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Research Report

Farmer-Based Financing of Operations in the Niger Valley Irrigation Schemes

Charles L. Abernethy
Hilmy Sally
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and
Chégou Maman

International Water Management Institute

Research Reports

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The International Irrigation Management Institute, one of sixteen centers supported by the Consultative Group on International Agricultural Research (CGIAR), was incorporated by an Act of Parliament in Sri Lanka. The Act is currently under amendment to read as International Water Management Institute (IWMI).

Contents

Note on currency equivalents.

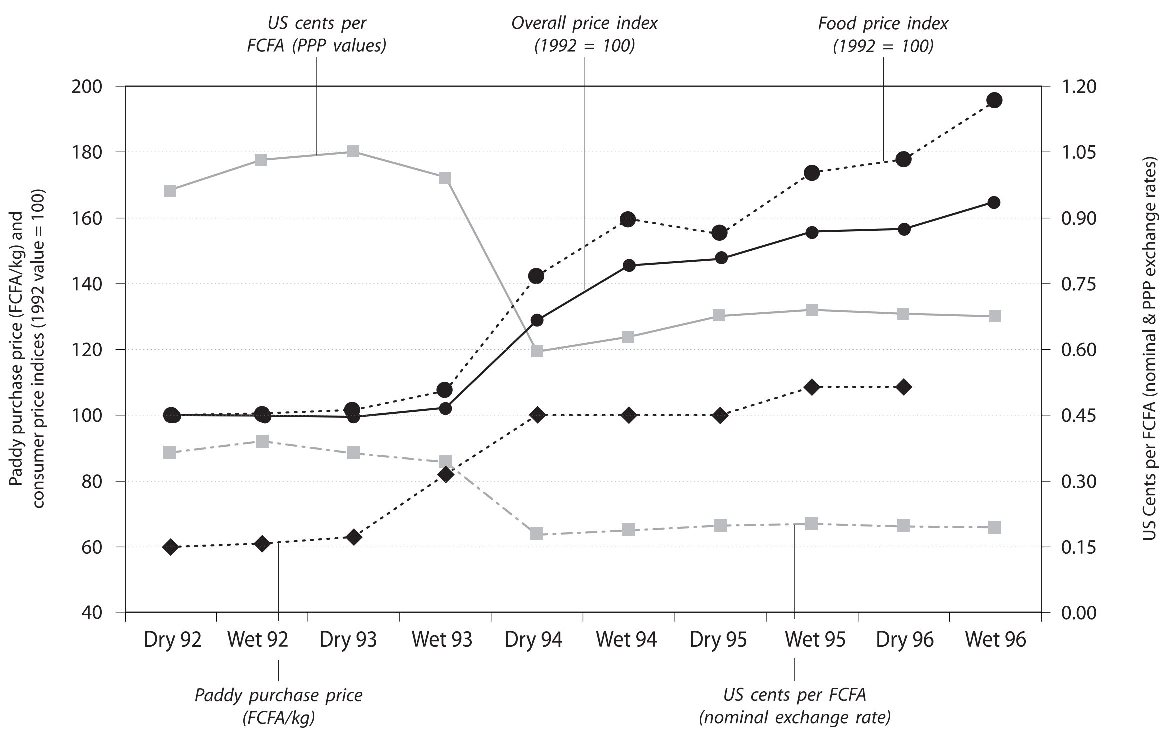
Many of the organizational issues of irrigation systems in Niger (as in other countries) are related to their financial arrangements. The currency of Niger is the CFA franc (FCFA), which it shares with other West African francophone countries. In addition to stating financial information in that currency, in order to help international readers of this publication, we also express an equivalent value in United States dollars, generally in terms of Purchasing Power Parity (PPP). The PPP rate better reflects the actual impacts of prices, fees, and wages on a Nigérien farmer or consumer, by giving a clearer idea of their real value to that person.

The value of the FCFA has not been constant during the period of analysis, which presents some difficulties in interpreting the results concerning the financial viability of the cooperatives. The nominal (bank exchange rate) value of the currency is pegged to the French franc (FF) at a fixed parity rate. For many years the rate was 1 FCFA = 0.02 FF, but in mid-January 1994 it was changed to 1 FCFA = 0.01 FF, at which it has since remained. Insofar as PPP is concerned, prior to 1994, the PPP value of the CFA franc in Niger was 2.5–3.5 times higher than its nominal bank exchange value. More recently (1998) the factor between the two rates has reached about 4.5. In the meantime, two other changes have occurred. The value of the French franc, in terms of the United States dollar and some other international currencies, has declined. Internally, within Niger, the 1994 devaluation was followed by sharp inflation, so the purchasing power of the FCFA has reduced.

The figure below shows the variations of the FCFA purchasing power parity, in terms of equivalent US cents, for the period 1992–1996. It also shows the domestic consumer price index for Niamey, the capital of Niger, and the seasonal price at which the main rice-milling organization contracts to purchase paddy from the cooperatives.

The impact of the devaluation acted initially to assist the rice producers. However, the benefit was immediately offset by comparable rises in prices of imported inputs such as fertilizers, and through time, the benefit was eroded further by general rises in prices. In real terms, the price obtained for a kilogram of paddy in 1996 was only some 10 percent more than it had been in early 1992.

N.B. In this report, financial information is presented in the local currency; the applicable US dollar conversion rate is 1FCFA = 0.68 US cents (PPP exchange rate for January-June 1995).



Summary

This paper presents the results of case studies of the functioning of four pump-based irrigation systems in the Niger River Valley. These studies were carried out between 1991 and 1997 as part of a research-development grant from the African Development Bank (AfDB) to the government of Niger. The International Water Management Institute (IWMI) was the executing agency of this project.

The objectives and performance of these schemes, and their prospects for sustainability are analyzed, especially in the light of the government's policy of promoting irrigator organizations to take over responsibilities for operating and maintaining the irrigation facilities.

Overall, the irrigation systems are producing acceptable results. The systems that have relatively convenient market access in particular show good performance in yield, land utilization, and gross output. Though the performance of remoter systems is lower, their output results are still moderately good by current developing-country standards for such enterprises.

The organizational arrangements in the Nigérien cooperatives do not conform to the principles cited in the literature as being characteristic of sustainable, autonomous locally-managed organizations of irrigators. Significant improvements in sustainability could be expected through better adherence to the principles of transparency, rule-compliance, autonomy from the government, and functional decentralization. In addition, the large size of the organizations puts practical stresses on the available management skills in the community. Indeed, the lack of organizational skills in the rural environment of Niger presents challenges to managing relatively large new organizations, some of the order of 1,000 households.

Financial weakness of the irrigator organizations seems to pose the most serious threat to their sustainability. None of them has been able to accumulate reserve funds to cater to future needs for major repairs and renewals, and they all face shortage of operational funds.

Lessons and recommendations for future organizational and institutional design, with particular emphasis on the reduction of constraints to physical and organizational performance, and on enhancing sustainability, are suggested.

Farmer-Based Financing of Operations in the Niger Valley Irrigation Schemes

Charles L. Abernethy, Hilmy Sally, Kurt Lonsway, and Chégou Maman

Introduction

Background

This report deals with some experiences of a set of irrigation systems situated in the Republic of Niger, along both banks of the Niger River. All these systems draw water from the river through low-lift, electrically powered pumping stations, which have been installed by the Government of Niger over the past 30 years. Irrigation of this kind is not a tradition in Niger. The introduction of this technology caused considerable changes in the way of life of local communities. A host of questions regarding land and water rights, allocation of labor resources, joint financing of communal procurement and marketing, a new relationship with government bodies, and procedures for framing, implementing, and obtaining compliance with practical rules of cooperation had to be faced in the development of the institutional side of these enterprises.

The Republic of Niger is not endowed with substantial financial resources. In 1995, its gross national product per person was US$220 at the nominal exchange rate (World Bank 1997), equivalent to US$750 at purchasing power parity (PPP) rate. It also faces severe human resources problems, having the lowest adult literacy rate in the world, at 12.4 percent, and almost the lowest school-enrolment rate (UNDP 1995). Together, these resource weaknesses pose great difficulties for the sustainability of the newly introduced irrigation technology. The capital funds for the installation of new irrigation systems may be obtained from external donors or lenders, but those sources do not generally fund operational costs. The government's total annual budget is equivalent to about US$153 per person (at PPP), so it obviously finds it difficult, or impossible, to afford the operational cost of about US$550–600 per hectare per year to keep the irrigation systems functioning. On the other hand, the alternative of financing through the systems' users faces different difficulties, due to lack of organizational skills in the rural environment.

The path of institutional development chosen by the Government of Niger for these irrigation systems has been through the formation of cooperatives. These are government-sponsored organizations, established according to a paradigm laid down by the government. In general, there is one cooperative corresponding to each main irrigation pumping station.

The policy objective is to minimize (if possible, eliminate) the financial support from the government, by developing organizations of water users that will be sustainable and financially viable. In applying this policy, the Government of Niger has gone farther than most other governments currently pursuing such policies, and it endeavors to ensure that the irrigation users repay a significant share of capital costs as well as of operational costs. This general policy orientation dates from a broad-based forum on rural development held at Zinder in 1982 (République du Niger 1982). The policy has been elaborated since then and although there have been various political changes in the country during this period, successive governments have adhered consistently to the main thrust of this policy.

The detailed information presented in this paper refers to a subset of four of these irrigation systems, called Saga, Kourani-Baria I, Kourani-Baria II, and Tillakaïna, which were the subject of a research study during the period 1991–97, under a grant from the African Development Bank to the Government of Niger. The International Water Management Institute (IWMI) was appointed as Executing Agency and a study organization designated *Projet Management de l'Irrigation au Niger* (PMI-Niger, or Irrigation Management Project, Niger) was set up to conduct the research.

Themes of the Study

Studies concerning the detailed functioning of irrigation systems and their institutions involve diverse factors and the linkages of causes and effects are not always clear. In this analysis, we seek to address the following four issues, which should influence the institutional and organizational design:

1. There is a high degree of interactivity among various domains that are superficially quite different (water management, agricultural practices, markets and finance, organizational constitution and processes, management skills, irrigators' alternative uses of their labor, etc.), which means that intervention by an external organization, if designed without paying attention to all these factors, is likely to fail.

2. There is a deficit of organizational skills in the rural environment of a country such as Niger, where resources of every sort are scarce, and this presents practical difficulties in managing relatively large new organizations.

3. A sound set of financial procedures is necessary to ensure solvency and viability in these organizations, but it is difficult to ensure these without perpetuating the government involvement and, therefore, attitudes of dependency on the government.

4. The organizational design in actual use is not in conformity with the principles of sustainability developed by Ostrom (1992).

To address these themes, the report employs the following structural arrangement: Firstly, we describe the context in which modern irrigation facilities have been installed, and organizations and institutions have been created in Niger over the past 30 years. Secondly, we briefly review some of the available literature about the process of transferring control of government-created irrigation systems to organizations of irrigators, and about the characteristics of irrigator organizations that may contribute to their sustainability. Thirdly, the performance of the four irrigation systems that have been studied in detail is presented. Fourthly, the specific constraints that may restrict either the physical or the organizational performance of the irrigation systems are identified. Finally, we revisit the above four themes, review the evidence about them in the context of the four irrigation systems, and try to extract some lessons and recommendations for future organizational and institutional design, with particular emphasis on reducing constraints, and on enhancing the likely sustainability.

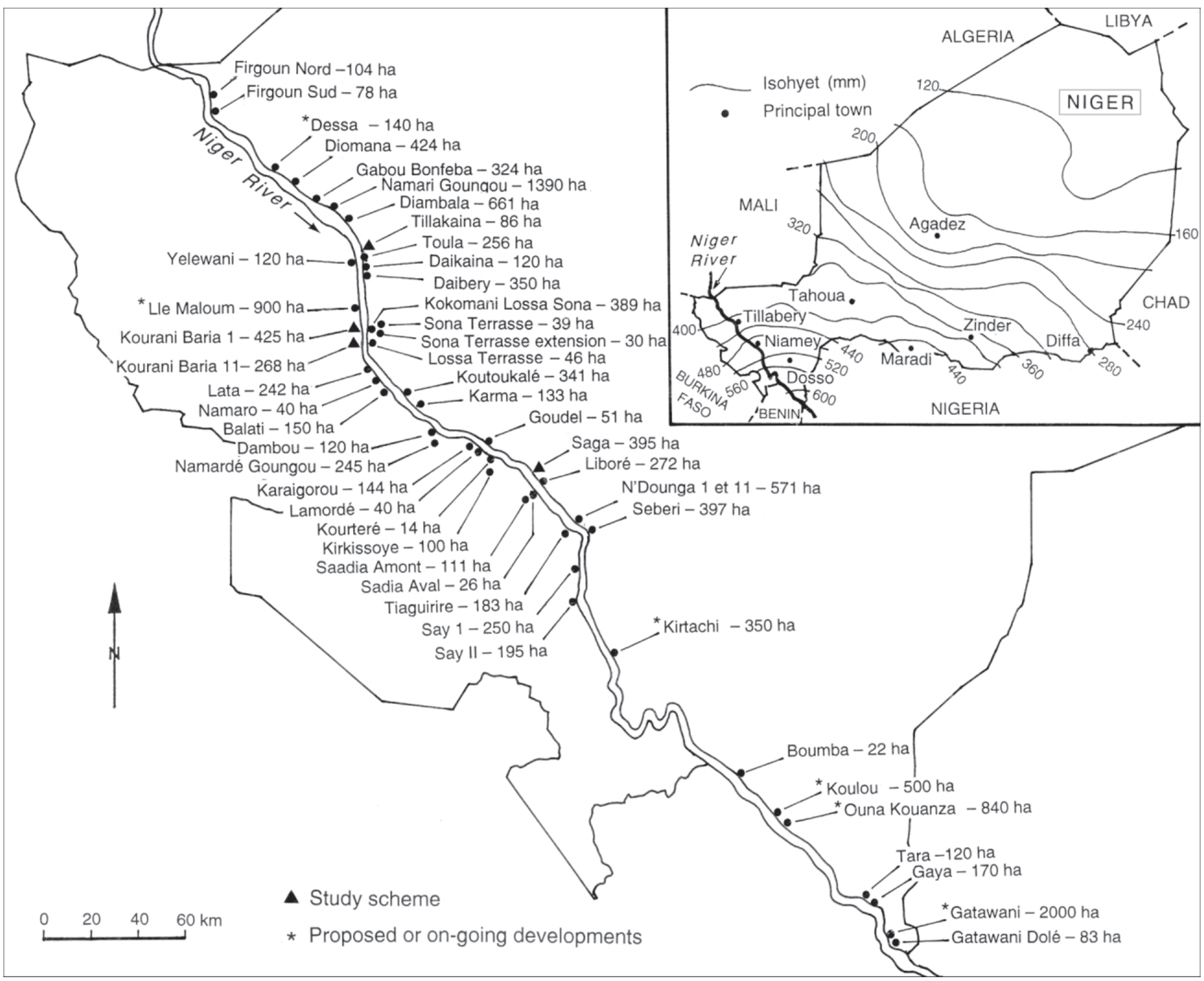
Context and Description of the Study Schemes

Climate and Water Resources

The geography and social features of Niger present formidable development problems. The country is large (1,267,000 km^2 in area), thinly populated (9 million inhabitants in 1995, with an overall population density of only about 7 persons per square kilometer), and land-locked (around 1,000 km from the sea). It does not have abundant water resources. Most of it is hot and arid.

Rain-fed agriculture is possible in a narrow belt running across the southern part, approximately parallel to the frontier with Nigeria. Annual rainfall in this belt varies from about 600 mm at the frontier to about 300 mm at its northern limit (see figure 1). Isohyets of average annual rainfall run nearly parallel to the lines of latitude, so the agricultural potential is strongly influenced by the latitude. In the Niger River Valley, the mean annual rainfall is 500 mm/year at Niamey, the republic's capital, and declines

FIGURE 1.
Location of irrigation systems in the Niger River Valley (Inset: Isyohyets of mean rainfall, 1961–1990).



progressively in the northward direction. The rainy season is brief, with significant amounts of rainfall received from June to September, but in the latitude of Niamey July and August are the only months when rainfall can generally be expected to exceed potential evapotranspiration. To the north of Niamey, adequate rainfall is usually obtained only in August. Annual average potential evapotranspiration at Niamey is 1,889 mm/year.

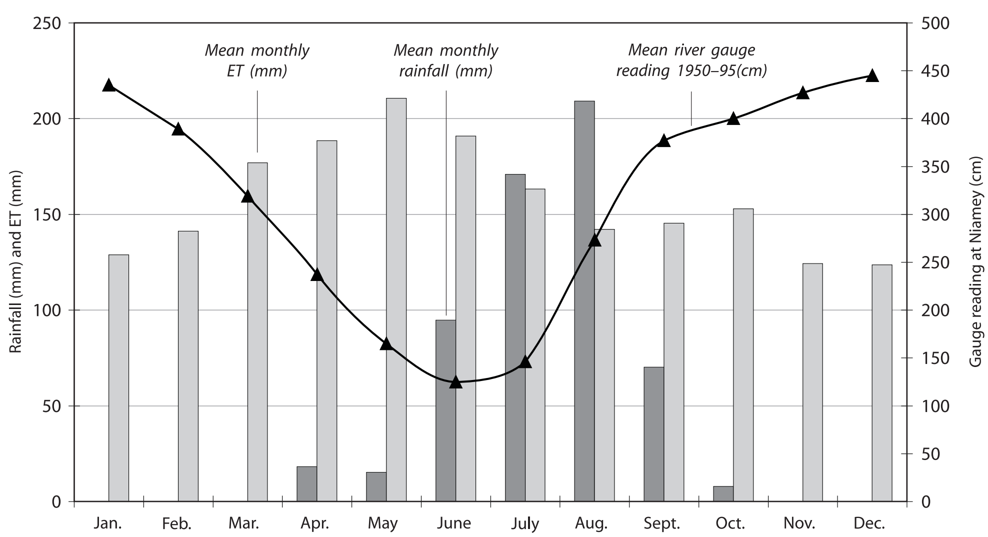
Groundwater resources are significant, and are traditionally utilized in some arid places. Their development is restricted by the country's lack of indigenous energy resources, and the high cost of imported energy.

The annual renewable water resources of the country are estimated at 32.5 km^3/year, of which 29 km^3/year is carried in the Niger River, making it the principal source of surface water resources.[1] This may seem quite a high figure in relation to a population of about 9 million; but it is misleading for two reasons. First, there is no effective water treaty to regulate the country's rights. Nigeria, which lies downstream and whose population is 10 times greater, is also heavily reliant on this river. Second, data on annual averages do not provide information on the wide range of variability of the river. Although the long-term annual average discharge at Niamey for the period 1929–1991 was 29 km^3/year, it ran at 32 km^3/year for the period 1929–1968, and in the years since 1969 it has averaged only 23 km^3/year. The reasons for this variability remain uncertain. Intra-year variability is also high.

The discharge of the river at Niamey can reach 2,000 m^3/s. However, the reliable discharge that can be used for irrigation development (in the absence of a storage reservoir) is only a small fraction of this.

Figure 2 shows the monthly variations of some key parameters: rainfall, river level, and potential evapotranspiration, for Niamey. It will be observed that the rise and fall of the Niger River

FIGURE 2.
Mean monthly values of rainfall, evapotranspiration, and river water level at Niamey, 1950–1995.



[1]The Republic of Niger shares the river with Guinea and Mali upstream, and Benin and Nigeria downstream. The length within Niger is about 550 km, or 13% of the whole length of the river. The Niger River has numerous small, ephemeral tributaries in the Republic. Though they are small in relation to the main river, these can have significant impacts on the irrigation systems. The tributaries deliver flash floods, often with high sediment content, in the rainy months of July and August. These events can have locally devastating effects, both by damaging existing crops, and by temporarily waterlogging the land and thus disrupting the calendar of agricultural activities.

are out of phase with the rainfall, with the river reaching its maximum elevation in December or January, three or four months after the end of the rainy season. This is largely due to the very slow passage of the annual flood wave through an extensive inland delta region in Mali.

The Irrigation Systems

The irrigation potential of Niger is estimated to be 270,000 hectares, of which 140,000 hectares are situated in the Niger River Valley. But the total area presently developed for irrigation is only around 78,000 hectares (FAO 1995a), which is equivalent to about 2 percent of the total cultivated land in the country. Cultivation of rice along the river valley using traditional methods began to be replaced by modern technical irrigation in the 1960s. There are now about 42 of these modern systems, and their total nominal command area is 9,700 hectares, so the average system size is 230 hectares. The distribution of these systems as well as the locations of the four schemes for which detailed studies are reported here, namely Saga, Kourani-Baria I, Kourani-Baria II, and Tillakaïna, are shown in figure 1. Together, these 4 schemes amount to 1,186 hectares, or 12.2 percent of the total area developed so far.

The majority of the Niger River Valley irrigation systems have been designed on the assumption that rice will be the dominant crop, and, in most cases, the only crop. A double-crop system is assumed, with the wet season crop being transplanted in early July and harvested in November, while the dry season crop is expected to be transplanted in early January and harvested in May. However, the actual seasons in use by the farmers differ from these expectations, as discussed later. Some irrigation systems, of which Tillakaïna is one, are not designed for rice production but for vegetables. Such systems use the more permeable terrace soils, somewhat farther from the river and at higher elevations.

Water is pumped from the river, by electrically powered pumps, and distributed to the fields through canal networks that are usually lined. The lift required is in the order of a few meters, but may be somewhat higher if land that is farther from the river is taken into command. Electricity is supplied to the pump stations via the main distribution system of the national power organization NIGELEC, which in turn imports most of its power from Nigeria. Automated water control facilities are installed at many key points within the irrigation systems. In many cases, these are not now functioning as intended. Table 1 summarizes the salient features of the four systems that are the subject of this detailed study.

National Food Needs

Niger faces great difficulty in ensuring food security for its population. The recent development of irrigated agriculture has to be seen in this context. Its population of about 9 million (mid-1995 estimate) has an average growth rate of 3.3 percent per year (World Bank 1997). This implies that the country has to cater to the food requirements of nearly 300,000 extra people every year.

Rain-fed agriculture has focused on coarse grains, especially millet and sorghum. These are grown on very extensive, low-yield farming systems. An enormous increase of the extent of these rain-fed farming systems has been necessary to keep pace with the population growth. However, this expansion has been accompanied by decline in yields, which is, to some degree, inevitable as less suitable land is used. Niger now has the third-largest extent of cereal-growing lands in Africa, at 7,234,000 hectares (FAO 1995b) but yields per planted hectare remain some of the lowest in the world. According to the national agricultural statistics, the average yield of rain-fed millet in the years 1991–1995 was 366 kg/ha, and of sorghum,

TABLE 1.
Principal characteristics of the four study schemes.

Characteristics	Scheme			
	Saga	Kourani Baria I	Kourani Baria II	Tillakaïna
Location	Left bank of the Niger River, 10 km southeast of Niamey	Right bank of the Niger River, 100 km northwest of Niamey	Right bank of the of the Niger River, 100 km northwest of Niamey	Left bank of the of the Niger River, 115 km northwest of Niamey
Year constructed/Year rehabilitated	1967/1987	1986/not rehabilitated	1989/not rehabilitated	1967/1983
Mean annual rainfall (mm)	587	385	385	350
Mean annual evapotranspiration (mm)	1,890	2,060	2,060	2,060
Total developed area, S_0 (ha)	407.3	425.0	267.8	86.0
Area of paddy nurseries, S_1 (ha)	11.3	19.3	11.5	Not applicable
Net available area, S_2 (ha) [= $S_0 - S_1$]	396.0	405.7	256.3	86.0
Area regularly cultivated,[a] S_3 (ha)	379.4	381.4	216.3	76.6
Number of irrigated landholdings, n_1	1,524	1,166	741	248
Number of users, n_2	1,112	1,098	698	207
Average size of landholding (ha) [= S_2/n_1]	0.26	0.35	0.35	0.35
Average area cultivated per user (ha) [= S_3/n_2]	0.34	0.35	0.31	0.37
Wet season crop	Rice	Rice	Rice	Not applicable
Dry season crop	Rice+horticulture	Rice	Rice	Horticulture
Type of irrigation	River-lift + open canal network	River-lift + open canal network	River-lift + open canal network	River-lift + open canals +buried pipes
Pumping equipment	2 pump stations; 7 electric pump sets	1 pump station; 4 electric pump sets	1 pump station; 3 electric pump sets	2 pump stations; 6 electric pump sets
Conveyance and distribution network	2 main and 6 secondary canals+ tertiary network	1 main and 9 secondary canals+ tertiary network	1 main and 4 secondary canals+ tertiary network	2 main and 8 secondary canals+ tertiary network
Nature of farmer organization	Cooperative	Cooperative	Cooperative	Cooperative
Number of GMP[b] units in the cooperative	7	9	5	3
Number of GMP representatives in the cooperative	49 (i.e., 7 per GMP)	90 (i.e., 10 per GMP)	50 (i.e., 10 per GMP)	30 (i.e., 10 per GMP)
Technical support and extension	1 perimeter director from ONAHA[c]	1 perimeter director from ONAHA	1 perimeter director from ONAHA	1 perimeter director from ONAHA

[a] This refers to the average of the areas used for computing irrigation fees during 9 seasons, from the 1992 dry season to the 1996 dry season.
[b] Mutual Production Group, the lowest form of formal organization, which typically covers a secondary canal command area.
[c] National Office for Irrigation Systems (See page 9 for more details).

166 kg/ha. These yields were 73 percent and 25 percent, respectively, of the levels recorded 30 years before. At these rates of yield decline and population increase, some 280,000 additional hectares of rain-fed land[2] have to be brought into use each year to sustain the existing levels of nutrition. This causes significant impacts on the natural environment, especially through the loss of forest land and wildlife species that formerly inhabited it.

The potential contribution of irrigation in this situation is significant, although the scale of the water resources is not sufficient to solve this food supply dilemma. Average yields of 10,000–12,000 kg/ha/year are obtainable with irrigated paddy. With land productivity about 30 times higher than that in the rain-fed systems, irrigated agriculture offers some alleviation of the extreme environmental pressure of continued expansion of unirrigated methods. Another reason for promoting rice-growing facilities in Niger is the increasing demand for rice, especially among the urban population. Domestic production has not been able to satisfy this demand, and the cost of importation, from Asian countries such as Thailand and Pakistan, was growing, at least until the currency devaluation of 1994 changed the relative price advantages.

Of late, the demand for irrigated crops other than rice has also grown. When the Tillakaïna irrigation system was established some 20 years ago, its principal product was green beans destined for an export market. Since then, local demand for irrigated vegetables and fruits, especially in the Niamey markets, has improved. The private-sector small irrigators who pump water directly from the river near Niamey do not use it for rice cultivation, but for these higher-value crops.

This rising demand for irrigated non-rice crops complicates the task of analyzing the performance of the irrigation systems. Not all the irrigators can pursue the option of crops other than rice. The Kourani-Baria systems were not served by a reliable road until very recently, so they could not deliver perishable crops such as vegetables to the Niamey markets; also, these systems experience more flood risks. On the other hand, at the Saga irrigation system, the attraction of growing vegetables for the nearby Niamey market, or for direct selling from roadside stalls, has been strong enough to cause some illicit extensions of the irrigation system, and diversion of water, without collection of corresponding fees from these “unofficial” lands.

The Farming Community

In each of the four irrigation systems studied in detail, the land to be irrigated was taken into the effective control of the government, at the time of installation of the irrigation facilities or before. Land within the irrigation system was then distributed among the future irrigated farmers. Since all these irrigation systems were not built at the same time, the rules of land distribution were not the same in each case. It is also possible that the views of donors of foreign funds had some effect on the land distribution procedures used.

In the initial allocation of the irrigated land, priority was given to people who were former landholders or land users in the area; people of the surrounding areas had the next priority. The size of family also sometimes influenced the size of plot allocated. At Saga, the physical layout of the system made it possible to divide it into nearly equal land units of about 0.25 hectares each. At the two Kourani-Baria irrigation systems, this uniformity was not possible, because of the nature of the terrain. The land units therefore vary quite widely there.

[2]Assuming the mean annual cereal requirements of 280 kg/person and average rain-fed cereal yield of 300 kg/ha/year.

These initial allocations were made some years ago. The precise ownership rights on the irrigated lands remain unclear. Former owners dispute the action of a past government in taking over the land without compensation. The present users of the land are not true owners, since they cannot sell the land if they wish to do so. The irrigator organizations are, to some degree, in the position of owners of the land, since they can charge the irrigators a fee for using it, and can evict and replace irrigators in certain circumstances. However, these powers are not fully in the hands of the organizations, but are subject to a joint decision process with local public officials.

The irrigator households generally have other economic activities. Irrigated agriculture is the primary activity for relatively few of them. Other economically significant activities include unirrigated agriculture, animal husbandry, fishing, trading, and handcrafts. The Saga irrigation system, being in a peri-urban location, has further diversification of activities, including working in the government sector. The households do not (usually) specialize in any one activity. Nor is there any "normal" strategy concerning the mixture of activities undertaken by a household. All possible combinations of these economic activities can be found. The mixing of activities contributes to the net income of the household. A survey of household incomes at Saga in 1992–93 indicated that, on average, 24.9 percent of the net income of the households, and 41.2 percent of gross income depended on irrigated land.

Although the irrigated land units seem small, and population density seems high at the irrigation systems, labor cannot be considered as an abundant resource. The amount of farm equipment available is small, and most agricultural activities have to be done by manual labor. The average amount of labor required to grow a single crop of paddy is 225 man-day-equivalents (mde)[3] per hectare, according to the research surveys. In these circumstances, allocation of the labor resources of the households among their varied economic activities assumes considerable importance. The household labor is likely to be applied where the household members believe the returns are likely to be best. One cannot assume that households will automatically apply their labor to their irrigated land at the agronomically optimal time, or in some agronomically optimal intensity. That will depend on many external or contextual factors, which may vary from season to season and from year to year.

A period of difficulty for the irrigators is the onset of the wet season, usually in June. Because the length of the season for the rain-fed coarse grains is short, farmers cannot afford to delay the planting of their rain-fed land. The extent of rain-fed lands is, for most families, much greater than the extent of their irrigated land, and the two kinds of land may be quite far apart. The reaction of the households to the conflicting demands of labor at this period is not uniform, but is affected by factors such as family size, the timing of first rains, and the specific mixture of activities in each household. These labor-related problems are of greater significance at the Kourani-Baria irrigation systems than at Saga. Irrigated land units at Kourani-Baria are larger, and at Saga, labor is more readily available for temporary employment.

Irrigator Organizations and Management Transfer Policy

Since the Zinder Seminar of 1982 (*République du Niger* 1982), the government's policy has been to promote irrigator organizations at each

[3]The unit of family labor, the man-day-equivalent (mde), is obtained by assuming that a day's labor contributed by a woman or a child (below 15 years of age) is equivalent to 0.67 mde or 0.50 mde, respectively, and that one full day's work is made up of 8 hours.

of the river valley irrigation systems, and to transfer the responsibility for operating and maintaining the facilities to these organizations. The new systems constructed since this (such as the Kourani-Baria systems) were installed with this expectation from the beginning; so, for them, this is not a true management transfer policy involving a drastic change in expectations and attitudes.

Two levels of irrigator organizations were promoted:

- **GMP (*Groupement Mutualiste des Producteurs* or Mutual Production Group)**: This is the lowest formal level of organization. On average, a GMP has about 150 members. Its area is hydraulically defined. Typically, a GMP exists for the command area of a specific secondary canal and all tertiary canals dependent on that secondary. The size of a GMP area usually ranges from 40 to 60 hectares.

- **Cooperative**: This is the unit responsible for an entire irrigation system, including the main pumping station on the river. The cooperative is usually regarded as the more significant of the two organizations. It controls almost all of the collection and spending of financial resources. It also possesses some administrative buildings: usually at least an office and a store enabling it to handle agricultural inputs and crop outputs.

These two types of organizations are established under general laws, which set frameworks for such rural organizations. The framework laws are not specific to irrigation. There are, however, two other documents that govern the activities of the organizations and their relationship to their members. These are:

- A standard or model constitution for the cooperative; this is supposed to be adopted by the members at the time of establishing their cooperative, and it has clauses specifying how they can thereafter amend it.

- A standard contract between each irrigator and the cooperative, which each household head is supposed to sign before taking up a plot of land.

The government established the agency called ONAHA (*Office National des Aménagements Hydro-Agricoles*: National Office for Irrigation Systems) as its vehicle for constructing irrigation facilities and delivering operational support services to them after construction. The services provided by ONAHA have been gradually reduced over the past decade. Its major contributions to irrigation operations and maintenance can be summarized as follows:

- ONAHA provides a system director to each irrigation system. This official is supposed to have an advisory role, rather than an executive role, and is expected to help the committees of the irrigator organizations perform their tasks effectively.

- ONAHA repairs and services the pumping equipment. It does not employ the pump operators, who are locally engaged by the cooperative.

Financing of Irrigation Services

Niger is among the poorest countries in the world. Its government has been able to achieve some development of irrigation, primarily through capital investment projects funded by foreign donors. After an irrigation system is installed, the donor may be prepared to finance operating costs for an initial period of a few years, but after that the costs must somehow be met by local resources. The Nigérien government seeks to arrange that the system users pay the operational costs of irrigation systems. This policy is being followed by an increasing number of countries, since the 1970s. However, the self-financing policy in Niger goes farther than most other examples.

When we speak of "the costs of providing irrigation," we can identify four major components of these costs:

1. the capital cost of building the irrigation facilities,

2. the routine annual cost of operating and maintaining the facilities,

3. the occasional cost of major maintenance and renewals of the facilities, and

4. the overhead cost of any national or regional organizations that exist to organize and provide technical support services.

In many countries, efforts to collect irrigation service fees aim only at the second component. In the Philippines, where fee-collection policies have advanced farther than in most countries of Asia, there are contributions by users towards the third and fourth items, but they are not large, and payment is spread over several decades.

The Nigérien government has developed a system of fee calculation, which is imposed on the cooperatives. Each cooperative employs its own accountant, but the system director (provided by ONAHA) is in a position to monitor compliance with the official approach.[4] The items considered in the computation of irrigation service fees can be divided into two categories: (a) actual expenditures incurred for system operation and maintenance for which the cooperative is required to make direct payments (e.g., wages, goods and services such as electricity); and (b) items that do not require any current payment, representing capital charges for system facilities and equipment (primarily pumps), and also savings for the eventual replacement of these items.

Accounts are compiled for each season. A specimen seasonal account for the Saga cooperative is given in the annex. The seasonal account is closed at the end of each season. The fee that each irrigator should pay during the immediately following season is calculated according to their proportionate share of the area cultivated during the season in which the costs were incurred. Irrigators whose crop fails through no fault of their own (for example, those affected by flood, pest attack, or water shortage) may be exonerated. On the other hand, those who fail to plant in a season when the committee considers that they could have done so, may be held liable to pay a fee share.

The irrigation service fee is large, by current international standards. The main reasons for this are the high cost of energy for pumping and the inclusion of capital charges. The average fee at the three rice-growing systems, Saga, Kourani-Baria I, and Kourani-Baria II for ten seasons from 1992 to 1996 was 61,970 FCFA/ha/season (equivalent to about US$425 per hectare per season at the average PPP rate of exchange for 1995–96). Fees are supposed to be paid in an equivalent amount of crop, but at Saga, the alternative of cash payment is being used increasingly. The conversion of cash amounts to paddy equivalents is calculated at a nationally agreed rate, in which the National Union of Cooperatives bargains with the rice-milling organization and announces the new season's paddy prices before the start of each season.

The cooperatives can supply inputs and services to the members, and collect the corresponding charges in the same manner as the irrigation fees. This has attractions

[4]This is a substantial reduction of the idea of independent decision making by the cooperatives as associations that are theoretically responsible to their own members.

particularly for the farmers at the more remote sites, where access to private-sector suppliers of inputs such as fertilizers may be difficult. A greater attraction is the implicit provision of credit. The irrigator who takes fertilizer from the cooperative store at the beginning of a season does not have to repay its cost until just before the end of the subsequent season. Hence, the effective grace period is nearly a year.

The capital charges, which ONAHA requires the cooperatives to include in their accounts and fee computations, are not the same as the amortization payments required in the Philippines after agreed capital work has been executed by the government. In the Philippine case, irrigator organizations must in turn repay funds to the government agency. In Niger, the payment is retained by the cooperative for the savings system just outlined.

The Nigérien system is unusual in that it does not use a fixed fee (which is the normal practice in Asian countries, if irrigation service fees are levied) but a “true cost” calculation, the result of which has to be available and published to the members very soon after the end of each season. It is clear that such a system requires higher skills in accounting and general management than does a fixed-fee system, in which adjustments may occur only occasionally, at intervals of perhaps, many years.

Organizations of Irrigators

In this case study of specific Nigérien organizations of irrigators, it is not possible to offer a comprehensive review of the considerable literature dealing with irrigator organizations in general, or of the efforts of governments to promote new organizations and use them as a tool in advancing certain irrigation policies. However, some key elements of the recent literature, which seem to be relevant to the conditions observed in the Nigérien systems, are summarized below. We may note that there is a preponderance of Asian cases in the relevant literature, and the applications to the different circumstances of sub-Saharan Africa are not always confirmed.

Locally Created Organizations

Locally generated organizations, if their primary purpose is to provide irrigation services, are frequently referred to as Farmer-Managed Irrigation Systems (FMIS). This terminology is used strictly in situations where the farmer organization controls the water source.

Ostrom (1992) compiled an extensive database on FMIS from many countries, and used it to develop a set of eight principles, which appear to be strongly correlated with sustainability. The principles can be summarized as follows.

1. *Clarity*: There are clear boundaries and rules about who has rights to water.

2. *Equity*: Rules ensure that each member’s contributions and benefits are in balance.

3. *Flexibility*: Rules can be modified by collective decision of the members.

4. *Transparency and accountability*: Monitoring of conditions and actions is done by users or by people accountable to them.

5. *Compliance with rules:* Violators of rules receive graduated penalties, decided by other users or by people accountable to them.

6. *Conflict resolution:* Arrangements exist for settling conflicts, among users or between users and officials, quickly and at low cost.

7. *Autonomy:* Government authorities recognize the users' right to devise their own organization and rules.

8. *Decentralization:* There are different levels of organization, which deal with different functions and decisions.

Yoder's (1994) work on FMIS focused on the practical issue of how governments can relate to these organizations. His studies agree with the above principles at most points, and he adds others to finally arrive at a set of eleven characteristics of successful locally managed irrigation systems. In addition to these general reviews of the subject, numerous studies of individual organizations have been published.

Government-Sponsored Organizations

In recent times, many governments have introduced new policies, which involve transfer of rights and duties to the irrigators as a community in irrigation systems that are owned and established by the government. The implementation of such policies requires some kind of organization of the irrigators, with which the government can negotiate and arrange the transfers. If there is no pre-existing organization appropriate for the implementation of the policy objective, then the government will take steps to promote the formation of such an organization. The essential problem faced by many governments in this regard is that these organizations tend to remain dependent on the government, and their leaders look to government agencies (rather than to their own members) as the source of their legitimacy, and in many cases, the source of their financial support. On the other hand, the members and office holders, being aware that the existence of the organization is important to government policy objectives, may take advantage of this state of affairs to extract concessions and subsidies from the government.

Hunt (1989) used the concept of the "charter of authority" to describe this dilemma. The "charter" is generally a concept, rather than a real document. The holder of the charter of authority is the person or the organization that has effective power to make major decisions—making or ratifying rule changes, deciding whether large physical changes will be made or not. In government-constructed systems, the charter of authority almost always rests with a government agency. Bureaucratic attitudes make it quite difficult to change this perception. The management issue here is: how can these government-sponsored organizations be reoriented, so that they become truly independent of government, and accountable to their own members? How can the charter of authority be passed effectively to the new organizations of the users?

In practice, there are two levels to this problem. In relatively small irrigation systems, governments try to sponsor single organizations that can take complete control of a whole irrigation system. In larger systems, where the irrigation facilities may often be more complex and technically more difficult to handle and maintain, the government usually aims to create a number of organizations internally to each system, but does not aim to relinquish all its involvement in the main system operation. This second case, which is more difficult, is not present among the Niger River Valley schemes, so we shall not pursue it here.

Cernea and Meinzen-Dick (1994) reviewed the experience of projects financed by the World Bank, in which the promotion of new organizations of irrigators was a significant component. They, like Yoder, and as in Ostrom's fourth and fifth principles, stress the importance of accountability of water user associations to all their members rather than to a subset such as large farmers or those in one part of the system, or to the irrigation agency.

They also note a problem that is often faced by government officials who feel it is necessary to give the organization a lot of freedom of action to develop its organizational strength. But what if this leads to deficient performance by the irrigation system? Not every new, inexperienced organization can be relied on to make sound decisions. The authors observe: "*In some instances, independent water user associations will not produce the same results the agency would desire, or will not produce results at the desired time."* This poses a dilemma for field officials of irrigation agencies, especially engineers, who may feel that performance goals should always be supreme.

Cernea and Meinzen-Dick note specifically about the Niger case, that this perception of nonuniformity has itself led to difficulty in transferring the charter of authority. Bureaucracies prefer uniformity and the application of rule systems with wide generality. This is at variance with the need for diversity of organization and localized rule-systems, which characterize irrigation systems, because of their great range of difference in many essential dimensions such as land and water resources, market access, financial resources, economic alternatives, and traditional structures. Issues of this kind have persuaded many people that the transfer of the charter of authority depends largely on changes of attitude within the sponsoring bureaucracy itself. The experience of the National Irrigation Administration in the Philippines, recorded in several papers in Korten and Siy (1989), has been most often quoted in this regard.

Cernea and Meinzen-Dick also address the question of the optimal size of these organizations. In particular, they are concerned with the appropriate size for the "base unit" of an organization, meaning the smallest organizational unit in a hierarchy that may also include larger units fulfilling different functions in what Ostrom calls a "nested" system. The size of an organization is most frequently considered in terms of the number of members or the number of hectares although various other measures are possible. Cernea and Meinzen-Dick, noting that the optimal size depends on certain balances or trade-offs, which in turn depend on local contexts, observe (based to some extent on conclusions of Addison 1986):

"…the costs of maintaining an organization, particularly in terms of conflict resolution and information management, will increase with the size of an organization. There are no economies of scale to be expected in this respect. Groups should be large enough, however, to accomplish the designated tasks by collective action. The median size of approximately 40 hectares found in the examination of Bank-sponsored projects appears to offer a reasonable compromise between these two factors.…The farmers themselves are best able to determine the exact boundaries of actual units. Therefore, flexibility in the actual size of each unit must be allowed."

This recommendation of 40 hectares as the rough guideline for the optimal base unit does not say how many farmers may be involved. In South and Southeast Asia, an area of 40 hectares may typically be expected to mean about 40–50 farm households, whereas, in Niger and neighboring West African countries, it may mean 50–200 households. However, Cernea and Meinzen-Dick also mention cases where organizational units were found to be too large. These include a case with 900 households, described as *"administratively impossible."*

We can surmise that the levels of education and organizational experience should probably be relevant to this issue of size. These factors are likely to be scarce in more remote environments. Good communication is essential for achieving transparency and accountability, and is less likely to be achieved in a large group. These considerations may lead us to the view that the optimal size of base units in an organization of irrigators should be smaller in places that are relatively remote and impoverished.

The ownership of irrigation facilities is another issue that arises regularly in the process of establishing government-sponsored organizations of irrigators. In Niger, and in many other cases, where irrigator organizations have taken over the operation and maintenance of irrigation facilities, ownership of the facilities themselves has not been transferred to the irrigator organizations. This can affect the attitudes of the organizations to undertake the responsibility for major maintenance and renewals, for which they are supposed to set aside savings. Vermillion and Garcés-Restrepo (1996) report a similar situation at two systems in Colombia, where after turnover, farmers did not raise a capital replacement fund as they expected that the government would pay for any future costs of rehabilitation or structural replacement.

Performance of the Irrigation Systems

Generalities

In this section, we present the research findings about the performance of the four irrigation systems. Performance assessment enables verification of the degree to which targets and objectives are being realized. It also provides the different stakeholders (system managers, farmers, and policy makers) a better understanding of how a system operates. It helps diagnose problems and identify ways and means of improving the system. Performance can be assessed in various domains (agronomic, financial, resource consumption, etc.) and at different time scales. In the present study, we seek to examine two sets of questions:

- *Productivity or resource-use issues*: Are water, land, irrigation facilities, and human and financial resources being used in sufficiently productive ways?

- *Institutional issues*: Is the current institutional policy, based on developing the role of the cooperatives, succeeding in producing local organizations that will be viable, sustainable without government subsidies, and able to satisfy the aims of their members?

Outputs and Output Value

Table 2 shows the ONAHA data on the extent of paddy cultivated between 1989 and 1996 in the three rice-producing schemes studied (Saga, Kourani-Bari I, and Kourani-Baria II) and table 3 provides information on outputs and yields in the three schemes.

Table 4 shows the gross values of output per hectare achieved in the four irrigation systems, according to sample surveys conducted for at least one year at each of the four systems. These surveys were conducted in different years, and the money values of output have been converted to a common base of dry season (i.e., January–June 1995) values, using the official indexes of cereal and vegetable prices in Niamey markets as the best available measures of price inflation. The data of table 4 do not indicate the trend of production. At the rice-producing schemes, agronomic yields and crop intensity are estimated by ONAHA in each

TABLE 2.

Utilization of land in the three rice-producing study schemes, 1989–96.

Season	Area cultivated (ha)			
	Saga	Kourani Baria I	Kourani Baria II	Total
Dry 89	375.0	405.0	Still under construction	
Wet 89	373.0	403.3	252.9	1,029.2
Dry 90	380.0	405.2	252.9	1,038.1
Wet 90	381.0	405.2	248.8	1,035.0
Dry 91	376.0	405.0	250.0	1,031.0
Wet 91	376.0	405.0	250.0	1,031.0
Dry 92	375.0	406.0	251.0	1,030.0
Wet 92	381.0	391.0	216.0	988.0
Dry 93	381.0	406.0	249.0	1,030.0
Wet 93	381.0	387.0	240.0	1,008.0
Dry 94	380.0	390.0	254.7	1,024.7
Wet 94	376.0	360.4	200.8	937.2
Dry 95	380.0	403.0	88.2	871.2
Wet 95	380.0	325.0	234.0	939.0
Dry 96	380.0	405.0	255.0	1,040.0
		Mean values		
Dry	378.4	403.2	228.7	1,005.7
Wet	378.6	382.4	234.6	998.8
Annual	757.0	785.6	463.3	2,004.5

Source: ONAHA, Service Suivi-Evaluation: Monitoring and evaluation service of ONAHA.

TABLE 3.

Production and mean yield of paddy at the three rice-producing schemes, 1989–96.

Season	Saga		Kourani-Baria I		Kourani-Baria II		Total	
	Production (tonnes)	Mean yield (kg/ha)	Production (tonnes)	Mean yield (kg/ha)	Production (tonnes)	Mean yield (kg/ha)	Production (tonnes)	Mean yield (kg/ha)
Dry89	1,770	4,720	2,251	5,557	[a]	[a]		
Wet89	1,737	4,656	1,841	4,564	1,458	5,767	5,036	4,893
Dry90	1,735	4,567	1,633	4,029	1,363	5,151	4,671	4,500
Wet90	1,992	5,226	2,212	5,458	1,321	5,308	5,525	5,338
Dry91	2,369	6,301	2,227	5,498	*	*		
Wet91	1,964	5,224	*	*	*	*		
Dry92	1,592	4,245	2,424	5,970	1,180	4,700	5,196	5,035
Wet92	1,943	5,100	1,132	2,894	977	4,522	4,052	4,101
Dry93	2,084	5,469	2,139	5,348	1,139	4,574	5,362	5,206
Wet93	1,972	5,175	1,124	2,903	954	3,972	4,050	4,018
Dry94	2,093	5,508[b]	1,236	3,168[b]	1,180	4,634[b]	4,509	4,400
Wet94	*	*	1,080	2,996[b]	698	3,474[b]		
Dry 95	1,862	4,898	1,082	2,683	261	2,959[c]	3,205	3,679
Wet95	1,801	4,739	525	1,612	832	3,557	3,157	3,362
Dry96	2,019	5,312	1,821	4,493	1,473	5,785	5,313	5,109
				Mean values				
Dry	1,940.5	5,128	1,851.6	4,593	1,089.3	4,763	4,709.3	4,683
Wet	1,901.5	5,021	1,318.8	3,449	1,040.0	4,433	4,364.0	4,365
Annual	3,842.0	10,149	3,170.4	8,042	2,129.3	9,196	9,073.3	9,048

Sources: ONAHA, Service Suivi-Evaluation.
PMI-Niger field surveys, for items marked [b].

*Data not available.
[a]Kourani-Baria II under construction.
[b]ONAHA data not available; PMI-Niger data used instead.
[c]ONAHA data for yield; cooperative's data for area.

TABLE 4.
Gross value of output per hectare in the four study schemes.

Irrigation system	Season	Value of production at dry season 1995 prices (million FCFA)	Area cultivated (ha)	Area developed (ha)	Production value per cultivated hectare ('000 FCFA/ha)	Production value per developed hectare ('000 FCFA/ha)
Saga	Dry 93	199.2	380.0	407.3	524.1	489.1
	Wet 93	198.0	380.0	407.3	521.1	486.1
	Annual	397.2	760.0	407.3	522.6	975.2
Kourani-Baria I	Dry 94	116.9	390.0	425.0	299.7	275.1
	Wet 94	102.1	360.4	425.0	283.4	240.2
	Annual	219.0	750.4	425.0	291.8	515.3
Kourani Baria II	Dry 94	111.6	254.7	267.8	438.2	416.7
	Wet 94	66.0	200.8	267.8	328.6	246.5
	Annual	177.6	455.5	267.8	389.9	663.2
Tillakaïna	1993-94	81.6	76.1	86.0	1,072.6	948.8
Total	Annual	875.4	2,042.0	1,186.1	428.7	738.0

Notes:
1. Production values are based on "farm-gate" prices i.e., prices received by producers without any element of transport or other marketing cost.
2. Prices are converted to a common basis of dry season 1995 by suitable price adjustments.
3. 1 FCFA= 0.68 US cents (PPP exchange rate for January-June 1995).

season but the estimation of vegetable and fruit areas, outputs, and values is not done regularly— these estimates would require a much greater amount of work.

In summary, these data show that:

- The average gross value of production at the four systems studied was 738,000 FCFA per year per developed hectare. This is equivalent to US$1,464 (using the average bank exchange rate for January-June 1995 of 1,000 FCFA = US$1.98) or US$ 5,018 (at the PPP rate for that period).

- There were large variations in the observed performance. The Kourani-Baria I and II systems produced at 69.8 percent and 89.9 percent, respectively, of the average rate, whereas Saga and Tillakaïna produced at 132 percent and 129 percent, respectively, of the average.

- In the rice-producing systems, table 3 does not indicate any clear trend, upward or downward, in the total production obtained in these irrigation systems. Table 2 suggests that land utilization in some of the systems (especially Kourani-Baria I) may be decreasing. But land utilization varies under short-term climatic variables such as drought and flood, and the length of record is not enough to show clearly whether any long-term trends are also present.

Use and Productivity of Water

Water use was considered at three levels: the amount pumped from the river into the irrigation system, the amounts received at the field in sample landholdings, and the degree of equity in distribution among the GMP (Mutual Production Group) areas.

Water deliveries are not normally measured at any point in these irrigation systems. The measurements discussed in this section were made as part of the research studies. The amounts delivered into the irrigation systems were based on analysis of the records of pump operating hours, which are maintained at every pump station and indicate the daily times of starting and stopping, for each pump unit separately. Pump calibration curves were developed by combining the pump characteristics published by the manufacturer with on-site measurements of present capacities. Some stations had river-level records as well, but in some cases, the measuring scales no longer existed. For those, the daily magnitudes of the required lift were found from various records of river levels at locations upstream or downstream, adjusted according to observed seasonal values of river surface gradients.

Water deliveries to the borders of individual fields were measured in sample fields, using observations of the rise in water level in the rice field during each irrigation event, with an adjustment to allow for water evaporation and percolation occurring during the period of the irrigation. The samples were of about 60 fields in each irrigation system (except Tillakaïna, which cannot be measured in this relatively simple way, as it does not grow rice). Observations were made in both wet and dry seasons.

These measurements produced information about water use, which is not normally available to managers or users of these irrigation systems. In the absence of water measurement facilities, their information about water consumption is based solely on the monthly bills for electricity. These bills are shared, under the accounting system, among all users, in proportion to the sizes of their landholdings.

Table 5 summarizes findings at three of the systems, with regard to the amounts and costs of water delivered. In this table, the standard fixed capital and renewal charges for pumping equipment (see page 10, under *Financing of Irrigation Services)* are included as part of the cost of providing water, along with all other water-related costs such as pumping energy, operator wages, and so on.

TABLE 5.
Quantities and costs of irrigation water deliveries.

Item	Units	Saga Dry 92	Saga Wet 92	Saga Wet 94	Saga Dry 95	Kourani-Baria I Wet 92	Kourani-Baria I Dry 93	Tillakaïna 91–92
Water-related fixed costs	000 FCFA	4,675.1	4,675.1	4,675.1	4,675.1	3,210.3	3,210.3	2,740.1
Energy costs	000 FCFA	6,813.7	4,982.7	5,419.3	6,642.3	6,407.8	8,431.8	5,255.3
Other variable costs	000 FCFA	2,008.5	2,020.7	8,698.5	5,197.6	3,126.7	2,672.2	1,502.1
Total costs	000 FCFA	13,497.3	11,678.5	18,792.9	16,514.0	12,744.8	14,314.3	9,497.6
		Water deliveries						
Volume pumped	000 m³	5,682.9	2,487.0	3,112.6	3,875.8	4,947.1	7,735.6	2,145.8
Deliveries to landholdings	000 m³	3,080.1	1,352.9	1,864.4	2,282.8	2,028.3	4,138.5	–
		Costs per cubic meter						
Water–related fixed costs	FCFA/m³	0.82	1.88	1.50	1.21	0.65	0.41	1.28
Energy costs	FCFA/m³	1.20	.00	1.74	1.71	1.30	1.09	2.45
Other variable costs	FCFA/m³	0.35	0.81	2.79	1.34	0.63	0.35	0.70
Total costs/m³	FCFA/m³	2.38	4.70	6.04	4.26	2.58	1.85	4.43
Estimated water losses between pump stations & landholdings	%	45.8	45.6	40.1	41.1	59.0	46.5	–
Net unit cost of water delivered to the landholding	FCFA/m³	4.38	8.63	10.08	7.23	6.28	3.46	–

Table 6 shows some examples of the productivity obtained with the water delivered.

The findings in regard to water use are, in summary:

- Conveyance losses (although the main and secondary canals are generally concrete-lined) were found to be in the range of 40–60 percent (table 5).

- The cost of delivering a cubic meter of water to the farmer's field was found to vary between 3.5 and 10 FCFA. Costs were lower in the dry seasons, because (a) the pumping lift is less (as river water levels are highest in the early part of the dry season), and (b) the volume of water required is more, which means that fixed charges are spread over a larger volume.

- The value of production, per unit of water pumped into the irrigation system, in the dry seasons, varied between 15.3 FCFA/m^3 and 33.5 FCFA/m^3. When calculated on the basis of water delivered at the field, these figures improve to 30.6 and 67 FCFA/m^3.

- The value of production exceeds the total cost of providing water by a factor of about 7 on average.

- There is no evidence of any trend of increase or decrease in water consumption or water productivity.

The equity of water distribution was studied at the level of the secondary or GMP units. The results of measurements of water received at sets of sample land holdings throughout one dry season in the Saga and Kourani-Baria I system are shown in table 7 and figures 3a and 3b. It is observed that higher land productivity is obtained in the GMP areas, where fields are better supplied with water. But water productivity shows an opposite trend. This is consistent with the fact that farmers are more concerned with maximizing returns from their (limited) land-holdings and will tend to take as much water as possible to achieve this objective. There is little incentive to reduce water use. Volumetric measurements of water to individual fields are not made. Water (and energy) costs are apportioned among all farmers according to the size of their landholdings.

The conveyance losses of 40–60 percent, noted in table 5, may seem unexpectedly high, since the principal canals are concrete-lined. Losses are probably occurring in three ways: leakage from the lined canals, through cracks and deteriorated joints; leakage from unlined tertiary channels; and overspill of water to the

TABLE 6.
Overall productivity of irrigation water.

Irrigation system	Season	Value of production at dry season 1995 prices (million FCFA)	Volume of water pumped into the system ('000 m^3)	Value of production per unit of water pumped (FCFA/m^3)
Saga	Wet 93	199.2	3,216.0	61.9
Saga	Dry 94	198.0	5,908.1	33.5
Kourani-Baria I	Dry 94	116.9	7,634.7	15.3
Kourani-Baria I	Wet 94	102.1	4,334.9	23.6
Kourani-Baria I	Dry 95	99.1	6,475.5	15.3

Notes:

1. Kourani-Baria I and II pump data are not complete. Wherever possible, gaps in the data have been filled by estimation, based upon other years and the areas in cultivation.
2. For the calculation of seasonal water volumes, the wet season is considered here as half the month of June plus all of the months July to November.

TABLE 7.
Variations of water supply and yield between GMP units in the Saga and Kourani-Baria I schemes.

	Saga : Dry season 1994				Kourani-Baria I : Dry season 1995			
GMP number	No. of land-holdings sampled	Mean total water delivered to the field (mm)	Mean crop yield (kg/ha)	Crop production per unit of water delivered (kg/m³)	No. of land-holdings sampled	Mean total water delivered to the field (mm)	Mean crop yield (kg/ha)	Crop production per unit of water delivered (kg/m³)
1	5	658.4	7,400	1.124	6	423.0	2,795	0.661
2	8	421.1	4,920	1.168	5	355.6	1,947	0.548
3	12	449.5	4,786	1.065	9	401.2	3,313	0.826
4	8	620.2	5,642	0.910	4	418.2	2,239	0.535
5	4	649.6	6,474	0.997	3	427.3	2,959	0.692
6	9	540.3	5,541	1.026	9	624.1	3,066	0.491
7	3	491.3	6,018	1.225	9	565.9	3,397	0.600
					5	619.2	3,458	0.558
					8	563.3	3,073	0.545
Whole system	49	529.6	5,566	1.051	58	503.4	3,003	0.597

Notes:
1. The column "crop production per unit of water" is based on the volumes of water delivered to the sample landholdings.
2. If we wish to consider the overall productivity of the water pumped into the irrigation system (as in table 6) it will be between 40–60 percent of these figures, because much of the water that is pumped into the irrigation systems does not reach the landholdings but is lost to seepage.

drains. The last of these may explain higher losses at Kourani-Baria I, where the pump facilities are not adequate for the irrigated area. Hence, night irrigation is often necessary, but is difficult to organize. No analysis of these different types of loss has been done. The high level of losses may confirm findings of other researchers, for example, Upton and Chancellor-Weale (1988), who found that in Indian systems linings were effective for seepage reduction only for a few years, probably due to environmental stresses and deficiencies of maintenance.

Costs

The costs of irrigated agriculture for a sample of irrigator households and the costs to the cooperatives of providing irrigation services were analyzed.

Table 8 shows the household costs of production. The components included here are: all agricultural inputs, paid labor, and irrigation fees, plus the estimated opportunity costs of seasonal capital and of family labor.

Table 9 shows the net returns obtained by the household, in terms of net revenue per person-day of family labor (in this case, net revenue is taken to be crop value minus all costs except the opportunity cost of family labor).

At the household level, these tables show that,

- In general, irrigated agriculture is profitable for the households. This is not an unexpected result, since the demand for irrigated plots, when any plot becomes vacant, is said to be high, and land utilization remains high except in climatically adverse seasons.

- Costs, including family labor valued at opportunity cost, are usually about 70–80 percent of crop value; the average is 75.4 percent.

- Irrigation fees are generally in the range 12–25 percent of gross crop value. This is

FIGURE 3A.

Influence of water deliveries on yields in different GMP areas in the Saga and Kourani-Baria I schemes.

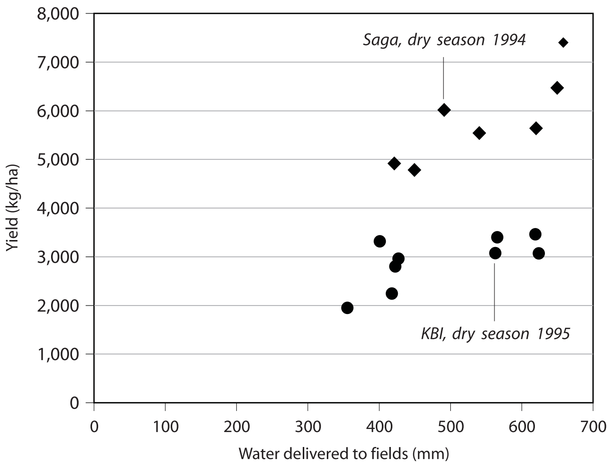


FIGURE 3B.

Influence of water deliveries on water productivity in different GMP areas in the Saga and Kourani-Baria I schemes.

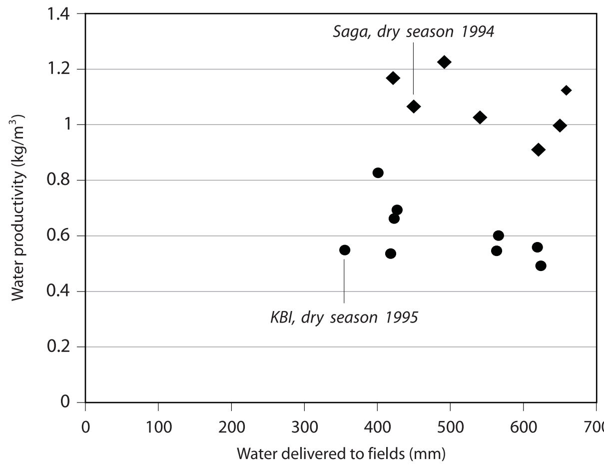


TABLE 8.

Mean costs of production per hectare (Units: FCFA/hectare).

Cooperative and season	Direct costs					Opportunity costs			Total
	Paid labor	Other immediate expenses	Inputs bought at the co-operative	Irrigation fees	Total direct costs	Capital	Family labor	Total opportunity costs	costs of production
Saga wet 93	92,108	37,540	10,430	60,190	200,260	29,170	91,270	120,440	20,700
Saga dry 94	104,780	46,340	13,540	62,890	227,480	34,000	106,360	140,360	367,840
Kourani-Baria I dry 94	36,700	8,000	43,250	59,830	147,780	10,060	69,370	79,430	227,150
Kourani-Baria I wet 94	43,890	6,390	50,780	60,670	161,730	11,310	58,430	69,740	231,470
Kourani-Baria I dry 95	37,510	6,940	39,020	64,710	148,180	10,000	69,370	79,370	227,550
Kourani-Baria II dry 94	65,410	8,220	46,350	51,470	171,430	16,560	70,150	86,710	258,140
Kourani-Baria II wet 94	47,760	9,650	54,470	70,460	182,350	12,920	58,880	71,800	254,150
Kourani-Baria II dry 95	31,550	31,680	12,260	81,000	156,500	14,230	70,160	84,390	240,890
Tillakaïna wet 93-dry 94	39,610	3,770	53,140	208,310	304,790	9,760	100,130	109,8904	14,680

Source: PMI-Niger field surveys (Socioeconomic section for Kourani-Baria I&II, SS94; Agronomy section for all other lines).

Notes:

1. All data represent actual expenditures at current prices. No price adjustments for inflation effects are used.
2. (a) The opportunity cost of family labor was taken to be the same as the prevailing local rates for salaried labor: Saga (wet season) = 750 FCFA/mde (For mde definition, see footnote 3); Saga (dry season) = 800 FCFA/mde; All other sites = 500 FCFA/mde; the values at Saga are higher on account of its proximity to the capital city, Niamey.
   (b) The opportunity cost of capital was taken to be equivalent to 50 % per year (or 22.5 % per 6-month season), based on the work of Kaboré et al. (1994); this rate was applied to all items of immediate costs, essentially salaried labor and fertilizer purchases from outside suppliers.
3. Tillakaïna data refer to a period of 12 months. All other lines refer to periods of 6 months.

high by the standards usually reported from Asian irrigation systems, and is primarily because of the high energy cost element, and the inclusion of substantial capital elements.

- The returns to family labor are on average around double the current cost of unskilled manual labor in the same areas. This again seems to confirm or explain the motivation of the households towards irrigated agriculture.

- However, this margin may be necessary to maintain that motivation. When a sample of about 150 households is examined in detail, the variation of results is found to be wide, and for a few households the returns are negative. At Kourani-Baria I, as tables 8 and 9 show, the average margins obtained are less satisfactory; there is also indication of some decline in cropping intensity (table 2). It seems plausible that this represents a loss of motivation among the less successful irrigators, who may be giving preference to other activities in their allocation of household resources.

Figure 4 shows how the costs incurred by the cooperatives have varied over recent years. The values shown here are total seasonal costs, inclusive of capital and renewal charges; so these are exactly equivalent to the fee charges that will be levied from farmers during the course of the ensuing season.

Costs have been rather stable, especially when the effects of devaluation and inflation are taken into account. The variation among the three rice-producing systems is almost negligible. The effective level of costs improved after the currency devaluation of January 1994. The irrigation fees rose by 25 percent or less, in the subsequent two-and-half years, while the general cost of living index went up by about 50 percent. This is largely because the formula for calculating capital charges has no inflation adjustment.

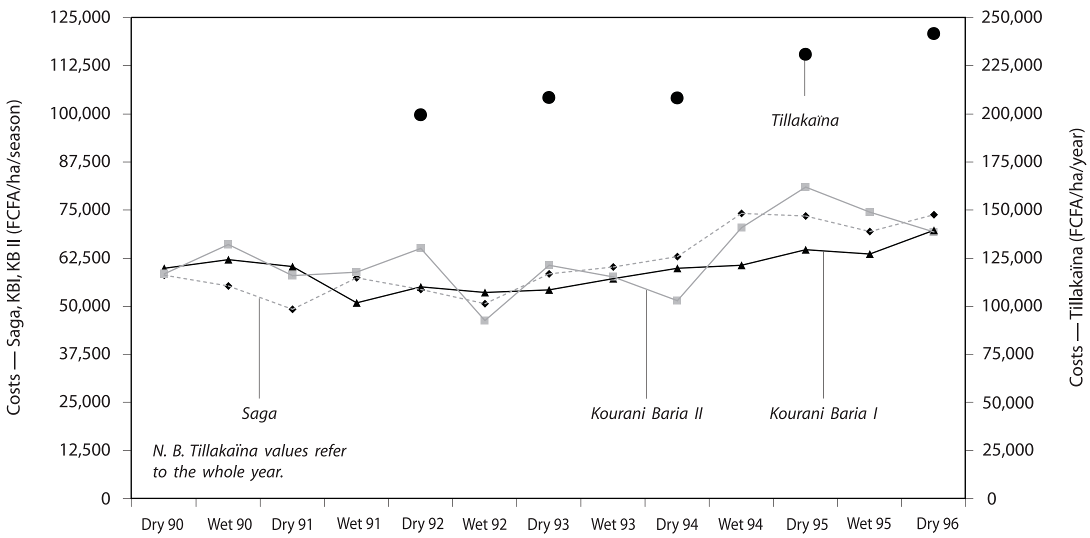
TABLE 9.
Net returns per unit of family labor.

Irrigation system	Season	Gross value of production (FCFA/ha)	Total costs of production (not including family labor) (FCFA/ha)	Net revenue to farm families (FCFA/ha)	Family labor inputs (mde/ha)	Net revenue per unit of family labor (FCFA/mde)	Current cost of agricultural labor (FCFA/mde)	Ratio of net evenue to current cost of labor
Saga	Wet 93	429,800	229,400	200,400	121.7	1,646.8	750	2.20
Saga	Dry 94	521,050	261,500	259,560	132.9	1,952.4	800	2.44
Kourani-Baria I	Dry 94	299,700	157,800	141,880	138.7	1,022.6	500	2.11
Kourani-Baria I	Wet 94	283,400	173,000	110,350	121.7	906.9	500	1.81
Kourani-Baria I	Dry 95	280,100	158,200	121,910	138.7	878.7	500	1.76
Kourani-Baria II	Dry 94	438,300	188,000	250,340	140.3	1,784.3	500	3.57
Kourani-Baria II	Wet 94	328,600	195,300	133,370	117.8	1,132.6	500	2.27
Kourani-Baria II	Dry 95	222,400	170,700	51,690	140.3	368.4	500	0.74
Tillakaïna	Wet 93 Dry94	845,700	314,500	531,170	200.3	2,652.3	500	5.30

Notes:

1. Prices and costs refer to the year in which the surveys were conducted.
2. Costs and production values per hectare are based on cultivated hectares, not developed hectares.
3. In this table, the column “Total costs of production” includes all cash costs and payments to the cooperatives, plus the opportunity cost of capital employed. No cost of family labor is included.

FIGURE 4.
Seasonal costs of providing irrigation services, 1990–1996.



Fee Collection and Operating Finances of the Irrigator Organizations

The cooperatives have to finance their activities by collecting irrigation service fees from the irrigators. In addition, they collect charges for other services that they may provide, such as supply of inputs (especially fertilizers). They may also give loans to members, which will have to be recovered. In the following paragraphs, we use the word "fees" to mean the standard payment per hectare, which everyone who cultivates is required to make; and we use the word "charges" to mean payments required for extra services such as input supply, which are to some extent optionally requested by irrigators individually.

There is no profit element in the fee computation. It may be possible for the cooperative to make some profit on input supply charges, but the scope for this is not great. On the other hand, the capital elements of the fees do not have to be paid out to anyone, and so it has been assumed that the cooperatives would accumulate surplus funds in the bank, which would also generate interest income at least until they were required to be used for equipment renewals. In fact, all the cooperatives have struggled financially. Some have not been able to make timely payments for services they receive. No cooperative has accumulated the expected savings.

A major reason has been late payment of fees and charges by the irrigators. They do not easily escape altogether from payments, because individual accounts are maintained and unpaid arrears are carried over from one season to the next. The cooperatives also have power under the standard form of constitution, to evict members from their irrigated land, if they persist in arrears. However, a certain level of arrears remains and seems to be difficult to eliminate.

Figures 5 and 6 show the patterns of arrears at the cooperatives of Saga and Kourani-Baria II. A member is allowed one season to pay the normal fees and charges of the preceding season. If the member does not pay within this permitted time, then at the end of that season the debt will be classified as "arrears." Hence at each change of season, the total of arrears increases in a sharp step. Through each season, the cooperative collects some outstanding arrears; then, at the end of the season, a fresh increment of unpaid amounts is added, producing the "saw-tooth" profiles shown in figures 5 and 6.

Unfortunately, the research team was not able to develop histories of arrears at the Kourani-Baria I and Tillakaïna cooperatives, in the same manner as in figures 5 and 6. (This is not surprising, since the level of accounting work required to keep track of some thousands of individual accounts is quite large, and the arrears problem was not given close attention initially). However, there seems no reason to suppose that they would show a very different trend from the two shown, except that the actual level of debt at Kourani-Baria I seems at the present time to be substantially greater than the others (see below, table 10).

The problem that confronts all the cooperatives is essentially one of cash flow. They have no way to augment their cash resources, because the standard fee-calculation system is rigid and only allows them to levy fees in exact accordance with their expenditure. The cooperatives' needs for working capital have been growing, due to various reasons:

- The devaluation of 1994 has increased the nominal amount of their cash transactions by about 25 percent.
- The state-owned agricultural bank failed in the early 1990s, during an early phase of the government's economic reform program. Some of the cooperatives had placed resources there; these accounts have since been described as "frozen," and it is not clear whether any will eventually be recovered.
- In the more remote systems at Kourani-Baria, where local resources are scarce, the great majority of irrigators prefer to obtain

FIGURE 5.
Arrears of payment for fees and charges: Saga irrigation scheme, 1992–96.

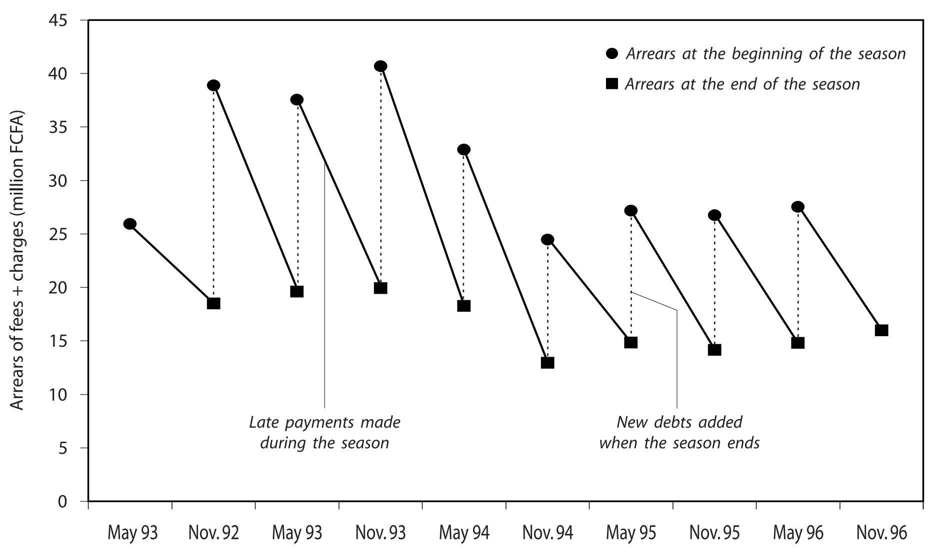
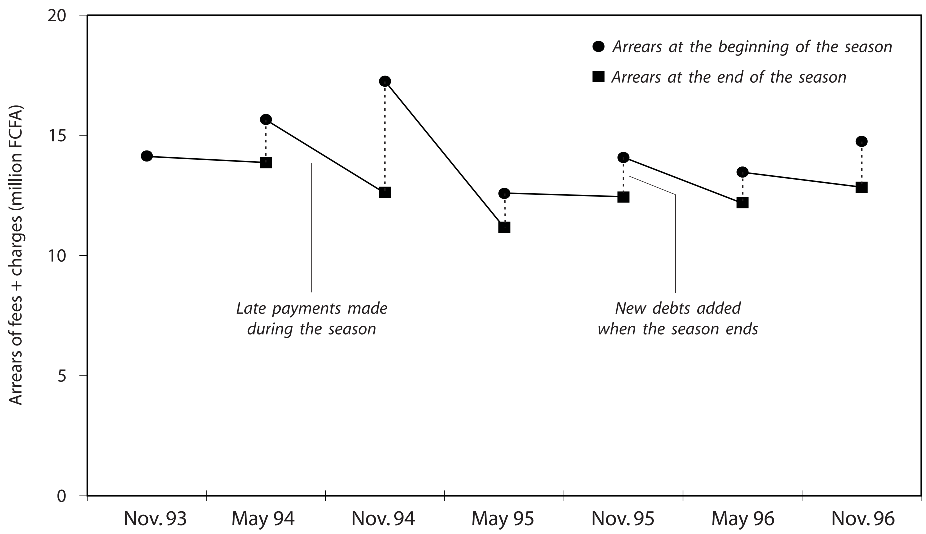


FIGURE 6.
Arrears of payment for fees and charges, Kourani-Baria II irrigation scheme, 1993–96.



their fertilizers at the cooperative. To meet this demand, the cooperative must buy before the season commences, but then the members are entitled to wait until any time before the end of the following season, before the rules oblige them to make payment. The scale of this difficulty, for the cooperatives, is shown by the fact that, at Kourani-Baria, the amount of the accounts for these input charges has now grown to exceed the amount of the fees.

- A proportion of irrigators, as indicated by the arrears levels in figures 5 and 6, delay payment even beyond the end of the allowed grace period.

The result of these pressures is that the present cash needs of the cooperatives are much greater than what was initially envisaged. Because of this they are unable to develop the expected savings, and are not setting aside resources which would enable them to deal with any serious emergencies, such as the replacement of a large pump.

Table 10 shows the state of the three rice-producing cooperative funds at a specific point in time, the end of the wet season of 1996. If the restricted accounts (that is, the funds intended for capital purposes) were really retained, these organizations would all be insolvent. The Kourani-Baria cooperatives are insolvent in any case, and can only make cash payments for vital needs such as electricity and fertilizers after considerable delays. Kourani-Baria II cooperative has not yet been able to put anything into its savings account. The most successful of these cooperatives, Saga, has developed a savings account, but has to access it regularly to meet current cash needs.

Institutional Strength

In the preceding section we have described the financial capacities of the cooperatives, which can be measured and quantified. However, although finance is certainly very important, it should not be considered as the only factor in sustaining the cooperatives. In this section, we

TABLE 10.
Financial position of the three rice-producing cooperatives as at 30 October 1996 (Units: FCFA).

	Saga	Kourani-Baria I	Kourani-Baria II
Assets			
Bank accounts:			
Current account	495,552	224,338	87,567
Restricted account	24,856,818	4,278,248	–
Frozen accounts (Niger Rural Development Bank)	2,494,590	10,778,053	–
Subtotal	27,846,960	15,280,639	87,567
Debts owed to the cooperative:			
Irrigator arrears	27,544,009	70,989,955	14,751,365
Others	2,708,868	4,755,698	
Subtotal	30,252,877	75,745,653	14,751,365
Total of assets	58,099,837	91,026,292	14,838,932
Liabilities			
Debts owed by the cooperative to:			
Fertilizer suppliers	3,100,000	52,003,680	–
NIGELEC (Niger Electricity Company)	597,448	2,613,473	–
ONAHA	1,000,000	496,540	8,197,377
RINI (Niger Rice Processing and Marketing Company)	1,822,690	500,000	–
Central Input and Supplies Agency	–	–	1,961,500
Seed farm	1,560,125	–	–
Total of debts	8,080,263	55,613,693	10,158,877
Net assets	50,019,574	35,412,599	4,680,055
Net current assets	19,980,975	-46,355,409	-10,071,310
Net current unrestricted assets	-4,875,843	-50,633,657	-10,071,310
Net assets per available hectare	126,312	87,288	18,260
Net current assets per available hectare	50,457	-114,260	-39,295
Net current unrestricted assets per available hectare	-12,313	-124,806	-39,295

Source: System directors and accountants of the cooperatives.

Notes:

1. Net assets = total financial assets - total financial liabilities.
2. Net current assets = net assets - frozen accounts - irrigator arrears.
3. Net current unrestricted assets = net current assets - restricted accounts.

review the available evidence about the strength and the longer-term viability of these organizations. In making this assessment, we do not have clearly quantified parameters, and must depend, to some extent, on our own judgements.

In their responses during field interviews, irrigators in the two Kourani-Baria systems frequently showed that they had low levels of satisfaction with their organizations. The organizations have not, generally, developed attitudes of transparency and accountability, in their relations with their members. They have also not developed ways of involving their members into their decision-making processes, or consulting them generally about planning decisions. Many farmers said that they were not aware who their GMP representative for water management was, or what their cooperative's plans were, and in other ways, they expressed alienation from the system of management. The irrigators show by their behavior that they do not have high respect for the decisions reached by the executive committees of the cooperatives.

The relationship of the organizations to their members is affected by the land tenure situation. Irrigators do not obtain formal title to their lands. The cooperative does not own the land, but it has one of the basic powers of an owner, since it can evict and replace an irrigator who breaks any of the key rules. (Strictly, this power is held by a local committee that includes some government representatives; but in practice, it seems that these committees usually support the cooperatives). The common reason for exercise of this power is nonpayment of fees. The cooperatives vary in their use of this power. The Saga cooperative has not used it at all in recent years, but the Kourani-Baria I cooperative has evicted some 43 percent of its members over a period of 5 years. It seems reasonable to surmise that the exercising of this power changes the relationship between the irrigators and the organization, and there is no evidence that using it has improved performance.

Other aspects of transparency, such as the holding of regular general meetings of all members, the recording and publicizing of decisions, presentation of annual expenditure plans for authorization by members, and presentation of annual accounts or reports to members, are generally absent. Elections of office-bearers and committees occur, and the timing of these seems to be respected. These elections take place at the lower level (the GMP). However, members frequently state that they are not informed about what happens afterwards, such as the allocation of specific duties among the elected committee members.

The initial constitution of each cooperative is adopted by the members, in accordance with a standard document provided by the government. This standard constitution specifies procedures for amendment by the members. No case of actual amendment was found among the cooperatives studied. Aspects of the standard constitution that require clarifying details at each individual cooperative (for example, specifying the sanctions and procedures that can be used in cases of rule violation) therefore remain vague.

Some problems of institutional development can no doubt be traced to inherent conflicts that arise when the new form of organization, required for an irrigation system, interacts with and appears to challenge previously existing traditional organizational structures. Cernea and Meinzen-Dick (1994), describing the establishment of irrigator organizations in Niger and Senegal, wrote that "…*the traditional forms of social organizations were deemed to be inappropriate: they were dominated by chieftains using them for personal gains and were unsuitable for efficient agricultural production.*"

Problems of this type were noticeable: for example, in the Tillakaïna scheme, effective dominance of the irrigation organization was achieved by a person of forceful personality and strong traditional and religious linkages. But there are grounds for thinking that such problems may be temporary, and may respond to pressures, which derive from the wish to use the economic opportunity that the irrigation system represents. In this particular case, after a few years the dominant person was removed in an election after dissatisfaction with his style and performance grew, and organizational control then moved to a group of younger irrigators.

Summary of Performance Findings

We can draw the following conclusions about the performance of these four systems:

- In normal years, without severe flood or drought events, annual production values of 900,000–1,000,000 FCFA per developed hectare are achieved at Saga and Tillakaïna; 750,000–800,000 FCFA at Kourani-Baria II, and 650,000–700,000 FCFA at Kourani-Baria I. These are valued at the (post-devaluation) price levels of 1995.[5] These production

[5]The US$ equivalent of these production value, in PPP terms are: US$6,125–6,833 at Saga and Tillakaina, US$5,125–5,466 at Kourani-Baria II, and US$4,433–4,784 at Kourani-Baria I.

levels at Saga and Tillakaïna can be considered good (although the potential is probably somewhat 20% greater); but the results at Kourani-Baria II show a significant deficit relative to the potential of the site, and at Kourani-Baria I the deficit is larger.

- The ratio of water pumped into the irrigation systems to water actually used by the crops is in the range of 1.65–2.50. Though most or probably all of this water returns to the river and is available for reuse, the large volumes of water that have to be pumped cause substantial increases to the pumping charges that irrigators must pay. At Kourani-Baria I, the installed pumping capacity is only just able to meet peak demands and, therefore, requires prolonged pumping hours and nocturnal irrigation.

- Farm-level productivity of water delivered is high at Saga (1.05 kg/m^3 for paddy) but only moderate at Kourani-Baria I (0.60 kg/m^3). In value terms, the gross product value obtained at Saga is about 10.1 times the gross cost of delivering water at the landholding, and at Kourani-Baria I this ratio is about 7.9. In these calculations, the gross cost includes all identifiable water-related costs, and capital and renewal charges for pumping equipment, calculated according to the standard formulas used by ONAHA.

- Equity in water distribution is not satisfactory. At Kourani-Baria I the least-supplied secondary canal block receives 70.6 percent of average water supply, and at Saga 79.5 percent; this degree of inequity is certainly among the reasons for the deficit of production specially at Kourani Baria.

- Rewards to irrigator families are moderately good. Net revenue per person-day of family labor is generally more than 1.75 times the current cost of agricultural labor, and the overall weighted mean of this ratio is 2.19, which probably explains why most irrigator families are adequately motivated and are maintaining a high intensity of land use.

- Irrigation service fees are very high, by comparison with levels generally reported in other developing countries. On average, they are just over 20.0 percent of gross product value. Irrigators in general succeed in paying these fees, but a significant proportion of payments is late, resulting in cash-flow problems for the cooperatives.

- Arrears of payments by irrigators to their cooperatives are a serious problem at Kourani-Baria I. At Saga and at Kourani-Baria II arrears seem to have stabilized or reduced in recent seasons.

- All the cooperatives calculate fees according to the standard method prescribed by the government. Although this method incorporates a substantial savings element, amounting to nearly 20.0 percent of the fee, which is supposed to accumulate in special restricted accounts, the cooperatives have not succeeded in setting aside these savings. In fact, they use this money to provide their working capital requirements.

Constraints

In this section we try to identify specific constraints to account for performance deficits, notably at the two Kourani-Baria systems.

Labor

Labor is not abundant. Because the availability of farm equipment is low, the number of labor days required for producing a crop is very large. Household economic strategies involve a range of activities, among which irrigated agriculture is only one, and is to some extent in competition with others for a share of the family labor resource. On average, irrigated agriculture provides 41.2 percent of household gross income at Saga, but only 24.9 percent of net income. It is reasonable to assume that households are motivated by net results. Hence, irrigated agriculture competes with other activities, which are altogether three times more significant to the family.

Households would be expected to make their economic decisions with a view to maximizing the net returns to their land and labor. The objective of achieving good returns to family labor seems to be achieved in general, according to the data of table 10. On average, household labor in irrigated agriculture is rewarded at more than double the current wage rates of agricultural labor. This explains the motivation of households to maintain generally high crop intensities. It could also account for the lower crop intensities at Kourani-Baria I, where the returns to labor are substantially less.

Reducing the consumption of water is not likely to be a prominent objective at the household level. Rather, it should be expected that the household would normally seek to obtain as much water as needed to irrigate its crop adequately. Households have to pay increased fees for water lost through seepage or through mal-distribution, but the impact of this extra cost is greatly reduced by the fact that it is shared among all members of the cooperative, who may number about 1,000. Although water losses appear to be in the order of 50 percent of the amount pumped and although energy for pumping is the biggest item in the cooperative budgets, it is not economically sensible for any household to apply its labor towards reducing this loss, since the household can expect to receive only about one-thousandth part of any benefit that may result. On the contrary, the reasons for the failure of numerous attempts to persuade the irrigators to reduce water use by following tighter irrigation schedules seem very likely to be linked to labor questions. Families having different labor situations may find it difficult to conform to the discipline of jointly organized timing of irrigation, and they may perceive no benefit to themselves from conforming.

Savings and Investment

The financial burden of providing an irrigation service has to be borne by the cooperative. It is responsible for paying for all the common services that are implied in the provision of an irrigation service. These include, in Niger, a quite wide spectrum of pre- and post-harvest services (such as fertilizers, and marketing) as well as the operating costs such as power, and administrative costs such as accounting.

The tasks of major maintenance and renewal of equipment are not allocated so clearly. The wish of the government about this aspect is however clear enough. It lacks resources for ensuring these services, and so it has built in a "savings" element into the standard method of calculating the irrigation service fees. Each cooperative collects money in excess of its expenditure, because of the items of capital and savings charges included in the fee calculation.

However, this is not profit, because it is supposed to be placed immediately in the restricted account to allow the cooperative to accumulate reserves for future contingencies such as equipment renewals. In reality, as table 10 has shown, this is not happening. The restricted accounts are more or less empty. Even at the Saga cooperative, whose financial performance is the best among the four study schemes, the amount in the restricted account is small, and it is used in each season to finance current expenditure.

The roots of these difficulties are in the tightness of the financial rules applied to the cooperatives, through the standard accounting procedures prescribed by the government. The origin of this stringent attitude is not clear, but we may probably surmise that (when these cooperatives began some 20 years ago) the government sponsors of the policy may have feared that there would be risks of corrupt behavior, or of simple loss of money through inexperience. Perhaps tight rules were introduced to reduce such risks. The result is that, under these accounting procedures, it is impossible for any cooperative to increase its financial assets. It cannot make a profit, since that must be used to reduce the seasonal fee, but it can make a loss, through management incompetence. Since these organizations exist in an environment where business management skills are scarce, it should be expected that, over time, the net financial assets of every cooperative must reduce. Table 10 shows that this is the result that has indeed occurred.

This situation is aggravated by the expansion of the annual budgets of the cooperatives. Year by year, the cooperatives must produce larger amounts of cash to pre-finance the seasonal activities. The growth of the budgets has had two primary causes: first, the ordinary monetary processes of inflation, which were given a large acceleration by the currency devaluation of 1994, and second, the wish of the members (especially at the remoter Kourani-Baria systems) that their organizations should expand services, especially the purchase and resale of fertilizers. These expanded budgets can be met only by using unsatisfactory devices, such as delaying payment, or utilizing the restricted “savings” funds as working capital.

The effects of these aspects have been particularly apparent in Kourani-Baria I. Its assets have reduced, partly due to a previous period of unsatisfactory management, and its budget has grown, with fertilizer purchases now dominating it. The cooperative has to wait for up to a year before its members repay their fertilizer supplies. Such delay is allowed within the accounting rules.

The impact of all these effects varies, because the initial working capital provided to each cooperative varied (table 11), not only in regard to the amounts provided, but also the proportions provided in cash and in other forms such as equipment (whose real value often turned out to be quite negligible, because of suitability defects). Probably, the initial foreign donors supporting each irrigation system were unaware of the longer-term impact of their decisions about the appropriate amounts of capital that such an organization would need.

Maintenance

Maintenance of these irrigation systems has to be considered at several levels. Smaller maintenance tasks can be performed by the cooperatives through their own members or employed staff. Larger tasks need at least technical guidance, and perhaps financial as well, from the government. At present, neither is being done well. Collaborative minor maintenance, which is within the capacity of the cooperative, the GMP, or small field-channel groups, is often defective, and in many cases, especially in the field drains, it does not seem to happen at all. Almost all the irrigation systems have areas where tasks that could be done at

TABLE 11.
Initial operating capital provided to the cooperatives.

Cooperative	Date of funding	Funds provided			Total start-up capital per developed hectare (FCFA/ha)
		Cash (FCFA)	Equipment or inputs (FCFA)	Total (FCFA)	
Saga	–	15,683,031	12,604,000	28,287,037	69,450
Kourani-Baria I	1989	19,835,830	41,667,818	61,503,648	144,714
Kourani-Baria II	1989	12,417,551	23,488,398	35,905,949	134,077
Tillakaïna	1983	10,400,000	–	10,400,000	166,400

Sources: (quoted in IIMI 1998):
(a) Gauff Ingénieure: Rapport Final, Mise en valeur du périmètre de Kourani-Baria. Dec 1989. [Annexes 2 and 8 and chapter 5]
(b) Didier Allely: Coopérative Agricole de Tillakaina: Manuel de procédures comptables. May 1985. Page 7.

Notes:
1. The initial area developed at Tillakaïna was 62.5 ha.
2. The equipment fund provided at the Kourani-Baria cooperatives was not in the form of cash. Most of the funds had already been applied, during installation of these irrigation systems, to purchase agricultural equipment, which was sold on credit to irrigators. The irrigators were expected to repay these loans to the new cooperatives, but in reality, much of this fund was not recovered by the cooperatives.

these levels have been omitted. It seems reasonable to think that this is an important factor contributing to the observed inequities of water distribution. Major maintenance is not in a better condition. Items that are beyond the technical capacity of the users (such as automatic structures that have become jammed) remain unrepaired for many years. Protective dikes and other large works also receive little attention. Pumps, which have to be taken out of service for repairing mechanical and electrical faults, are sometimes not returned to service for many months.

In each of these cases, the problem seems to be due to a lack of clarity about responsibilities or finance. Common tasks that can be done (in principle) by farmers require organization and allocation of duties. For example, it is not clear whether a household with a large landholding should supply the same labor as another that farms less. There are generally no systems for monitoring and recording labor contributions, and there is no provision in the rule systems for small graduated penalties for those who do not take part. Without these features, it is predictable (Ostrom's principles 2 and 5) that people will not generally apply their labor in this way.

Management Skills

Niger has some of the lowest levels of literacy and basic schooling in the world. Irrigation systems are generally located in the rural environment, where these educational levels will be even lower than the average. It is not, therefore, surprising that the management skills of the rural population are very limited. The problem is made more difficult by the complexity of the management and financial systems that the government and its foreign donors chose to install. In other countries, where governments are trying to create self-financing irrigation organizations, these systems are usually much easier to understand and to operate than the Nigérien system. For example, the use of a true-cost system of fee calculation, which means that each seasonal fee is calculated from the net expenditure of the previous season, requires continuous attention to maintaining control of all bills, individual personal accounts for every member household, strict supervision of arrears, and so on. Some cooperatives have been able to apply this system. Some have not succeeded. There are other areas where the deficit of management skills and experience may have direct impacts on the organizational performance. Some are intangible, but may be significant, such as the alienation felt by members towards the cooperative.

These problems reflect unfamiliarity with formal processes of record keeping and other transparency mechanisms. It is likely that they would be easier to handle if the organizations were smaller. The size of the cooperatives in the Niger Valley is however dictated by the typical capacity of the pump stations. Organizations with several hundred members, or even well over a thousand, therefore required to take responsibility for payment of some large central bills, such as for electricity.

Summary and Conclusions

Verifying Study Themes

Under "Themes of the Study," p.2, we stated a set of four themes to be addressed by this study of the Nigérien irrigation systems and their cooperatives. We now review each of these four, in the light of the evidence presented from field observations.

a. *There is a high degree of interactivity among various domains that are superficially quite different (water management, agricultural practices, markets and finance, organizational constitution and processes, management skills, irrigators' alternative uses of their labor, etc.), which means that intervention by an external organization if designed without attention to all these factors, is likely to fail.*

The field data have confirmed this at many points. These are complex systems set in a complex social setting. Their users are not (on the whole) primarily irrigation farmers. They have complex household economies with multiple small interests. Their irrigation activities cannot be separated from their rain-fed and other activities, because these constrain what they can and cannot do. In particular, the irrigators have difficulty in following a sound agricultural calendar, and (at some sites) they seem to be losing heavily as a result of this failure. An organizational constitution has been externally imposed upon these people, and in some critical aspects it constrains them so severely that the organization cannot discharge its assigned functions.

b. *There is a deficit of organizational skills in the rural environment of a country such as Niger, where rural resources of every sort are scarce, and this presents special difficulties for managing relatively large new organizations.*

This point has been discussed in the preceding section. It is a major constraint at the present time. However, it is not the kind of constraint that cannot be overcome. This seems to be the area, where capacity building would be most effective. There are some particular aspects where better management skills could be most valuable. These include communication, and record keeping, both of which are central to developing transparency and equity. Training that is concentrated on developing these skills should be valuable.

c. *A sound set of financial procedures is necessary, to ensure solvency and viability in these organizations, but it is difficult to ensure these without perpetuating the government involvement and, therefore, attitudes of dependency on the government.*

The government has established a strong set of accounting procedures. The rules are detailed and clear, but the principles that are used are more complicated than in many other countries. They enable the government supervisory officials (the System Director, and his superiors within ONAHA) to monitor the finances of the organizations, to compare different cooperatives, identify those which are getting into trouble, and so on. These rules also can reduce risks of corrupt behavior, and make it less likely that a cooperative will be brought to financial disaster by bad office bearers. However, they are the government's own rules, and do not seem to meet the organizations' own needs in every way.

The cooperatives cannot make profit, cannot expand their financial base, and so cannot expand their activities. Some other countries have had considerable success with "multi-functional" organizations of irrigators, which develop other businesses such as forestry or fishery according to their situation, or which provide sociocultural facilities to enhance their members' quality of life. It would be difficult for the Nigérien cooperatives to evolve in that way. The expansion of the Kourani-Baria I cooperative into fertilizer provision has already over-strained its financial situation.

In theory, this should not be the case. The standard document used as the initial constitution of a cooperative states explicitly that it could be amended by the members. This appears to make it possible for a cooperative to adopt different rules, even about fee calculation. However, the research team could identify no case of a cooperative using this power of amendment. The present reality, therefore, is that the cooperatives follow standard procedures, laid down by the government, and in some important aspects these procedures seem to serve government objectives rather than the members' own objectives. In these circumstances, it is difficult to predict an early end to the condition of dependency on the government.

d. *The organizational design in actual use is not in conformity with the principles of sustainability developed by Ostrom (1992).*

The eight principles of Ostrom were presented on pages 11–12. At present, the organizational arrangements in the Nigérien cooperatives violate, in some degree, each of these principles. These eight principles are probably the best prescription presently available for the design of an autonomous organization of irrigators. Any adjustments that would bring the Nigérien organizations nearer to conformity with these principles seem likely to improve their sustainability. If specific priorities are sought, it seems likely that the greatest impacts might be obtained by adapting to the second, fourth, fifth, seventh and eighth of these principles, aiming respectively at equity, transparency, rule compliance, autonomy from government, and functional decentralization.

The cooperatives are large, and their size puts practical stresses on the available management skills in the community. The eighth Ostrom principle recommends that there be different organizational levels for different functions. A smaller organizational level, the GMP, already exists, but has not been given many effective powers. Some formal delegation of functions to that level, and enhancement of the capacities existing at that level (such as provision of a small office and store as an administrative focus in each GMP), might help to overcome some of the observed management deficiencies, by (for example) facilitating communication and organization of group work.

Task-based development of local rules, equitable sharing of contributions and benefits, and application of sanctions, also do not seem to have occurred yet. The opportunity to initiate these developments during the construction phase appears to have been missed, even in the most recent case of the Kourani-Baria sites, because rules were imposed externally rather than developed by discussion and negotiation within the communities.

Sustainability

The irrigation systems do not appear to be sustainable, unless there is some change in the policy of the government or in the procedures of the cooperatives. The essential difficulty is the financial weaknesses observed at all the cooperatives. None has been able to build up a reserve fund that could enable them to deal with future needs for major repairs and renewals. In all cases, resources intended for building such funds are used to finance current operational needs. The lack of liquid assets in the cooperatives causes deficits in technical performance levels, especially at the Kourani-Baria systems. It prevents cooperatives from maintaining stocks of fertilizers for their members, and consequently, fertilizers are applied at times and in quantities that are far from the agronomic optimal patterns (IIMI 1998).

The present system of accounting does not allow the cooperatives to make profit, so they cannot solve their liquidity problems within the present framework. They cannot increase their net assets and, therefore, cannot respond effectively to the increased costs, arising from price inflation, expansion of activities, or any other reason. On the other hand, it is quite possible that a cooperative will undergo a period of weak, inexperienced or dishonest management and thereby lose some of its resources. There is no way, at present, for even an excellent new management committee to recover from that, except by applying the capital renewal funds to operational uses. At the least successful of the four cooperatives that were studied, Kourani-Baria I, there are many signs of lack of support by the members for their organization, and many criticisms were voiced during field interviews. This cooperative, in an attempt to resolve the cash deficiencies, has used its power to evict members who have arrears. The use of this power, however, does not automatically lead to debt repayments, and may increase the sense of alienation between the irrigators and the committee.

Since so many of these difficulties seem to be linked to cash shortage, it seems important to study the initial capital needs of a new organization of irrigators. There has been little discussion in the literature about this, and it is to some extent specific to the local situation, because it is linked to the accounting and cost-collection system. In the Nigérien cooperatives, there is inconsistency in the processes that different donors have applied, but in every case, the needs have been underestimated. If farmers can pay by delivering part of their crop to the cooperative after the end of the season, and if the time limit for this payment is six months (the duration of the next season) then the cooperative’s need for operating capital will be an amount approaching the costs of two full seasons. The actual sum that this represents depends on the specific range of services that members want their organization to provide. In these four cooperatives, the operating capital requirement seems to be of the order of 180,000–260,000 FCFA per developed hectare. The amounts of operating capital provided to these government-sponsored organizations at their inception were only a small fraction of the true need (see table 11).

General Policy

The systems that have relatively convenient market access (Saga and Tillakaïna schemes) show good performance in yield, land utilization, and gross output. The remoter systems (Kourani-Baria I and II schemes) fall farther below potential, but their output results are still moderately good by current developing-country standards for such enterprises.

The fee-charging process for these irrigation systems has been devised and imposed by the government, and it is one of the most stringent fee schemes being applied in the developing world. Fee calculations include all actual operational costs, components for the initial capital cost of installing the schemes, savings towards future major repairs and renewals, and a contribution towards the costs of the government's supervisory agency. The irrigation service fee paid by an irrigator to the cooperative organization that manages the system is a little over 20 percent of gross product value. In addition, the irrigator may also buy other services, such as input supply and marketing from the cooperative.

In general, these large fee amounts are being paid, and fee collection ratios are usually high, in the range of 90–100 percent. However, the scale of the fees puts obvious stresses on household capacities to pay and there is generally significant delay in payment. These payment delays, in turn, stress the cooperatives, which have inadequate operating capital and have no means to increase it.

Management weaknesses in the cooperatives include lack of communication and consequently lack of transparency. Improving management skills through carefully targeted training and capacity building initiatives could lead to better coordination of agricultural processes and reduction in costs, especially water-pumping charges, which is the highest cost item.

The size of the organizations is probably too large, in relation to the available management skills. The GMP level of organization rather than the cooperative, conforms more nearly to the criteria indicated for the base unit size in such organizations, but it has not been invested with significant functions, funds, hardware or organisational structure, so it is not a genuine base unit. Actions to strengthen the GMP level are therefore desirable. Such actions should involve formal transfers of certain specific functions, from the cooperative to the GMP. The cooperatives show continued dependency on the government, and have not yet learned to develop rules and processes of their own.

The farmer-financed operations of the Niger River Valley irrigation systems are at present producing acceptable results. The irrigators and their leaders deserve recognition for their success in operating these systems under an unusually strict financial scheme. However, although current performance in conventional terms such as output value and fee collection is above average and in some respects very good, the situation does not appear to be sustainable unless significant modifications of the organizational system can be made.

Specimen computation of irrigation service fees: Saga, dry season 1994.

Account No.	Item		Amount (FCFA)
	A. FIXED CHARGES		
6811	Amortization of irrigation pumping equipment		2,054,449
6812	Amortization of drainage pumping equipment		486,445
	Amortization of motor cycle		106,250
6821	Provision for renewal of irrigation pumping equipment		1,725,776
6822	Provision for renewal of drainage pumping equipment		408,411
6824	Investment fund		1,525,352
6825	Solidarity fund		344,916
	Sub total of fixed charges		**6,651,599**
	B. VARIABLE CHARGES		
6101	Fertilizers		266,500
6102	Seeds		1,528,030
6103	Plant protection		215,550
6111-3	Lubricants and fuel		96,000
6140	Electricity for pump station		7,475,992
6160	Spare parts		637,945
6170	Miscellaneous supplies		450,458
6171	Office supplies		354,445
6220-30	Staff transport and other transport		23,400
6300	Technical support by ONAHA		1,520,000
6320	Infrastructure maintenance		781,405
6330-3	Other maintenance		91,600
6340	Land preparation		338,975
6350	Temporary labor wages		98,750
6360-80	Other services		86,300
6410	Assurance		19,992
6420	Subventions and donations		100,000
6460	Reception expenses		90,190
6480	Travel expenses		120,000
6510	Staff salaries		2,478,052
6520	Honorarium to President		150,000
6521	Other compensation		97,000
6530	Social charges		216,225
6540/6610	Taxes and miscellaneous items		9,010
	Sub total of variable charges		**17,245,819**
	Total of all charges		**23,897,418**
	C. FEE CALCULATION		
	Area cultivated	380 ha	
	Fee per hectare	62,887 FCFA	
	Fee for 0.25 ha	15,725 FCFA	

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