AVD founder, recognized that the organization was largely attempting to fill the need for a technical school/training program in the region – something that is considered normal to subsidize (public investment) in most developing countries (Imboden, 2004). He also recognized the role of AVD in informal technology transfer, noting that some PPIVs were beginning to experiment on their own with using various locally available motors with imported pumps to extend GMP life.

The brothers at *Garage Moderne* have been working with ORM and VRES PPIVs to service GMPs by contract and on an as-needed basis. The *Garage* also rents GMPs and offer seasonal service contracts for GMPs owned by the PPIV or rented from other private rental businesses. A unique aspect of the *Garage* approach is that under a seasonal service contract, the PPIV management agrees to let the *Garage* verify that the GMP is in good working order at the beginning of the season. Based on the review, pre-season repairs may be required to ensure that GMP is in working order at full cost to the PPIV. These repairs can be made by any garage, but must be made in order for the *Garage* to accept a contract with the PPIV. A set fee is then paid for repair services for the entire season – like a retainer for a mechanic (Diarra, 2004).

The *Garage* is in communication with serviced PPIVs by radio, so news of a breakdown is timely. In the event of a breakdown, the PPIV pays for parts at cost plus any shipping costs from Bamako or Europe. All costs of finding the part and the mechanics' labor and transportation are paid by *Garage Moderne*. Temporary GMPs can be used by the PPIV if repairs may take long. While the *Garage* (agent) has the opportunity to provide unnecessary repairs at the beginning of the season at the expense

of the PPIV (principal) due to asymmetrical information, the *Garage* faces the incentive to reduce number of breakdowns per season – eliminating the moral hazard problem for the season.

The *Garage's* experience contracting directly with PPIVs is relatively new. Previously, the *Garage* contracted to service all GMPs through VRES/AFAR and farmers were to repay the NGOs (repayment was a formal requirement but not a strictly enforced agreement). The bulk of the PPIV clients have continued their contracts with the *Garage* (10 of 13). Two have dropped out and two other new PPIVs joined for just one or two years. The *Garage* explained that those dropping out did so because of disputes over the pre-contract GMP review; PPIVs either did not want the equipment to be reviewed or did not agree to the pre-season repairs identified by the *Garage*.

The *Garage* agreed that renting GMPs is more expensive for PPIVs than ownership *if* the GMP is well maintained and appropriately operated. The mechanic interviewed noted that some PPIVs have been quite successful GMP ownership and management, but added that if all users were capable of handling O&M appropriately then the *Garage* would not have a much of a rental business.

5.5 PPIV Conclusions

In the case of the PPIVs, the pricing structure is fairly straightforward and seems to be appropriately simple for the current needs of the perimeter system. The effectiveness of the other three components of the pricing strategy for cost-recovery – price level, decision-making institutions, and sanctions – is more complicated.

The potential for irrigation pricing to serve as a cost-recovery mechanism that promotes food security and reduces poverty in PPIV communities is limited by each

association's ability to manage costs and revenues over time. If this capacity is inadequate, cost levels of irrigation service can be much higher than they need to be, leading an otherwise well-designed and important project to be financially unsustainable.

Much of the debate about the potential for PPIV cost-effectiveness has focused on the 'best' approach to recover GMP costs (among options of leasing, renting, or ownership). This debate needs to be broadened and deepened to address how costs can be reduced for all options. Understanding how decisions are made and how/if sanctions promote upward and downward accountability is essential to understanding how to reduce costs and price levels.

External agents, like the ORM, VRES, USAID, and AFAR can play an important role in shaping incentives and market structures, but in the end, they do not make many of the daily decisions that can drive down costs for PPIVs. GMP providers and service providers' behavior is an important factor in cost/price levels, but this behavior is determined by how their relationship with the PPIVs is structured based on competitiveness of the sector, the contract they have with the PPIV, and the means of the PPIV to monitor and enforce that contract.

Committee members must have the institutional incentive and capacity make appropriate decisions with respect to GMP acquisition and management. No single contractual solution would be best for all PPIVs, and any one PPIV may have different needs as it experiences organizational learning. External agents such as donors or ORM administrators can serve an important co-management role in all GMP provision scenarios to address the sources of asymmetrical costs of information, bargaining and enforcement that lead to moral hazard and adverse selection problems. General

recommendations below are examples of how external agents can change the market rules and power dynamics without providing direct subsidies that might mute other important market signals.

- Perimeter committees would benefit from, at a minimum, being able to compare different price options among GMP providers, reducing the problem of adverse selection. NGOs could also compile and distribute lists of different organizations' prices for purchases, rentals, parts, and repairs to help promote competition within the sector.
- Promoting contractual designs (e.g., fixed payments per year for GMP services rather than cost-reimbursement contracts) that align the incentives of the principal and agent so that both parties have an incentive to produce effort and apply it toward a common goal, like the example of *Garage Moderne*, would be a useful area for external support.
- Establishing and funding a system regular information exchanges or a referral network among PPIVs to exchange information about GMP management would reduce the cost of contracting for PPIVs, improving the balance of power and information and potentially reducing problems of adverse selection. Such information exchange could incentivize providers to leave their clients satisfied, if there is sufficient competition in the sector to make reputation a factor in PPIV contract decisions. This could turn providers' efforts to make profit away from generating creative new ways to cheat farmers and toward creative ways to earn farmers' business, an example of how technological ingenuity to reduce costs can be induced by appropriate incentive design.

- A system in which an NGO or government agency formally certifies ‘approved’ sales and service providers who submit to periodic external reviews could provide important information to PPIVs and provide an instant reputation to new market participants. To a limited degree, the *Garage* and AVD have this type of endorsement informally as a result of continued NGO patronage. Institutions could be designed to allow PPIVs to file complaints with an interagency/multi-donor board against GMP providers or service providers for evaluation by external reviewers. If this information were verified and disseminated, it would reduce costs of enforcement and provide a layer of upward accountability that would reduce moral hazard problems among service and pump providers.
- Establishing and funding (at least partially) a pump operator-training program that allows operators to exchange experiences and learn how to better maintain GMPs and reduce operating costs could reduce overall PPIV costs. ORM provides these workshops regularly and assumes the cost of this training much the way US extension offices provide various trainings.

With respect to PPIV committees’ efforts to reduce costs, accountability institutions such as transparent bookkeeping and PPIV elections are only a partial step toward balancing power in a way that will generate incentives to reduce costs and address moral hazard. For monitoring institutions to be effective, farmers must have the capacity to use the available information to hold committee members accountable for providing the level of services they are elected to provide. External agents could play an important role in this area by conducting annual audits of PPIV financial books to both increase accountability and educate non-committee farmers about the process of

monitoring and accounting. This does not necessarily solve the problem of how to apply sanctions in the event of intentional financial mismanagement; public disclosure of problematic financial practices, however, may trigger a layer of important social-based incentives at the village level. This is one of the benefits of irrigation management transfer (IMT) and participatory irrigation management (PIM).

Farmer capacity-building, at the individual and committee levels, should be considered an investment to improving the symmetry of information, bargaining, and enforcement transaction costs. This is an important step toward making farmer participation, effective rather than nominal participation. If such investments decrease the high PPIV failure rates, they would increase the long-run returns to donor efforts by allowing PPIV stakeholders to learn from mistakes and experience and apply those lessons in future seasons. AFAR recognizes that high PPIV failure rates are more costly to donors than literacy programs because of high start-up infrastructure and training costs. Training that addresses power asymmetries through capacity building and information dissemination must happen at a much larger, more intense, and more multifaceted scale to induce a sector-wide path change from high failure rates to promoting poverty reduction goals.

6 CONCLUSIONS

This paper has explored the link between cost and price in two irrigation schemes in Mali - the large-scale gravity irrigation authority *Office du Niger* and a number of small pump-irrigated fields at village perimeters along the Niger River, *Petits Perimetres d'Irrigation Villagois*. I have argued that the effectiveness of cost-recovery pricing strategies for improving the long-run financial sustainability of irrigation systems *and* for advancing national development objectives – namely, to improve the effectiveness and efficiency of irrigated agriculture as a means to reduce poverty and improve food security – requires that each of the four pricing strategy components (decision-making institutions, sanctions, price levels, and price structures) be designed specifically to achieve these goals. Seasonal financial cost-recovery does not necessarily result in long-run financial sustainability or poverty alleviation. How price strategy components are designed influences the distribution and absolute levels of cost and benefit flows; design determines how/if decision makers have an incentive to invest effort and ingenuity into reducing irrigation system costs; appropriate designs account for sources of power imbalances among decision makers.

In both cases reviewed, those individuals who would seem to have the greatest incentive to invest effort and ingenuity into reducing irrigation prices (farmers whose livelihoods depend on slim margins of profit) often do not have the means and/or institutional incentives to invest effort into reducing system costs. Asymmetrically distributed transaction costs and perverse incentives to increase irrigation system prices (and total costs) detract from poverty alleviation goals. Appropriately designed pricing strategies can help reduce these asymmetries and reconcile individual and collective

objectives. Understanding the specific irrigation situation is essential to crafting appropriate institutions.

Incentives must exist for those who manage irrigation funds to reduce costs, particularly where there is no competition among service providers. These incentives can be measures of upward accountability such as performance-based sanctions or rewards. Enforcement of such mechanisms will fall largely to external agents or unified farmer advocacy groups like unions. For example, investing effort into reducing irrigation costs is not currently in the interest of ON officials. There is no formal performance-based accountability system for ON officials. Informally, high eviction rates from non-payment will not result in financial problems for the ON given the high demand for parcels, but they may exacerbate poverty and inequality problems – particularly if land redistribution practices are benefiting ON officials, police officers, and the other key power holders as is rumored. Finally, the ON has a monopoly on service provision so irrigation service “buyers” (farmers) cannot find an alternative product or reduce their costs with a lower-cost alternative if dissatisfied with ON performance. Media, unions, and donors are all potential key players in advocating for better financial decision-making processes and fair rule enforcement.

Individuals and secondary or tertiary management groups have little incentive to creatively reduce irrigation system costs in the monopolistic, top-down management context of the ON; cost savings are unlikely to benefit the individual or small group. In the smaller PPIVs, system cost-savings are more likely to impact individual farmers’ lives more directly and more quickly, generating a credible incentive for farmers to personally invest in creative cost-saving behaviors. PPIV management committees have a

collective incentive to invest effort and ingenuity into cost reductions to retain a functional PPIV; in the PPIVs, inability to reduce and recover costs will result in the eventual failure of the PPIV. This provides a layer of upward accountability that does not exist in the ON and a proximity among stakeholders that allows for/encourages coordination across hierarchical levels. This collective incentive may be compromised at the individual committee member level if management's manipulation of cost and price records can lead to personal gain with impunity. If there is a functional monitoring system in place, PPIV committee members can be formally removed from their position and/or the PPIV. They may also be subject to prevailing informal institutions of social reprimand. Reliance on informal village institutions, however, can also exacerbate intra-village privilege and power asymmetries as much as poorly designed formal rules. None of these upward accountability mechanisms exist in the ON. The effectiveness of their existence in the PPIVs is a function of whether or not farmers have the means (time, skills, social clout) needed to monitor committee member behavior or committee members' ability to monitor GMP providers' behavior.

Farmers must also have an incentive to invest in cost-reduction efforts – improving applied technology, participating in management tasks, or monitoring management. In the ON, reduced system costs are not likely to result in lower seasonal fees. The relationship between prices and expenditures is difficult to monitor for farmers – particularly for the portion of funds spent by the ON rather than by the secondary committees. Farmers have no institutional means to hold the ON accountable for wasteful or unethical expenditures that might be discovered through monitoring. As a result, farmers and farmer representatives have little incentive to invest energy or creativity into cost-reducing behaviors to benefit the irrigation network as a whole -

including efforts to monitor ON expenditures - if reduced costs do not reduce prices for farmers and do not noticeably improve irrigation services.

Sources of asymmetrical information and power that undermine farmers' ability to participate fully and effectively in decision-making and bargaining processes to reduce prices or to improve service benefits are areas where external agents like donors, non-governmental organizations, and donor-supported contractors can work to improve the institutional market infrastructure of irrigation service provision. Where there are imbalances in decision-making processes, external agents can provide independent monitoring and auditing services, advocate increased transparency measures such as regularly publishing audit results in newspapers, and provide training in specific skills germane to bargaining and monitoring (literacy, technical knowledge, contract design alternatives, etc.). External monitoring and publicly disseminated performance reviews are particularly important in situations where there is no formal system of upward accountability. Reputation and moral suasion can also be invoked as institutional tools. Investment in these areas can improve the usefulness of pricing as a tool for cost recovery while advancing the broader development objectives of increased and financially sustainable agriculture productivity for poverty alleviation.

These areas of government or external investment may be perpetually necessary given the nature of irrigation systems like the ON. Even if farmers or their representatives do have the data, literacy, or technical skills required for bargaining or monitoring contracts, they may remain on the disadvantaged side of imbalanced power with irrigation system management. Farmers' lack of employment alternatives and the absence of alternative irrigation service providers eliminate their exit option in

negotiations. In PPIVs, if the GMP sector develops and prices and competition are forced to be more transparent through training GMP providers and users, then PPIV committee members will enjoy some of the benefits of competition, such as improved incentives for GMP providers to build reputations for reliable products and service in order to retain business.

Institutional economic theory provides tools for the researcher to look beyond the narrow neoclassical examination of a price structure's ability to meet cost recovery objectives. Analysis of prevailing institutions can help external agents identify where perverse incentives exist for decision makers to increase irrigation service costs – such as GMP leasing agencies, individual ON officials who do not face an individual incentive to invest effort into improving organization-level operations, and farmers who do not have secure property rights. It suggests the need to examine the design of entire price strategy – price levels, decision-making institutions, sanctions, and price structure – within the specific context of asymmetrical means and power among decision makers that characterizes the situation. Particularly in situations of rapid change and uncertainty, the dynamics or formal and informal relationships among diverse parties in decision-making and accountability processes are of significant importance to price and cost levels and distribution. Financial cost-recovery alone is an insufficient measure for evaluating the performance of a pricing strategy against the development objective of irrigation in Mali, which is to support sustainable and productive agricultural sector that promotes poverty reduction and food security.

APPENDIX I: DRAFT IRRIGATION WATER PRICING SURVEY GUIDE

Guideline for Water Pricing Questionnaire

DRAFT

September 23, 2004

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Introduction

This questionnaire guide is based on Elinor Ostrom's book (1992), Crafting Institutions for Self-Governing Irrigation Systems. The questions included in this guide are not meant to be the final questionnaire. Differences among irrigation systems may result in divergence from the questions suggested below. Also, depending on the researchers' interest in quantitative or qualitative analysis, questions may need to be altered to suit those needs.³²

The first section provides two short lists of variables for classifying irrigation systems. These variables can be used to help select irrigation cases for study, to guide final survey design and related, to help structure the analysis of survey results. In the second section, there are specific questions regarding the price formula that can likely be answered by documentation or a system administrator/leader. In the third section, the guide draws on Ostrom's eight design principles for irrigation systems (below) to organize questions for system administrators and for user/farmer organizations. The last section is guide to questions for irrigation system users and draws from the design principles and her list of '*criteria for success*.'

It is intended that the questions will capture critical differences among pricing strategies with respect to their ability to promote various objectives of water pricing. While each system may have water pricing different objectives, they will likely include one or more of the following: cost recovery, demand management, equity, and economic efficiency. It should be understood that irrigation services include drainage services.

- 1 Clearly Defined Boundaries. *Both the boundaries of the service area and the individuals or households with right so use water from an irrigation system are clearly defined.*
- 2 Proportionality between Benefits and Costs. *Rules specifying the amount of water that an irrigator is allocated are related to local conditions and to rules requiring labor, materials, and/or money inputs.*
- 3 Collective-Choice Arrangements. *Most individuals affected by operational rules are included in the group that can modify these rules. (One way to promote ex post compliance with established rules).*
- 4 Monitoring. *Monitors, who actively audit physical condition and irrigator behavior, are accountable to the users and/or are the users themselves.*
- 5 Graduated Sanctions. *Users who violate operational rules are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other users, from officials accountable to these users or both.*
- 6 Conflict Resolution Strategies. *Users and their officials have rapid access to low-cost local arenas to resolve conflict between users or between users and officials.*
- 7 Minimal Recognition of Rights to Organize. *The rights of users to devise their own institutions are not challenged by external government authorities.*
- 8 Nested Enterprises. *Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.*

³² The implementing party may want to consult the *Best Practices for Irrigation Performance* study conducted in many CILSS countries by the Regional Association for Irrigation and Drainage (ARID) and the International Program for Irrigation and Drainage Research and Technology (IPTRID). Results are being diffused through the Improving Performance of Irrigation Perimeters in the Sahel (APPIA) project. The study's organization and financing aspects drew from Ostrom's irrigation management principles.

I. Variables that characterize irrigation situations (based in part on Chambers, 1980)

Basic

1. Average parcel and perimeter size
2. Type(s) of water supply over year (ground, retained runoff, retained river flows, lake, etc.)
3. Irrigation system (pump, gravity, flood, drip, sprinkler, other)
4. Cropping systems/possible crops per season
5. Climate/Length of growing seasons

Dynamic

1. Adequacy of water supply over year
2. Capacity of system to provide sufficient and controlled water supplies
3. Formal and *de facto* water rights of users
4. Financial responsibilities of various parties
5. Political organization of and among various layers of stakeholders
6. Farmer/farm labor relations
7. Labor availability (quantity and skill level)
8. System ownership (private individual, private business, collective, public)
9. Nature of system costs (high fixed costs, asset specificity, high O&M)
10. Land tenure/ownership system
11. Financial and educational status of system users

II. Price Strategy Information (could be gathered from documentation or from interview)

General system questions

1. How long has the perimeter existed?
2. When did irrigation pricing begin?
3. What land rights do users have over the perimeter (e.g., village association), their parcel (titled), or other?

Pricing questions

4. Pricing strategy has: increasing or decreasing block or constant per unit prices?
What is (are) the unit(s) considered in the price formula? Hectares, cubic meter water used, hours or weeks with water service, crop grown, season planted, etc.?
5. Does price have a fixed and variable component?
6. Is price based on estimated value added from irrigation service, on the cost of service provision, or neither?
7. Does price include the value of the water resource itself or just costs of irrigation service? Does it include inputs and other production-related costs?
8. If price includes cost of water, what determines the value of water (water market, government)?
9. Can fees be paid in cash, labor, or portion of harvest? If paid in labor or harvest, how is the unit price determined (collective decision, current market, imposed by another party, etc.)?
10. What financial costs are covered by user fees (if available, percentages covered of each cost by fees or percentage of fees collected that are allocated to each cost)?
O & M for: Dams/weirs, pumps, primary canals, secondary canals, tertiary canals, depreciation of O&M equipment
 - 10.1. *Repayment of capital investments;*
 - 10.2. *Depreciation of infrastructure;*
 - 10.3. *Research or extension costs;*
 - 10.4. *Rental of equipment or services (e.g., motorpumps);*
 - 10.5. *Association's cost of access to water supply, if any.*
11. When are fees paid? (how long do users have to pay fee?)
12. Is the fee fixed per season or is the formula for the fee fixed? Are changes in the cost of providing irrigation services considered in fee (O&M costs may vary significantly w/ changes in cost of labor, diesel fuel, other input costs for repair activities such as concrete, etc.)?

13. (How) Are changes in the value of output ever considered in fee (e.g., due to prices of other inputs, yield reductions from disease, output prices)? Who makes this decision?
14. Do farmers' water-use practices increase system costs? Is price strategy designed in way to generate incentives to improve water use efficiency (improved farmer investment in drainage, monitoring application of water, appropriate choice of crop for water availability)?

Group Motor Pump (GMP)-Specific Price Questions

1. What is the capacity of the pump in terms of irrigated hectares servable? Hectares served?
2. Is the pump or motor owned, leased, or rented by users? If not owned, who is the provider?
3. Do user fees change according to the number of hours the pump is running? The amount of water being pumped per hour?
4. How are recurrent costs paid (diesel fuel, regular maintenance, pump operator)? Do farmers pay motor-pump fees separately from other irrigation fees (e.g., canal service costs)?
5. Who manages the regular operation and maintenance of the pump?
6. Are depreciation funds collected? What is done w/ those funds before the next GMP is purchased?
7. What happens in the event of a break down? (provisional arrangements for water supply, service provider, collection for repair payment)? Can you give an example of what happened last time a pump went out of service?
8. How long is the GMP expected to last? (often given in terms of seasons, hours, or years; estimates of hours are best)
9. Do you use the GMP for the rainy and dry seasons?
10. Has a new GMP had to be purchased yet? How long did you have the last one? Were depreciation savings sufficient? If not, how was the remaining sum collected?

III Questions for Irrigation System Administrators or Council

Name Organization/Position

Place Date

1. Clearly defined boundaries

- 1.1. *Do non-users receive irrigation system benefits and how might that affect paying users (e.g., laundry, livestock, fishing, farmers with informal connections to network)?*
- 1.2. *Who incurs costs informally outside of direct network users (e.g., change in downstream flow quality, quantity, or timing, increased mosquito pop., well or surface water contamination, restricted access to water points)?*
- 1.3. Does the price cover any costs noted above (this may include cost of spraying for mosquitoes, drilling drinking village wells, providing alternative access to water for livestock, etc.)?
- 1.4. Does price formula encourage water conservation or is price independent of the quantity used?

2. Proportional equivalence between benefits and costs to users

- 2.1. *Are there different categories of irrigation service provided as defined by different categories of fees? (What are the fees by user category)?*
 - 2.1.1. *Do fees vary for different levels of service quality?*
 - 2.1.2. *Do fees vary by quantity of service used (number of months irrigating, amount of water used, etc.)?*
 - 2.1.3. *Does value added to annual yield change with the various levels of irrigation services (due to increased water supply, lengthened/additional growing season, or reduced risk)?*
- 2.2. Is there any cross-subsidization among different user groups? (Fees for one group partially cover costs of providing service to another user group.)
- 2.3. What obstacles (transaction and transformation costs) do farmers face when attempting to realize potential benefits from irrigation services?
 - 2.3.1. *Can farmers change crops or cropping practices easily due to decreased output prices, to increased water prices, or to the availability of improved water services? (e.g., learning, input or output market constraints – including labor, farmer or system asset specificity, seasonal lags)?*
 - 2.3.2. *Are some users affected differently than others (due to varied plot size, access to credit, information, decision-making power, etc.)?*

3. Collective choice arrangements

- 3.1. What is/are the source(s) of different operational pricing rules (e.g., sanctioning, allocation of financial or labor responsibilities, provision of corresponding service benefits, collection of payment)?
 - 3.1.1. *Are decision-makers elected? How often?*
 - 3.1.2. *How often are rules/contracts evaluated?*
 - 3.1.3. *How do users provide feedback about the implementation of these rules or during process of rule re-evaluation?*

- 3.2. How can users participate in making collective-choice rules (management, policy making, and adjudication rules that define the process to establish operational price rules)?
- 3.3. Can users participate in decisions that influence system O&M costs (technology choice, level or frequency of upkeep investments, service contracting/bidding processes)?

4. Monitoring and monitor accountability

- 4.1. What water or land use behaviors are related to price (quantity of water used, quality of land/canal upkeep, etc.)? *Are monitors external or internal or a mix?*
- 4.2. What strategies exist for users to monitor the collection and expenditure of fees?
- 4.3. What incentives/opportunities exist for monitors to demonstrate opportunistic behavior/corruption? Have there been recent problems?

5. Graduated sanctions

- 5.1. Are there formal sanctions that correspond to various levels or frequency of non-payment, late payment, or partial payment of water fee?
- 5.2. Are there other farmer behaviors that warrant fines or can result in increased or decreased fees according to operational rules?

6. Conflict resolution strategies

- 6.1. What are the formal processes for users to challenge the application of operational pricing rules? The application of collective choice pricing rules?
- 6.2. What types of pricing problems have these strategies been used for and by whom (organizations, different categories of individuals, etc.)?
- 6.3. How long might this process take and what are the associated financial costs to the farmer?
- 6.4. Are there informal conflict resolution strategies related to the design and application of operational pricing rules (union organizing, strike, protest, informal payments, etc.)?
- 6.5. (How) Have any advocacy groups for/of users been involved in setting or disputing pricing collective choice or operational rules?

7. Rights of users to organize

- 7.1. What legal or political obstacles are there for user organizing efforts (external recognition of organizations, existing organization pressure on new or independent organizing efforts, etc.)?
- 7.2. What supports exist to help user groups organize?

8. Nested enterprises

- 8.1. What are the different arenas and levels of making and implementing operational and collective-choice rules related to pricing (appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities)?
- 8.2. Is there a system of coordination and/or checks and balances among these arenas? Is there upward and downward accountability?
- 8.3. What is users' primary source of information about water pricing issues?

9. Equity

- 9.1. *Are there wealth, gender or ethnic/class differences among users that influence their ability to participate in decision-making processes?*
- 9.2. *Are there wealth, gender or ethnic/class differences among users that influence their ability to realize the (potential) financial benefits of their land (access to info, credit, markets, diversify, respond to relative changes in value)?*
- 9.3. *Do users gain decision-making rights by becoming paying users of the irrigation system?*

III. Guide to Interview with Farmers Organizations

Name	Organization/Position
Place	Date

1. Multiple layers of nested enterprises

- 1.1. What current role do you perceive for yourself/your organization *vis a vis* water pricing (representation, advocacy, lobby, monitoring, information, research, etc.)?
- 1.2. Does your organization participate/intervene at various decision making levels?
- 1.3. Are there any current price-related projects going on now?

2. Collective-choice arrangements

- 2.1. How are users represented by your organization (members, clients, beneficiaries, etc.)?
- 2.2. How do you keep users informed of your activities (particularly those regarding water pricing)?
- 2.3. (How) Do users participate in decision-making or agenda-setting in the organization?

3. Clearly defined borders

- 3.1. Does everyone who uses the irrigation system pay water fees?

4. Proportional equivalence between costs and benefits

- 4.1. Do you know what users pay for irrigation services? Do you feel this is too high or too low? Why?
- 4.2. Do some users receive better or lesser services for the same price?
- 4.3. Do you know what the collected funds are supposed to be used for? Do you have confidence funds are used correctly?
- 4.4. What obstacles might prevent your members from improving the profitability of their lands (access to credit, better input prices, crop insurance, limited knowledge of alternative crops, limited technical knowledge of improving practices, uneven diffusion of technical information, illiteracy, etc.)?
- 4.5. Does your organization play a role in assisting farmers to increase the profitability of their investments/assets (profit per hectare, if pricing is per hectare; profit per m³, if pricing by quantity of water used; etc.).
- 4.6. Does your organization play a role in assisting irrigation administration reduce costs?

5. Conflict resolution

- 5.1. What kinds of conflicts do you perceive regarding water prices (fee level, pricing structure, quality of service, level of user input, adequacy of sanctioning or monitoring systems)?
- 5.2. How are conflicts over pricing rules resolved? Does your organization play a formal or informal role in this (including preventative, information dissemination, advocacy, etc.)?

6. Monitoring

- 6.1. Do you monitor fee collection or expenditures?
- 6.2. What kinds of related information do you produce for your constituents/members?
- 6.3. Where do you find areas of corruption in the fee collection and expenditure system?
- 6.4. Do you perceive that users monitor each others' fee payment/water use behavior?

7. Graduated sanctions

- 7.1. What are the sanctions faced by people who do not pay their fee? Pay late? Pay in part?
- 7.2. Are these sanctions perceived to be fair?
- 7.3. Do certain user behaviors change the cost of service significantly? Are these behaviors sanctioned by other users or by the administration?

8. Minimal rights to organize

- 8.1. Is your organization recognized legally by the government? by the irrigation administration? (if no, why not?)
- 8.2. What obstacles, if any, do you face in trying to organizing users?
- 8.3. Does your political affiliation affect your ability to organize users?

IV. Questions for Irrigation System Users Regarding Irrigation User Fees

Name	Organization/Position	
Place	Date	
Parcel size	Owned/Rented	Number of years
Crop(s) planted	Yield/ha	
Gross revenue for last year's crop		
Net revenue for last year's crop (after irrigation fees and all other costs)		

1. Users are aware of the benefits of paying into system.

- 1.1. Do you think you should have to pay for irrigation services? (if no, who should pay for irrigation costs?)
- 1.2. What is the water fee you pay?
- 1.3. Do you think the fee is too high or too low?
- 1.4. Do you know what that money is supposed to pay for? (in general, water or services or both; and specifically O&M of secondary network, canal maintenance, pump diesel fuel and rent, etc.)
- 1.5. Do you have confidence that the fees are used correctly? Why or why not?
- 1.6. Did you participate in any decision-making process regarding what the price would be?
- 1.7. Did you participate in any decision-making process regarding what the money will be used for?
- 1.8. Do you know anyone who did participate in either process? How were they selected to be involved in that process? (if voted in: Did you vote?)
- 1.9. Are you part of an organization/community that is in contact with that person regularly?

2. Users understand that they will only receive future benefits if they all contribute to system O&M.

- 2.1. What happens if you do not pay your fee this year? If you do not pay two years in a row? If you pay late? If you can only pay part of the fee?
- 2.2. Do you know people who do not pay their fees?
- 2.3. What happens if no one can pay this year? (bad harvest, low output prices, etc.)
- 2.4. Do you know what your yields would be without irrigation services?
- 2.5. Do you know of fields that produce more because of better irrigation services?
- 2.6. Have you seen any new investments in the irrigation network recently (upgrades, drudging, etc.)?
- 2.7. Have they made a difference in the service you receive?
- 2.8. Do you know how those activities were paid for?

3. Users expect to lose benefits if they do not pay into system for operations and maintenance (as opposed to being bailed out by the state or an NGO).

- 3.1. What organizations have helped invest in the irrigation perimeter in the past? What kinds of payments were they (subsidies to O&M, motor-pump donations, infrastructure investments, etc.)?
- 3.2. Do you expect that these groups will continue to support the system?

4. Organizational and financial capacity to keep commitment to O&M responsibilities. Farmers have demonstrated capacity to mobilize resources, allocate benefits and duties, and resolve local conflicts.

- 4.1. Do you feel you have enough money to pay the water fee?
- 4.2. Have you ever missed a payment in the past? What happened?
- 4.3. Do you ever have to borrow money to pay the user fee? Where did you get it? When do you pay it back?
- 4.4. Who do you go to if there is a problem with paying your water fee this year?
- 4.5. Do you have confidence in the fee collection and expenditure system? Why/ why not?
- 4.6. Are you part of any farmers' organization that has worked on pricing issues?
- 4.7. What needs to be done to the irrigation system to improve it? Why do you think this hasn't this been done yet?
- 4.8. Do you share work responsibilities for the irrigation system operations & maintenance or management with other users?

5. Farmers have confidence that water will be available if they decide to invest in other inputs necessary for intensifying or changing crop.

- 5.1. Have you lost water when you expected to have it and needed it? Was this due to drought or a problem with the irrigation system?
- 5.2. What were you able to do? Did you pay a lower water fee as a result?
- 5.3. Are you interested in changing crops to save money on water or to increase your revenues per hectare?
- 5.4. What obstacles might you face before making those investments?
- 5.5. Did you include the kitchen sink?

APPENDIX II: UNION-ON CONFLICT OVER 2003 SEASON IRRIGATION FEE PAYMENTS

Productivity for 2003 season was low due to epidemic disease that attacked rice crops, heavy untimely rains that washed away rice plant pollen, and the late delivery of fertilizers (which turned out to be the wrong kind). The two farmers' unions (SEXAGON and SYNADEC) requested that fields be reviewed for exemption from fees and requested that overall fees not be raised for 2003 as planned in the 2002-2004 C-P.

Not receiving the response they sought, the unions went to the Minister of Agriculture and President for support. Food supplies were promised for the region (but never came). The ON reviewed all fields. Review committees exempted over 3000 hectares from full fee payment, and the ON gave a 3-month payment deadline extension (June 31 from March 31). The *redevance* was raised as planned in the C-P. A series of studies were conducted by different groups to estimate average harvest. Results ranged from 2.4 t/ha (a Dutch firm) to 4.7 t/ha (ON study, down from their first claims that average yields were 5.8 hectares). I was not able to find zone-by-zone yield averages from any other source than the ON. BRLi consultant's unofficial opinion was that the ON may have compromised the statistics, but that the average yield was likely higher than 2.4.

Eviction notices were issued to 4,222 farmers by July 2004. The Niono Zone was hit the hardest: 2,447 small-holder farmers were evicted from 1,914 hectares of irrigated land (average of 0.78 ha/per farmer). The actual final number of evictees is not known, as farmers were given one week after eviction notices were issued to make payments. The Chamber of Agriculture requested permission from Segou city officials on behalf of SEXAGON to hold a protest just before payments were due. Lack of response was translated to indicate permission was not granted. National guardsmen (*gendarmes*) were called in to end a peaceful protest in Niono in June.

Just from flipping through eviction notices to count them, it was clear that many of the evicted farmers had paid part of their *redevance* but still lost all land. SEXAGON proposed a rule change so farmers only lose what they do not pay for and that history of on-time payments be considered before total eviction is imposed. SYNADEC proposed formalizing permission for farmers to lease land to others if they anticipate not being able to pay a fee or allowing the ON to lease farmers land if they are behind in payments, allowing them one year to find payment funds before permanently taking land rights.

ON officials explained that SEXAGON promised farmers fee amnesty in exchange for votes in local elections. The SEXAGON president denied this charge and explained that the ON had cooked the harvest averages and that the ON financed SYNADEC candidates in last election for zone delegates.

It was not clear if evicted farmers did not pay out of protest or because they could not make the payment. Many farmers sell their *contre-saison* harvest to pay growing season water fees by the March 31 deadline. If they did not anticipate having to pay the fee, *contre-saison* revenues may have already been spent.

APPENDIX III: PPIV APPROACHES TO MANAGING GMP DEPRECIATION FUNDS

- 1. Bank up to 20 seasons of depreciation funds for the expected life of GMP:** Not a good option financially but one of the most often suggested by donors, NGOs and government agencies for lack of better idea (recommended for irrigation and drinking water GMPs). Funds are kept safe, but are insufficient since PPIVs generally do not last 20 seasons on the same GMP.
- 2. Bank *de Boeuf*:** Invest money in buying cattle every year and maintain a herd of cattle that can be sold for GPM (worked for one PPIV, was a disaster for another).
- 3. Buy low, sell high:** Redevice (including depreciation) is paid in paddy at an agreed-upon harvest price. Rice is stored and sold by user association when price is high. Redevice plus earned money is saved in the bank. Funds sufficient to buy new GMP and sell old one in just seven seasons instead of 20 and, hopefully, before expensive repairs are required (this has worked well for a few).
- 4. Don't save/collect enough:** Prior to 2001, donors would subsidize the purchase of new GMPs if the old ones broke down. This was a particular problem with the smaller-capacity GMPs which were less expensive, but not suitable for the 20 ha perimeters. Mechanics report that many operable and failed PPIVs have collections of old GMPs with usable parts but do not know their value or know how to make necessary repairs.
- 5. Invest in PPIV expansion:** Use funds to invest in perimeter expansion up to greatest capacity of GMP hoping that greater number of fees being paid will help cover spent funds for new GMP. Didn't work.
- 6. Mixed eucalyptus-rice perimeters:** Increase the value attained from the GMP. Planting eucalyptus throughout and surrounding rice fields creates a microclimate with reduced wind erosion and evaporation water losses, facilitating double cropping. Harvestable trees increase revenues from PPIV and reduce GMP pumping hours, particularly during the dry season. Positive environmental externalities gained in terms of wildlife habitat and reduced deforestation of existing forests. This approach also supposedly increased cash incomes in the village but trees were not managed sufficiently to allow expected revenues from trees to avoid collecting depreciation fees as part of the *redevance*. Trees were not of sufficient quality to sell as expected in timber market for cash.
- 7. Collective fields:** Some VRES PPIVs have allocated part of the perimeter to help cover common costs such as depreciation, and work on the parcels is shared. One agriculture advisor/extensionist said all seven functional PPIVs in his zone had functional collective parcels but could not anticipate if collective revenue would be adequate to serve as a replacement for *redevance*-based depreciation saving. Furthermore the remaining 17 perimeters in his zone were not producing in 2004 at all. Another advisor said none of the eight operational PPIVs in his area had revenue-generating collective fields.

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Comment: This reference is unclear. Is "Basic Concepts...." the title of the chapter in the book or the title of the book? Both need to appear in the citation.

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