EXPERIENCES OF SOME GOVERNMENT-SPONSORED ORGANISATIONS OF IRRIGATORS IN NIGER AND BURKINA FASO, WEST AFRICA

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1. Introduction

This paper describes the experiences, in the years since the early 1980s, of the promotion of irrigators' organisations in specific regions of two countries in West Africa.

The countries are Niger and Burkina Faso. Their main populated areas lie in the Sudano-Sahelian zone, a large belt of arid and semi-arid land that runs from east to west, just south of the Sahara desert. These are countries with low average rainfall and a short rainy season, so that (except in the extreme south of each country) rainfed cereal production has low and highly variable yields. Micro-scale irrigation has existed for long in these countries, but until relatively recent times there did not seem to be a strong case for augmenting this with larger irrigation developments.

In modern times, since about the 1960s, food production conditions have worsened, under a number of influences. Average annual rainfalls have tended to decline, human populations have increased, and there are signs of exhaustion of soil fertility in traditional rainfed areas. These influences have raised the significance and potential benefits of irrigation.

Although these two countries are neighbours, and have broadly similar climates, their surface water conditions are different. Niger has a major perennial river. South-western Niger is crossed by the Niger River, which is one of Africa's largest. Burkina Faso on the other hand occupies a plateau region containing the headwaters of the Volta River, a medium-sized river. Burkina Faso has therefore has many small rivers, most of which flow only for a few weeks or months of the year.

In this paper we compare the experiences of organising irrigation in the Niger River Valley of Niger Republic, with those in the central plateau of Burkina Faso. At the end, we try to draw some lessons from these experiences, which may be of interest in Asian countries.

One feature is that, although these are two of the poorest and driest countries in the world, with very low levels of literacy and general development, they have been able to develop irrigation systems with high productivity, high crop intensity, high fee collection rates, and low levels of government financial support.

On the other hand, there are reasons to doubt the sustainability of this favourable situation. We try to analyse the threats to sustainability, and to indicate possible actions that could reduce these threats.

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2. Context

2.1 *Physical context : Niger*

Niger is a large country, much of which is arid desert. The Niger River crosses the south-west of the country. The capital city, Niamey, lies on the river. Average annual rainfall at Niamey, over a period of 4 years, is 587 mm, and this occurs almost entirely in the months June to September. Average annual potential evapotranspiration at Niamey is about 1,876 mm, and rainfall exceeds evapotranspiration, on average, for only two months of each year.

Four countries share the Niger River. The republic of Niger has 550 kilometres of its middle course. It rises in the highlands of Guinea, and crosses Mali before reaching Niger, then continues across Nigeria to the sea. All these four countries are therefore interested in the river's water resources, but there is not yet an effective agreement about sharing. Irrigation development has proceeded at a faster pace upstream in Mali, so Niger's access and rights to this surface water are vulnerable.

In a dry year, the river flow at Niamey may already fall nearly to zero for periods up to about 15 days, but a number of low weirs in the river retain enough water depth for pumping to continue. However, the dry seasons are very variable. In many years, the minimum flow is substantial.

In Niger, irrigation in the river valley is based on electrically powered pumping stations at the river banks, which deliver water to strips of land generally lying quite near to the river. The average size of these irrigated systems is about 230 hectares. The layouts of the systems are technically quite modern, usually incorporating concrete-lined canals, some automated water-control structures, and drainage pumping stations. The water-delivery capacities are high (3 to 5 litres/second/hectare). These are therefore expensive installations, relative to the low wealth level of the country.

Rice is the major crop grown in these irrigation systems. In a few systems, the irrigation planning and layout were based on the intention that non-rice crops, especially vegetables and some fruits, would be grown, but the systems doing this are generally smaller than the rice-producing systems. Rice is grown in two seasons, the wet season from July to November and the dry season from December to June. Most of these irrigation systems can achieve cropping intensities at or near 200%/year, but some fall significantly below this, because of either water-logging of certain areas, or defects of the users' agricultural practices.

Upstream of Niger, in Mali, there is a large region of swamps and braiding of the river in an inland delta. This has two important impacts on river conditions in Niger. The flow through that area is slow, so the annual rise of the river in Niger is late and gentle ; and the sediment load from the river's mountainous source areas is largely deposited before it reaches Niger.

The river usually reaches its highest level in the early dry season, about December-January, so pumping is easiest and cheapest then. This situation, where irrigation costs are lowest in the dry season when demand is most, is quite unusual, and is due to the effect of the inland delta delaying the transmission of the flood wave.

Because the sediment load is low, the river has not formed an extensive alluvial plain, and in most years it does not flood the adjacent areas. However, flooding is a serious

management problem for the irrigation systems, some of which even face a double risk of flooding. In the wet season, tributary valleys which are normally dry sometimes deliver sudden high-discharge events, carrying large quantities of sand and gravel ; and in the dry season the river is high, so it may prevent drainage and may inundate low-lying bank areas.

2.2 Physical context : Burkina Faso

Burkina Faso is a land-locked country of 274,000 km^2, situated just south of the Sahara desert between latitudes 10° and 15°N.

The irrigation systems on the Burkina Faso plateau are very different from those of the Niger valley. The plateau forms the watershed between the Niger and the Volta basins, so all the streams on it are relatively small headwaters, gradually converging towards these major basins. The rivers are generally not permanent, and they flow in weakly incised valleys. Storage reservoirs are essential for irrigation, but the available reservoir basins in this topography are unfavourably shaped. They have large surface areas relative to their volume, and so they lose water rapidly in evaporation.

The plateau has a climate rather similar to that of south-west Niger. Mean annual rainfall varies from 400 mm in the north to over 1,000 mm in the south-west. The rains are usually between May and September. The dry season is 8 months in the north and 5 months in the south.

The capital city, Ouagadougou, lies on the plateau, and is a focal point for marketing of crop surpluses.

There are over 1,100 small reservoirs, mostly on the central plateau. Nearly half of them have storage capacities between 10,000 m^3 and 1,000,000 m^3. The construction of these reservoirs was motivated primarily by a need to protect rural populations against climatic variability by providing them with a relatively secure source of water for domestic use, livestock and modest home gardens.

Fewer than 100 of these small reservoirs support irrigated areas. These irrigation systems are very small, typically less than 50 hectares, and never more than 200 hectares. The storage dams which support them are large, relative to the areas to be irrigated, because of the very large losses to evaporation from the reservoir surfaces. Storage volumes equivalent to more than 60,000 m^3/ha (or 6 metres) are necessary to ensure double cropping, and in some cases this water-land ratio is even as high as 9 metres.

Irrigation is normally done by gravity flow from the reservoirs. However, because of the high variability of rain and surface flow in such semi-arid regions, there is a high risk of flood events in the wet season. This imposes large capital costs, to install dikes for protecting downstream irrigated lands in the valley bottoms against occasional flooding. Therefore, in some cases it is more economical to locate the irrigated area on the upstream side of the reservoir, where it can be more easily made secure against flood. In such cases the irrigation supply has to be pumped from the reservoir.

Rice is the major crop in the Burkina Faso systems, but it is not as dominant as in Niger. The Burkinabe irrigation systems grow significant amounts of vegetables and fruits in the dry season, and in some cases grow no rice.

2.3 History of irrigation development

In both countries, public irrigation development began in the 1960s. Development was initially slow, but the rate of installation of new facilities became more rapid in the 1980s. Most of the observations reported in this paper refer therefore to irrigation systems which were created between 1975 and 1990.

During that period, as in many other countries in the world, political and economic trends had the general effect of reducing the previously dominant authority of central governments, and increasing the significance of market forces and of local-level decision-making.

Under these influences, the amount of effort that the governments could provide, towards sustaining the irrigation systems, has been declining. State organisations, which earlier were expected to provide various kinds of supports, have been reduced or dismantled.

There was also increasing strictness in the application of self-financing policies for entities such as irrigation systems. In the past decade, concepts of privatisation, commercialisation, or simply more precise accounting have entered the government systems at many points. For example, at an earlier stage, if an irrigation organisation failed to pay its monthly electricity account, there would probably be no significant consequences, since this payment would be perceived as just a transfer within the overall public system. Since about 1992, public electricity supply organisations have been much more insistent on prompt payment. Many similar changes have increased the pressure for responsible financial behaviour in the irrigators' organisations.

The legal frameworks of rights to use land and water have also undergone large changes. At the present time these changes have not yet arrived at satisfactory conclusions which would seem likely to remain stable. Earlier feudal or group systems of land control and allocation were set aside by the governments, which took these resources into public control in the 1960s and 1970s. At present, there are serious ambiguities in both countries about the exact status of ownership of land, water and irrigation installations, and the rights to use these resources and to transfer them to others.

The demand for the products of irrigated agriculture, rice in particular, has been changing. Consumption of rice per person, nationally, is at levels that are among the world's lowest, and the traditional rainfed cereals, sorghum and millet, are much more significant. However the demand for rice is growing fast, especially in the capital cities, and importation of Asian rice is economically significant. At the same time the growth of city populations (especially in Ouagadougou and Niamey) has led to some dietary changes, including a rising demand for vegetable crops.

2.4 Socio-economic context

The population of Niger is about 10 million, and of Burkina Faso about 11 million, growing at about 2.8%. They are among the poorest countries in the world, and their human development is also low. The Gross Domestic Product per person in Niger is equivalent to about US$200 per person per year at official exchange rate ($920 at purchasing power parity rate) and in Burkina Faso the parallel figures are $240 and $990. Life expectancy is below 50 years, and adult literacy is below 15%.

The economies are agriculture-based, but the earnings from agriculture are low. Nearly 90% of the populations are engaged in agriculture but it produces 38% of GDP in Niger, and 35% in Burkina Faso.

Most of the agriculture is rainfed, and is very extensive, with extremely low yields. This tradition of extensive, low-yield agriculture is very different from south-east Asia, and reflects the relative abundance of land. In Niger there is 0.53 hectares of cultivable land per person, and in Burkina Faso 0.33 ha. Comparable figures are 0.19 ha/person in Lao PDR and 0.08 in Vietnam.

Since Niger and Burkina Faso are poor countries, with few resources, their modern irrigation development has been financed mainly by the donations and low-cost loans of foreign governments and international development-assistance organisations. There is no possibility that the governments, or the irrigation users, could have afforded the capital investment of these irrigation systems. It is also very difficult to expect that the governments alone will in future afford the costs of major repairs, equipment renewals, or rehabilitations.

Both governments therefore adopted policies of promoting organisations of irrigators, and of transferring the duties of performing and financing operation and maintenance of the irrigation systems to these new organisations. These policies were initially adopted in the 1980s. Some of the irrigation systems were initiated under the older management framework, but in the more recent systems it was known from the beginning of construction that they would be managed by irrigators' organisations, not by government.

The governments have been reluctant to abandon all their control over the irrigation systems. They continue to maintain some presence, and deliver some assistance to the user-operators. In Niger, each irrigation system has a Director, provided by the national irrigation agency (ONAHA : National Organisation for Irrigation Systems). It can also call upon ONAHA for certain services, such as pump maintenance. Irrigator organisations must repay ONAHA for these services, including the services of the Director. (The post of Director is advisory, not executive, and decisions are supposed to be made by the executive committee of the irrigators' organisation.)

In Burkina Faso, the main support role has been delegated to the provinces, and an organisation known as the Regional Centre for Promotion of Agriculture and Livestock (CRPA) provides a Technical Advisor to the irrigation system. The Advisors are assigned to the irrigation systems only on a part-time basis, and may have to support more than one system. The irrigators' organisations are not charged for this service.

The individual land holdings in the irrigation systems are very small. In both countries, an area of 0.25 hectares per household is typical, and there are several irrigation systems where the typical unit is smaller than this. In some cases, land was divided into equal units for distribution, and in others there was some land-entitlement formula which related to household characteristics such as the number of active members, and the amount of participation in the construction phase. Previous local residence was usually a factor in land allocation, but because the installation of an irrigation system increases the local population-support capacity, some immigrants to the district would also be accepted.

Thus, although the irrigation systems are quite small, the numbers of participating households are quite large. In both countries the number of members in an irrigators' organisation is usually some hundreds, and often exceeds 1,000.

An implication of the small size of irrigated land units is that households must have other economic interests. The irrigated land units are not, in general, sufficient to satisfy all the household's needs. Alternative activities include rainfed farming, livestock, fishing, handcrafts, and trading. Rainfed farming is traditionally performed on other land, often at some distance from the irrigated area. Since the rainy season in both countries is brief (typically some 120 – 150 days) it is vital to the household to plant the rainfed crops immediately when the rain begins. This need conflicts with the need to plant the irrigated areas at about the same time, so (since irrigation can be delayed but rain cannot) the irrigated land is often planted at a time that is not optimal.

The low level of literacy imposes a constraint on the effectiveness of new rural organisations. Normal organisational functions such as accounting, communication, planning, and recording of decisions are more difficult to arrange in this environment.

2.5 Contrasts and similarities between the two countries

The two countries are similar in many ways, but there are also important differences, which affect the evolution of their irrigators' organisations.

In both countries, coarse grains (millet and sorghum) are the principal rainfed cereals, and the role of rice in the national diet is relatively small. However it is growing fast, partly under pressures of urban demands for convenience, since the traditional cereals require much effort in preparation.

The environmental impact of the traditional cereals has also reached alarming levels. Because the yields achieved are low, about 400,000 hectares of new land must be used each year to provide for the population increase in the two countries together. Most of this has to be found by reducing the remaining forest areas. In Burkina Faso, for example, coarse grain production is currently about 2,500,000 tonnes/year from 3 million ha, which is 11% of the national land area. Rice production is 50,000 t/y.

Annual internal renewable water resources amount to 1,640 m^3 per person in Burkina Faso, and 375 m^3 in Niger. (Internal resources do not include cross-border flows, in or out.) These may be compared with 4,990 m^3 in Vietnam, and 9,840 m^3 in Lao PDR. Water is a very scarce and highly valued commodity in west Africa.

In both countries the irrigation sector is rather young, having begun to develop effectively in the 1960s, and it has not become a major social or economic sector (as in most Asian countries). There have therefore been problems in developing the necessary specific management skills, both in the agencies and among the irrigators.

The costs of providing irrigation services are high, but their components are different. In Burkina Faso, the systems have reservoirs, whereas in Niger they do not. These reservoirs are the biggest element of capital cost in the Burkinabe systems, which are therefore expensive to install. On the other hand, most of the Burkinabe systems can deliver water from their reservoirs under gravity, whereas the systems in Niger need to pump with electrical power, whose cost in that country is very high. The energy cost is the highest component in the accounts of the Nigérien systems.

Thus, there is a trade-off. The Burkina Faso systems have large capital cost, and the Niger systems have large operating cost.

In Burkina Faso, the irrigators' organisations do not have to contribute to the capital cost. The operating cost does not (usually) include energy for pumping, so it can be kept to a relatively low level.

In Niger, the financial situation is opposite to this. The government does require that the irrigators contribute a share of the capital cost. They must also pay the energy cost, which is large, and which must be paid quickly.

Irrigation service fees in Niger are therefore among the highest in the developing world. In Burkina Faso, they are lower by factors of about 5 (although still quite large by current Asian standards.)

The irrigators' organisations, and the irrigator households, are therefore under much greater financial stress in Niger than in Burkina Faso.

Another key difference between the two countries is the size of the irrigators' associations. In Niger, the organisations are generally several times larger than in Burkina Faso. The characteristic size of the irrigated area is in the region of 230 hectares in Niger and 50 hectares in Burkina Faso. The larger size of the Nigérien systems means that they can afford larger, more structured organisations, with a range of full-time employed staff such as accountants, storekeepers, and pump-operators. It also means that their leadership must have higher organisational skills, especially in areas such as communication, because they are dealing with more members, spread among more villages.

The government agencies' support is also different. Niger has maintained its national agency, ONAHA, whose main function has become monitoring and support to the irrigators' associations. It has been much reduced in size, but it has continued to discharge these core functions. Burkina Faso has not maintained central government support for the irrigators' organisations. It supports them through relatively weak regional agencies, which have many other things to do.

A significant result of the greater amount of central government involvement in Niger has been that it has defined and insisted on more rigid rules about organisational behaviour. The irrigators' associations are effectively controlled by ONAHA and by other administrative agencies in regard to the procedure for deciding their fee rates, eviction of indebted irrigators, crop calendar policies, elections of office-holders, and some other aspects ; whereas in Burkina Faso the irrigators' organisations have more freedom or flexibility in most of these areas.

3. Government Policies about Irrigators' Organisations

3.1 Niger policy.

In Niger, the government took a formal decision, promulgated at a national meeting at the town of Zinder in 1982, to work towards self-financing and self-managing irrigation systems. Until that time, irrigation systems which had been built in the Niger River valley were owned, operated and financed by government.

The transition process took many years. The role of the national irrigation agency, ONAHA, could not be reduced instantly, and it is still required for providing certain services. It has however been steadily reduced and restructured, to the point where its remaining functions can be put on to a commercial rather than a bureaucratic basis.

During the transition phase, numerous new irrigation systems continued to be built. These were in a new context, since their potential users knew from the beginning of construction that they would be expected to sustain the irrigation systems themselves, and would have to form organisations for this purpose.

The government-promoted irrigators' organisations in Niger are therefore of two kinds. In older systems, new organisations had to be developed. These organisations had to be persuaded to take over functions previously performed by government. In newer systems, the direct government-managed phase did not occur. Organisations were created with the clear purpose of performing these operation and management tasks.

It might be expected that the newer organisations would therefore be better, but the actual evidence from the field does not suggest differences in performance from this cause.

3.2 Burkina Faso policy

The policy followed in Burkina Faso has had many similarities with Niger, but also significant differences. Burkina Faso arrived some years ago at the same goal of self-management, but it has evolved more gradually. The policy objectives, when the country began to develop a coherent irrigation policy in the 1970s, were :

- improving food security, reducing rural migration, creating employment (especially during the dry season) and ensuring ecological equilibrium ;
- promoting the development of (ultimately self-supporting) farmer organisations and other co-operative structures responsible for running the irrigation schemes.

The first of these objectives implies the introduction of new cultivation technology that may replace, or coexist with, traditional methods of rainfed agriculture. Some of the exigencies of new technology related to sowing, application of fertiliser and other inputs, storage, and marketing might conflict with traditional practices.

The second objective sometimes involves profound changes in existing social structures, which would be difficult to achieve without the support of the concerned populations, especially if these organisations were to be autonomous and self-supporting.

The government also established legal and institutional frameworks covering questions such as land tenure, the rights and obligations of farmer organisations and individual farmers, institutions and their roles, etc. During the 1980s and 1990s, significant changes occurred in the institutions as well as in the legal texts, which were revised a number of times. The former single ministry of rural development was broken up into ministries for water, agriculture and livestock ; agrarian and land reform programmes were initiated ; specific authorities were set up for major irrigation development projects.

The government in Burkina Faso has not maintained an equivalent of Niger's ONAHA, a national organisation for supporting these irrigation systems. It has a national organisation for constructing irrigation systems, but support for operations, maintenance

and management is done through local government. Each of the country's twelve regions has an organisation for delivering various supports to agriculture and animal husbandry. These organisations of the regional governments are small and the support which they can give depends largely on the personality and effectiveness of individual local officials.

Financial management has not been brought into focus as strongly in Burkina Faso as in Niger. The reason for this is probably that the gravity systems of Burkina Faso do not face the heavy recurrent costs of electricity for pumping, which are normal in the Niger River valley systems. Without this cost pressure, the establishment of strict financial processes may have seemed less urgent.

The Burkinabe government was supported by the Netherlands government for many years in a joint programme for developing awareness of management in the irrigation systems. This programme tried to teach co-operatives' leaders about aspects of financial management and book-keeping. However these efforts were not supported by formal rules, sanctions, or transparency, and the actual state of the organisations' accounts is generally confused.

Financial weakness, in the gravity systems of Burkina Faso, is felt most severely when flood events occur (since these systems are located in valley bottoms). The organisation has to face substantial repairs to infrastructure such as flood protection dykes, and perhaps canals or dam spillways. The practice is that the irrigators' associations appeal to government to solve such disasters, and do not appear to try to accumulate savings to insure themselves against such events. The agencies of government do not in fact have budgets that could do this, so there is a growing amount of overdue repair and maintenance work, which is done neither by the associations nor by the government.

The Burkinabe irrigation systems are generally supplied with water by gravity, but there are a few cases where water is pumped to land on the upstream side of the irrigation system. There is evidence (see performance tables below : system D) to show that such an organisation develops better financial behaviour, presumably because, to pay for energy costs of pumping, it has to extract a larger fee from its users than a gravity system needs. It may therefore be put under more pressure by its members, for example to justify the fee level to them.

4. Features of the irrigators' organisations

4.1 Structural form

In Niger, the government has laid down standard formats for four key organisational documents : the constitution of an irrigators' organisation, the structure of its seasonal operating accounts, a contract between the organisation and ONAHA for support services, and a contract between each individual irrigator and the irrigators' organisation.

The constitution is initially adopted at a general meeting of all irrigators, in a particular irrigation scheme. The standard constitution contains an article which specifies the process by which the members can amend it later if they want to do so. However, it appears that they have rarely or never done this.

There are two organisational levels, the co-operative, which controls a complete irrigation system, and the Mutual Production Group (GMP) which is a block of the order of 30 to 60 hectares, usually along one secondary canal. Each irrigator is a member of the GMP, which handles field tasks, including water distribution. The GMP elects delegates to the management committee of the co-operative, which in turn elects the office-holders.

There are no general meetings of the whole co-operative, but it is the co-operative which controls finances and collects fees. In this structure, it is difficult for a member to express dissatisfaction about financial management. In the event of dissatisfaction about other aspects of management, ordinary members cannot directly change the office-holders, because the GMP committees indirectly elect these,, not by the ordinary membership.

The standard accounting system is quite complex, for the context of low literacy levels. All expenditure must be recorded and classified among some 30 different expense categories. There must be separate accounts for each member of the organisation, and all financial transactions with that member must be individually recorded. These procedures are required by the government's organisational scheme, but some irrigators' organisation do not find accountant staff who are able to apply them.

An unusual feature of the Niger system is that the rates of irrigation service fees are based on a calculation of true costs. The fee level is revised every season, using an exact calculation of the total net costs of the organisation in the previous season, per hectare cultivated. This is the fee charged for each hectare cultivated in the next season. Such a system can be operated only if financial record-keeping is accurate and up to date.

Elections of the management committee occur at intervals of a few years. The standard constitution does not specify an interval between elections, but in cases where the leaders seem to prolong their periods in office to the point where there may be unrest among the members, the government, through the local administrative official (prefect), sometimes intervenes to arrange an election.

The structure in the Burkina Faso organisations is less formalised. The government again lays down standard forms of the basic organisation, but the accounting system is much less rigorous. There is only one level of organisation, the co-operative. The law governing its procedures is a general law for many kinds of rural co-operatives, and has not been specially adapted to the particular case of irrigation.

The co-operative model is usually imposed on the irrigators from outside, rather than generated internally. Membership in the organisation is a necessary pre-condition for allocation of an irrigated land-holding. As in Niger, the constitution and internal rules are generally standard models proposed by government organisations and rarely emanate from the membership or are adapted to their particular needs.

The idea of a co-operative is based on concepts of solidarity and collective decision-making that are inconsistent with some characteristics of traditional of rural societies such as domination of and deference to village chiefs and elders, subordinate role of women. These societies function according to principles of reciprocity (rather than democracy) where each person gets a certain benefit from the collective organisation.

The irrigator co-operatives sometimes bring together people from different villages and social groups. They tend to be dominated, or taken over, by a few influential persons or groups.

The governments wish the irrigators' organisations to be self –sufficient, but on the other hand both governments have been reluctant to transfer ownership rights completely. In both Niger and Burkina Faso, the farmers in the irrigation systems are not owners of their land. They are given it, under various criteria such as having contributed labour in the construction, but they do not have ownership and transfer rights.

The irrigators' organisations do not own the irrigation infrastructure. For example, in the small dams in Burkina Faso, the co-operative cannot exert any rights over use of water resources stored in reservoir. Evidence of this is that agencies of government are able to plan other uses of the reservoir, such as domestic water supply to other communities, without needing permission from the irrigators' association.

4.2 Activities and services to members

These organisations exist in poor rural environments, where (in many cases) the irrigators face great practical obstacles in obtaining their agricultural input needs, and in marketing their crop surpluses. Therefore, the members of the irrigators' associations generally want the associations to provide not only water supply, but also various additional services. The most common requirements are for fertiliser and seed purchases by the associations, for resale to the members. Some associations also have equipment for hire to members, some organise common rice nurseries, some perform land-preparation for members' land, and some organise marketing or purchase crops from their members for transport and sale.

The demand for non-water services is greatest in the more remote organisations. Those which are located close to a city can satisfy their needs from the private sector and have easy access to urban markets. In the more remote places where traders in fertilisers may not even exist, the purchase of fertilisers by the irrigators' associations is the largest part of their annual financial transactions.

4.3 Finances

The irrigators' associations in Niger charge their members a seasonal fee for the provision of the basic service of delivering irrigation water. As we have noted, the amount of this fee is based on an exact calculation of the costs incurred by the association during the season. All operation, maintenance and management costs are included. In addition, the government agency ONAHA has specified several fixed charges, representing certain percentages of the capital costs of building the irrigation system, and other fixed charges which are also based on a percentage of capital cost, and are intended to be savings towards future renewal of equipment. The calculation also incorporates a payment to ONAHA, for providing the services of the System Director : this payment exceeds the actual cost of providing the Director, so it includes in effect a contribution towards the overhead costs of ONAHA's existence.

Thus, the members of irrigators' associations in Niger pay towards all the four major cost components : past capital investment, current operations and maintenance, future renewals, and government agency overheads. Since Niger is one of the world's

poorest countries, in wealth and in income, it seems remarkable to find such a system here. The basic reason is that the government itself has very insufficient financial resources, so irrigation would not be possible without this payment system.

The capital and renewal payments are not transferred to the government, as in some other countries. The co-operatives retain these funds, and are supposed to store them in interest-earning restricted bank accounts, for future re-investment in renewing and upgrading their facilities.

The irrigators must also pay separately for other services (for example, fertiliser supply) which they request individually from the association.

The total amounts paid are therefore very heavy. In the remoter co-operatives they amount to about 20-21% of gross crop value, on average. It is extremely difficult for the irrigators to pay these amounts. According to the standard rules, they are allowed to pay up to the end of the following season. Many fail to do so, and they then become liable to eviction from their land-holding by a procedure involving the co-operative and the local civil administration. However, eviction makes the debt repayment less likely, so most of the co-operatives do not use it often.

Payment delay, rather than non-payment, is the critical financial problem for the Nigérien co-operatives. Because of payment delays by irrigators, many co-operatives are in effect bankrupt. The more remote ones have to buy fertiliser at the beginning of a season to provide for the early stages of their members' crop ; but the members do not have to pay for it until the end of the next season, which is about one year later. Some members pay only after further delays. The total arrears due to the associations are large, and the supposed capital savings accounts have all been applied as working capital to solve this problem. Effectively, none of the co-operatives studied has at present any liquid financial resources.

The government has tried to ensure that savings accounts will be "blocked" in the banks, with rules that prevent their use for general purposes. This is very difficult to achieve in practice, and if such tight rules could be made, very probably the response of the co-operatives would be to cease to deposit funds into the special savings accounts.

The co-operatives in Burkina Faso have a less strict system of financial control. These associations do not have to pay for the energy cost of pumping, which is by far the biggest expenditure item for the Nigérien associations. Therefore, the budgets of the Burkinabe associations are much smaller, the per hectare fee levels represent a much smaller fraction of product value, and in general the need for tight financial management may seem to be less severe.

In addition the Burkinabe co-operatives are smaller, having on average about 10% of the numbers of members in Nigérien associations. This means that, even if they wish to, it would be difficult for them to afford a full-time accountant. Financial management is therefore weaker, and there is often a lack of transparency in these organisations.

More serious than the lack of transparency may be the lack of information to the leaders of the co-operatives. There is no clear basis for calculating how much the irrigation service fee should be, and there are probably opportunities for a proportion of individual members to avoid paying it. Debt levels and arrears of fee income are only vaguely known.

Because of these weaknesses, several of the Burkinabe organisations have survived only by obtaining grants or subsidised inputs, from sources such as government agencies or non-governmental organisations.

Irrigated agriculture is generally profitable for the farmer. Returns to land and labour are much higher compared to rainfed agriculture (2 to 7 times for land, and 1.5 to 2 times in the case of labour). But because the irrigated holdings are small (about 0.25 ha), actual incomes are insufficient to meet the needs of irrigator families.

Hence irrigated agriculture does not constitute a full-time occupation for farm families, who tend to spread their risks by pursuing non-irrigation activities in parallel, especially rainfed farming. A major constraint in the integration of irrigated and rainfed agriculture is the allocation of scarce resources, such as labour and farm power, at critical periods of the crop calendar. Consequently, cropping calendars stretch well beyond the end of the rainy season causing enhanced drawdown of reservoir water volumes, and diminishing the scope for dry season cropping.

There are anomalies and shortcomings in calculating and collecting irrigation service fees. The fees demanded are generally less than 5% of gross product value and are inadequate to meet costs of reasonable maintenance. On the other hand, although irrigation service fee collection rates are generally high, the funds collected are not necessarily set apart for maintenance and minor repairs. As a result, the irrigators' organisations frequently encounter cash flow problems.

5. Performance

5.1 Irrigation performance

The performance of an irrigation system has many dimensions. It is not always easy to say clearly whether a certain system is better than another, because their performance may differ according to which indicator of performance we choose to give attention to. It is also not easy to measure performance in each of the relevant dimensions, and even when we find data we often have doubts about the true quality and reliability of those data.

All of the above points are real obstacles to forming definitive conclusions about the quality and success of an irrigation system. Having noted that these problems exist, we must also deal with the practical problem of trying to find out which policies (on the part of the government) are most likely to deliver improvements of performance. To make that assessment, we must use the available data, even if they are not as securely validated as we would want them to be.

Tables 1 and 2 show ten key performance indicators for each of nine irrigation systems in the two countries. For the Burkina Faso systems, one more indicator is added, the gross product value per cubic metre of storage volume, which is an indicator that gives some idea of the productivity of the major investment cost.

These tables illustrate how difficult it is to decide whether an irrigation system is well managed. Most of these irrigation systems are above average according to some of the indicators, and below average according to some others. We cannot say, objectively, in any single case, that the irrigators' organisation has any impact on the values of these indicators.

In some instances, we can see physical reasons for low or high values of certain indicators. For example, system A (in Burkina Faso) has a small reservoir capacity equivalent to only 27,000 m^3/ha, which does not allow any water to be carried over between seasons. It cannot therefore cultivate a dry season crop. Therefore it has low crop intensity, and low annual production value, relative to other irrigation systems with bigger reservoirs. In Niger, system F and (to a lesser extent) system G suffer from flooding, which reduces their production potential.

So it is sometimes possible to identify the impacts of specific physical or environmental factors, in raising or lowering some specific performance values. But it is much more difficult to identify the impacts of organisational parameters.

5.2 Organisational performance

In Burkina Faso, the administrative and financial skills needed to run a viable enterprise effectively are lacking among the rural populations. Most irrigators' organisations are not able to prepare regular financial accounts and balance sheets. The organisations are generally too small to afford to hire people with those skills. Thus, it is not easy to understand their real financial situation.

The irrigators' organisations generate income through (a) irrigation fees, (b) profit on sales of inputs and produce, (c) fines, hiring of equipment, etc. The amounts generated vary from system to system ($50 to 270/ha/season). But their levels of income are not adequate – the organisations' net current assets are low, or negative.

The organisations have insufficient working capital and they are often unable to cover routine operational expenses (input purchases, salaries of employees) unless they can obtain loans. In such a situation, they are unable to accumulate reserves.

Thus, overall financial management is weak. In some cases, this is due to lack of knowledge. But even in instances where appropriate training has been given, accounts and balance sheets are not prepared, and no procedures to record debts and to follow-up on recovery of them were observed. Such an attitude may be due to the fact that the associations and their leaders do not feel entirely responsible or independent. They may probably believe that, if they found themselves in serious difficulties, the state would always come to their aid.

Other deficiencies affecting management in the Burkinabe associations are that the organisations do not always possess reliable basic system information; for example about the physical infrastructure (reservoir, irrigation network, irrigated areas), or organisational aspects (updated lists of members, minutes of meetings, etc). Also, legal and administrative texts and rules are not always translated or available in the local language.

The Nigérien organisations have higher levels of formality and much clearer accounting systems. They are larger, can afford some hired staff, and are more closely watched by government staff. However, they have also not been able to build up reserve funds, and would not be able to deal with the financial effects of any severe events such as replacement of pumping equipment, or a series of bad climatic conditions.

There is a lack of systems for obtaining compliance with organisational rules. The executive committees of the irrigators' associations have difficulty in enforcing any rules, because they cannot (in most of the systems) apply small penalties for offences, to

prevent their repetition. In Niger, the irrigators' associations can evict irrigators who do not pay their debts, but this is a severe punishment, and they do not have smaller punishments available, so the effect is that often no punishment at all is applied for breaking rules.

In both countries, there is a need for more objectivity and transparency in decision-making and in administrative and financial management of the irrigators' associations. Decisions that are (theoretically) supposed to be taken by the general membership, are usually taken by a small group of office-bearers; there is also absence of audits and publication of accounts.

Clear definition of roles and responsibilities of the principal actors -- the state, the irrigators' association and the individual farmer -- (and actual adherence to what is stated) would help to produce better results. In particular, the responsibility for major repairs and maintenance has been left vague, and the result of this is that it is not performed, neither by the government agency nor by the irrigators' association.

5.3 Sustainability

It is difficult to predict objectively the sustainability of an organisation. Financial sustainability can be quantified or measured approximately. It is possible to say that none of the nine organisations which have been studied in the two countries seems to be sustainable in the long term, unless the financial rules or procedures change, because none can afford to undertake necessary major maintenance or renewals of equipment or facilities. The organisations in Niger have in general more financial resources, but the pressures of inflation and increased service demands by members have consumed their savings. Those in Burkina Faso are not charging their members enough to develop significant savings, and some have survived only by obtaining grants or special subsidies. To assess organisational sustainability in a wider sense than the financial aspect only, we have compared these organisations against Ostrom's set of eight principles of long-sustained organisations of irrigators. The principles, which were derived from a study of organisational characteristics in organisations formed by irrigators in many countries, can be stated briefly as follows :

1. There are clear boundaries, and rules about who has rights to water.
2. Rules ensure that each member's benefits and contributions are in balance.
3. Rules can be modified by collective decision of the members.
4. Monitoring of conditions and actions is done by users or by people accountable to them.
5. Violators of rules receive graduated penalties, decided by other users or by people accountable to them.
6. Arrangements exist for settling conflicts, among users or between users and officials, quickly and at low cost.
7. Government authorities recognise the users' right to devise their own organisation and rules.
8. There are different levels of organisation, which deal with different functions and decisions.

Each of these eight rules addresses an aspect of good organisation :

- clarity
- equity
- flexibility
- transparency and accountability
- compliance with rules
- conflict solving
- autonomy
- decentralisation.

To assess how closely the nine organisations in Burkina Faso and Niger conform to these eight principles, we have assigned a score, for each organisation, against each principle. This score is in a simple four-level range : 3 = high conformity to the Ostrom principle ; 2 = moderate conformity ; 1 = low conformity ; 0 = no conformity (or behaviour that is opposite to the principle). Since there are eight principles, an excellent organisation with high expectations of sustainability could get a maximum score of 24, which we treat as a compliance level of 100%. At the low end, a score of 0 is possible.

This is of course a partly subjective assessment, but not entirely so as it is influenced also by some knowledge of events occurring within each organisation over a period of 5 – 6 years of observations of their processes and performance.

The results, as averages for each of the sets of organisations, are shown in Table 3. The final column of that table, which is titled "Percentage compliance," shows the degree to which each organisation conforms to the Ostrom principles. The organisations D in Burkina Faso and H in Niger, with about 46 – 47% compliance with the principles, are the most satisfactory by this test. But the ratings seem quite far from satisfactory, and the average of them all is only 37%. The average in Niger (41%) is considerably higher than in Burkina Faso (33%).

In Table 6, these assessments of organisational strength are compared with performance indicators from Tables 1 and 2. We have derived an "overall performance indicator" for each irrigation system, by combining the relative performance levels in each of these six indicators, in order to see which systems are (on the average of the six indicators) performing above or below the average of all the nine systems which were studied.

Tables 4 and 5 show the steps in making this combined indicator of overall performance. Six indicators were used, rather than the full sets shown in the earlier tables, because there were some differences in the data collection procedures in the two countries, and some items were not directly compatible. These six indicators show the management concerns : productivity of land and of water, equity, returns on initial investment, cost of management, and fee collection.

For each of the six component indicators, the mean values for all the nine systems in the two countries were calculated. These are shown in Table 4. Then, for each indicator, we have calculated how far it is above or below the mean of all the nine values, in terms of the number of standard deviations up or down from the mean. These deviations from the means are shown in Table 5. The last column of Table 5 shows, for each of the nine systems, the average deviation above or below the mean, which is the overall performance indicator. For example, Table 5 shows that System D

has an overall performance of +1.07. This means that System D's performance was higher than the mean of all 9 systems, by, on average, 1.07 standard deviations.

In Figure 1, these overall performance ratings are plotted against the assessment of conformity with the eight Ostrom principles.

The results indicate several interesting conclusions :

- The performance is correlated with the degree of conformity to the Ostrom principles ;
- The average performance, and the average level of conformity to the Ostrom principles, is higher in the Niger systems than the Burkina Faso systems ;
- The gravity-fed systems A, B, C, and E have poorer performance, and poorer conformity to the Ostrom principles, than the systems which depend on pumps ;
- In some cases where the actual performance is lower than the correlation line in Figure 1, there is a clear physical explanation (a small reservoir in system A, and a low-lying site with water-logging risks in system F).

5.4 Summary of strengths and weaknesses

A rough inventory of the strengths and weaknesses of the existing arrangements in the two sets of irrigation systems is as follows. The items in this list do not all refer to the irrigators' organisations : some of these strengths or weaknesses are due mainly to other parts of the institutional system.

In **Niger** :

- high cropping intensity
- high yields in some, but poor in others due to non-observance of calendar
- household incomes generally adequate for motivation
- high fee collection
- insufficient working capital
- low water productivity at some sites
- lack of major maintenance

In **Burkina Faso** :

- moderate cropping intensity
- moderate yields, stationary or declining
- insufficient revenue to organisations
- insufficient working capital of organisations
- moderate fee collection
- low water productivity
- low return to capital invested
- lack of maintenance
- weak financial management
- non-involvement of membership in decisions
- erratic supports from the state

6. Assessment of the Successes or Failures of Government Actions

There is a quite strong tendency to exaggerate the impact and importance of government actions. In reality, we know that the impact of government must be quite restricted. These are countries with very low national wealth or income, where collecting revenue for the governments is not easy ; consequently, the field presence of government officials is small. Laws can be written, but it is not easy to make them effective. In the Nigérien co-operatives, many even among the committee members seem to be unaware of the contents of the document that is, nominally, the constitution of the association.

Many of the observed strengths and weaknesses must have causes that are not connected closely to government actions. For example, the competition for labour resources, which occurs at the critical time when the irrigated rice crop and the unirrigated millet or sorghum crop both need labour, for optimal results, has little to do with the official policy.

The policy problem, when we study a list of strengths and weaknesses as presented above, is this : How much effect do government actions have, in encouraging the strengths or reducing the weaknesses? The answers to that question are a matter of opinion, not clearly proved by the small amount of systems we have yet been able to observe.

The Nigérien systems perform better, on average, than the Burkina Faso systems. This may be because they have more clear accounting systems (controlled by the government agency). There are other differences, such as the smaller size of the Burkina Faso systems, or the presence of a supporting agency of the central government, which may also partially explain this difference.

But it seems likely that the differences of national policies and institutions may not be the main reason for the differences of organisational performance and sustainability. The system D in Burkina Faso ranks better than the Nigérien systems in both respects. It is physically different from the others in the Burkina Faso group, because it depends on pumping, not gravity supply of water.

A probable explanation of the differences is that the systems which depend on pumping have developed stronger organisations than the systems which depend on gravity. All the pumping systems (D, F, G, H, and I) have higher ratings against the Ostrom principles than the gravity systems. In pump-based systems, the average compliance with the Ostrom principles is 42%, and average performance index is +0.25. The corresponding averages for gravity systems are 30% and – 0.32 (Table 6).

This may be because the pumping cost is high, and must be paid regularly, and the members know that if this is not done their water will stop. This provides a more direct and immediate danger to the system than the possibility of a flood in some future wet year ; so the members realise that they must support their organisation, at least financially. Stronger organisational support also raises the levels of performance in general.

In neither country do the organisations seem to be developing financial independence. They are all unable to deal with the costs of any large emergencies. Most of them

would be technically bankrupt, if they were true private-sector businesses, since their net available resources are generally negative.

One of the most interesting issues is whether the Nigérien policy of tighter government control over association structure and procedures is good or not. The results do not prove this clearly, but the general indication is quite favourable to the Nigérien policy. In Burkina Faso, the organisations have more freedom to decide their own irrigation service fee rates. All of them seem to have fixed these at levels lower than they really require. This has happened even though their requirements are very much less than the requirements of the Nigérien systems.

The experience of these two countries seems to suggest that it is desirable to keep some agency of central government which can provide residual services to the irrigators' associations, such as helping to achieve financial transparency. However, it is better that any such involvement of the central government should be very clearly defined and restricted, so that the associations do not remain permanently accountable to the government and dependent on the government. Most of the maintenance deficiencies which can be observed (especially in the Burkinabe systems) seem to be due to the associations' belief that, eventually, the government will come and arrange this work for them.

One of the most interesting lessons, from an Asian viewpoint, is that the Nigérien irrigators have shown that they have a capacity to pay fees that are set at levels very much higher than the Asian norms. This happens in spite of the general poverty of the people, and there are few signs that the fee level reduces the willingness of irrigators to participate in irrigated agriculture. Land utilisation remains high. Farmers clearly suffer many severe financial difficulties, but they still generally afford fertiliser inputs, and maintain agricultural performance that is generally as good as or better than the current norms of physically similar systems in Asia.

Table 1: Performance data from 5 irrigation systems in Burkina Faso

Irrigation system →		A	B	C	D	E	Mean
Indicator	Units						
Crop intensity	%/year	93	128	202	94	196	142.6
Crop yield	kg/ha	4,700	6,200	4,300	5,400	4,800	5,080
GPV per cultivated hectare	$/ha/season	759	1,130	793	1,976	738	1,079.2
GPV per developed hectare	$/ha/year	706	1,442	1,596	1,848	1,442	1,406.8
Water consumption	mm/y	1,140	2,560	2,550	1,240	2,650	2,028.0
Water productivity	cents/m^3	6.9	9.3	6.0	16.1	6.0	8.86
GPV/m^3 of storage volume	cents/m^3/y	3.2	2.9	2.3	4.2	1.7	2.86
Inequity of yields	%	35	33	43	34	40	37.0
Fee collection rate	%	85	96	75	100	92	89.6
Fee rate/GPV	%	18.6	6.5	6.1	4.7	4.6	8.10
GPV/management cost	--	5.4	15.4	16.4	21.3	21.7	16.04

Note : GPV = Gross product value

Table 2: Performance of 4 irrigation systems in Niger

Irrigation system →		F	G	H	I	Mean
Indicator	Units					
Crop intensity	%/year	193.6	180.8	191.2	89.1	163.7
Crop yield	kg/ha/season	4,020	4,60	5,070	-	4,560
GPV/cultivated hectare	$/ha/season	608	799	1,089	2,235	1,182.7
GPV/developed hectare	$/ha/y	1,074	1,382	2,032	1,977	1,615.9
Water consumption	mm/y	3,211	2,838	2,003	2,783	2,708.7
Water productivity	cents/m^3	3.76	2.83	9.94	7.92	6.11
Inequity of yields	%	35	36.5	27	44	35.6
Fee arrears	$/ha	364.5	119.9	144.9	132.0	190.3
Fee/GPV	%	21.5	16.0	12.0	20.4	17.47
GPV/management cost	--	17.5	23.8	31.2	18.5	22.77

Note : GPV = Gross product value

Table 3: Rating of the irrigators' associations relative to the eight Ostrom principles

Principle ⇐	1	2	3	4	5	6	7	8	
Irrigation system ↓									Percentage compliance
A	1.5	1.5	1.0	1.0	0.5	0.5	1.0	0.5	31.2
B	1.7	1.3	0.7	1.3	0.7	0.7	1.0	1.0	34.7
C	0.7	1.0	0.7	1.0	0.7	0.7	1.0	1.0	27.8
D	2.0	2.5	1.0	1.5	0.5	1.0	1.5	1.0	45.8
E	1.0	1.5	0.5	0.5	0.5	0.5	1.0	1.0	27.1
F	1.7	1.3	0.3	1.0	0.3	0.3	1.0	1.7	31.9
G	2.0	1.7	0.7	1.3	0.7	1.0	1.0	2.0	43.1
H	2.0	2.0	0.7	1.7	0.7	1.0	1.3	2.0	47.2
I	2.0	1.7	1.0	1.3	0.7	0.7	1.0	2.0	43.1
Mean	1.62	1.61	0.72	1.19	0.57	0.70	1.09	1.35	36.9

Table 4: Comparison of performance data

Irrigation system	GPV per cultivated ha. ($)	GPV per developed ha.($)	GPV/mgmt. cost	Water productivity (cents/m^3)	C_v of yields (%)	Fee collection (%)
A	759	706	5.6	6.9	35	85
B	1,130	1,442	15.4	9.3	33	96
C	793	1,596	16.4	6.0	43	75
D	1,976	1,848	21.3	16.1	34	100
E	738	1,442	21.7	6.0	40	92
Mean, Burkina	1,079	1,407	16.08	8.86	37.0	89.6
F	608	1,074	17.5	3.76	35	63.2
G	812	1,382	23.8	2.83	36.5	88.5
H	1,089	2,032	31.2	9.94	27	85.8
I	2,235	1,977	18.5	7.92	44	92.7
Mean, Niger	1,186	1,616	22.75	6.11	35.6	82.6
Overall mean	1,127	1,500	19.06	7.64	36.4	86.47
Standard deviation	583	429	6.96	3.92	5.29	11.31

Table 5: Performance indicators, relative to the mean of all 9 systems

Irrigation system	GPV per cultivated ha.	GPV per developed ha.	GPV/mgmt. cost	Water productivity	C_v of yields	Fee collection	Mean
A	- 0.631	- 1.850	- 1.933	- 0.173	+0.262	- 0.131	- 0.743
B	+0.006	- 0.135	- 0.528	+0.440	+0.641	+0.842	+0.211
C	- 0.573	+0.224	- 0.383	- 0.403	- 1.250	- 1.015	- 0.566
D	+1.458	+0.811	+0.319	+2.176	+0.452	+1.195	+1.068
E	- 0.667	- 0.135	+0.385	- 0.403	- 0.683	+0.488	- 0.169
Mean, Burkina Faso	- 0.081	- 0.217	- 0.428	+0.327	+0.116	+0.276	- 0.040
F	- 0.890	- 0.992	- 0.218	- 0.990	+0.262	- 2.058	- 0.814
G	- 0.540	- 0.275	+0.683	- 1.220	- 0.021	+0.183	- 0.198
H	- 0.065	+1.240	+1.752	+0.491	+1.775	- 0.057	+0.856
I	+1.902	+1.112	- 0.077	+0.082	- 1.439	+0.553	+0.355
Mean, Niger	+0.102	+0.271	+0.535	- 0.409	+0.144	- 0.345	+0.050

Table 6: Relationship between irrigation performance and compliance with Ostrom principles

Irrigation System	Ostrom compliance	Irrigation *performance*
A	31.2	- 0.742
B	34.7	+0.211
C	27.8	- 0.566
D	45.8	+1.068
E	27.1	- 0.169
F	31.9	- 0.814
G	43.1	- 0.198
H	47.2	+0.856
I	43.1	+0.355
Mean values :		
Overall	*36.9*	*0.000*
Pump systems	42.2	+0.253
Gravity systems	30.2	- 0.316
Burkina Faso	33.3	- 0.040
Niger	41.3	+0.050

[Note : The irrigation performance rating is the average performance of the irrigation system, relative to the mean performance of all the nine systems. A system whose performance is exactly equal to the average of all the nine would have a rating of zero ; a system which performs better than the average would have a + rating. Six performance indicators have been included in this rating. They are : Gross product value per cultivated hectare ; GPV per developed hectare ; Productivity of water ; Equity of yields ; Proportion of fees collected ; GPV/management costs.]

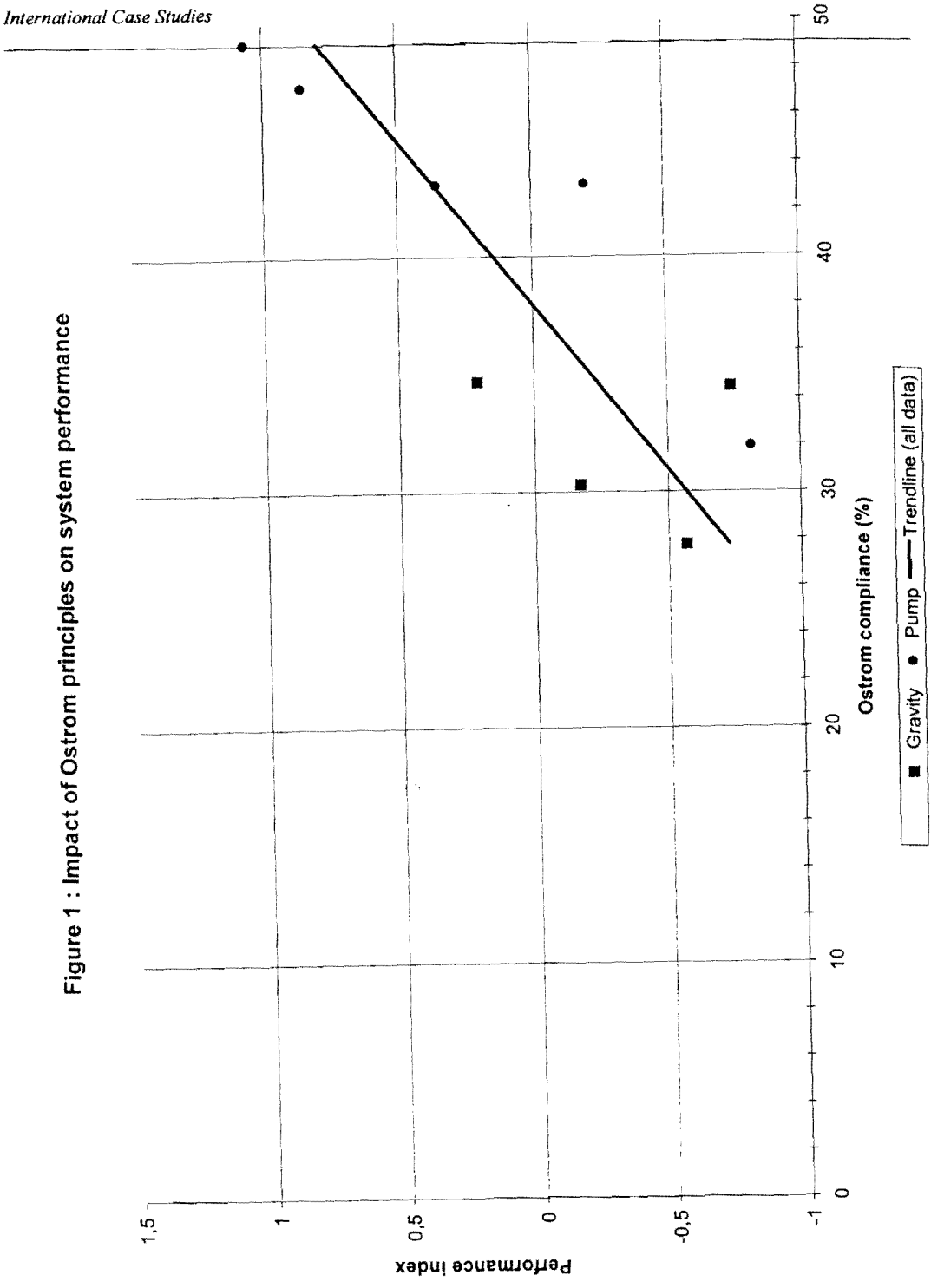

Figure 1 : Impact of Ostrom principles on system performance