CHAPTER 3

Mogtédo: The Sociotechnical Evolution of an Overexpanding Irrigation Scheme

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INTRODUCTION

BURKINA FASO IS a landlocked country of 274,000 km^2, situated between latitudes 10°N and 15°N in the Sudano-Sahelian agroclimatic zone, characterized by an annual rainfall of between 400 and 1,200 mm.

Irrigation development began in the 1960s with a view to help meet the food requirements of the country's 9 million people by supplementing the production from traditional rain-fed farming. Irrigated agriculture is presently estimated to cover about 16,000 hectares (ha), or about 10 percent of the irrigation potential. This area remains modest compared to the nearly 2.6 million ha of rain-fed agriculture.

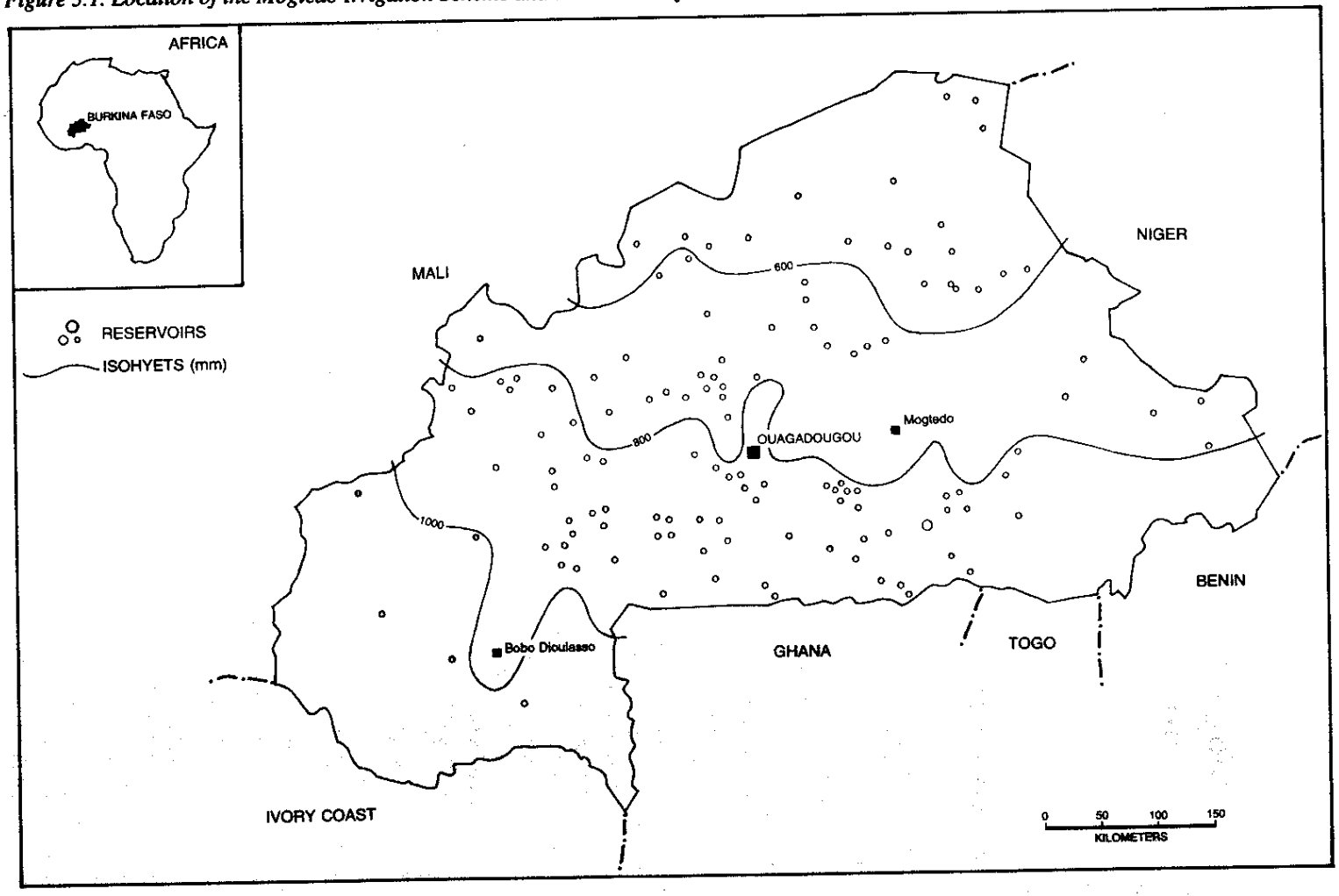
In the current socioeconomic context, dominated by the need to adhere to structural adjustment programs, the progressive transfer of management responsibilities in irrigation schemes to the beneficiaries is increasingly becoming a feature of irrigation development policy in Burkina Faso. The IIMI-Burkina Faso country program aims to strengthen the capacity of national partner institutions to improve and sustain the performance of small-scale, reservoir-based village irrigation schemes through collaborative research, training, and information dissemination. IIMI acts as the executing agency of a 4-year project financed through a technical assistance grant from the African Development Bank (AfDB) to the Government of Burkina Faso.

The project commenced in April 1991. This paper reports on the results of the first 18 months of work in Mogtédo, one of the five small-scale, reservoir-based irrigation schemes where IIMI is conducting field research. It also draws on the more generic work carried out on the institutional and legal frameworks related to the irrigation sector in the country.

The Mogtédo Irrigation Scheme, commissioned in 1968, is one of the oldest in Burkina Faso. It is typical of small, reservoir-based village irrigation schemes managed by farmer organizations with technical assistance and support services provided by government agencies. The scheme has undergone much change in the nearly 25 years of its existence. The initial reticence of the farmers vis-à-vis irrigation gave way to an avid interest in acquiring an irrigated plot. This resulted in a progressive expansion, formal as well as informal, of the irrigated area which continues even to this day. Much of this expansion however did not follow any rational development plan and escaped all supervision or control on the part of the state, which remains the legal proprietor of the reservoir, the irrigation infrastructure as well as the irrigated land. A deteriorating physical infrastructure and water piracy exacerbate system management. The farmer organization implicitly condones this situation by its inability or unwillingness to act against it.

The paper identifies the internal and external factors which are likely to have contributed to the present situation. It analyzes the mobilization and storage of the water resource, assesses operational practices relating to water conveyance, distribution and on-farm irrigation, analyzes

Figure 3.1. Location of the Mogtédo Irrigation Scheme and distribution of small dams and reservoirs in Burkina Faso.



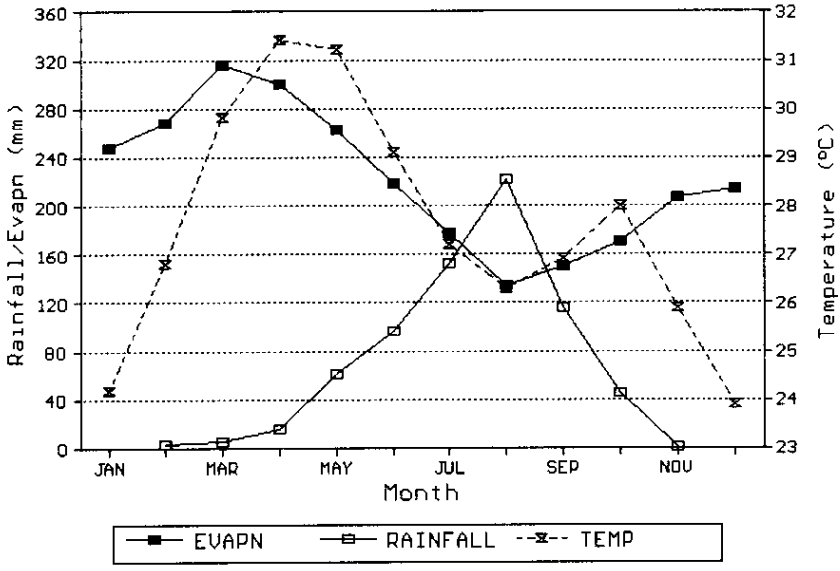
the formal and informal organizational arrangements in the systems, and reviews the institutional context. The interactions among the different actors of the system and the conflicts between the traditional seats of authority and "modern" administration are explored. Some key physical, institutional and organizational factors likely to contribute to ensuring the sustainability of irrigation schemes of this type are finally identified. This is especially in view of the current irrigation development policy in Burkina Faso which emphasizes the progressive transfer of management responsibilities to the beneficiaries.

THE MOGTÉDO IRRIGATION SCHEME

Location and Climate

The Mogtedo Irrigation Scheme is located near the village of the same name, 85 km east of Ouagadougou, the capital of Burkina Faso. The Mogtédo Reservoir is one of over 700 small reservoirs in the country (Figure 3.1) providing people and livestock with some degree of security against climatic variability. Use of the stored water resource for irrigated agriculture was rather limited until formal irrigation schemes were begun to be developed around these small dams and reservoirs in the 1960s.

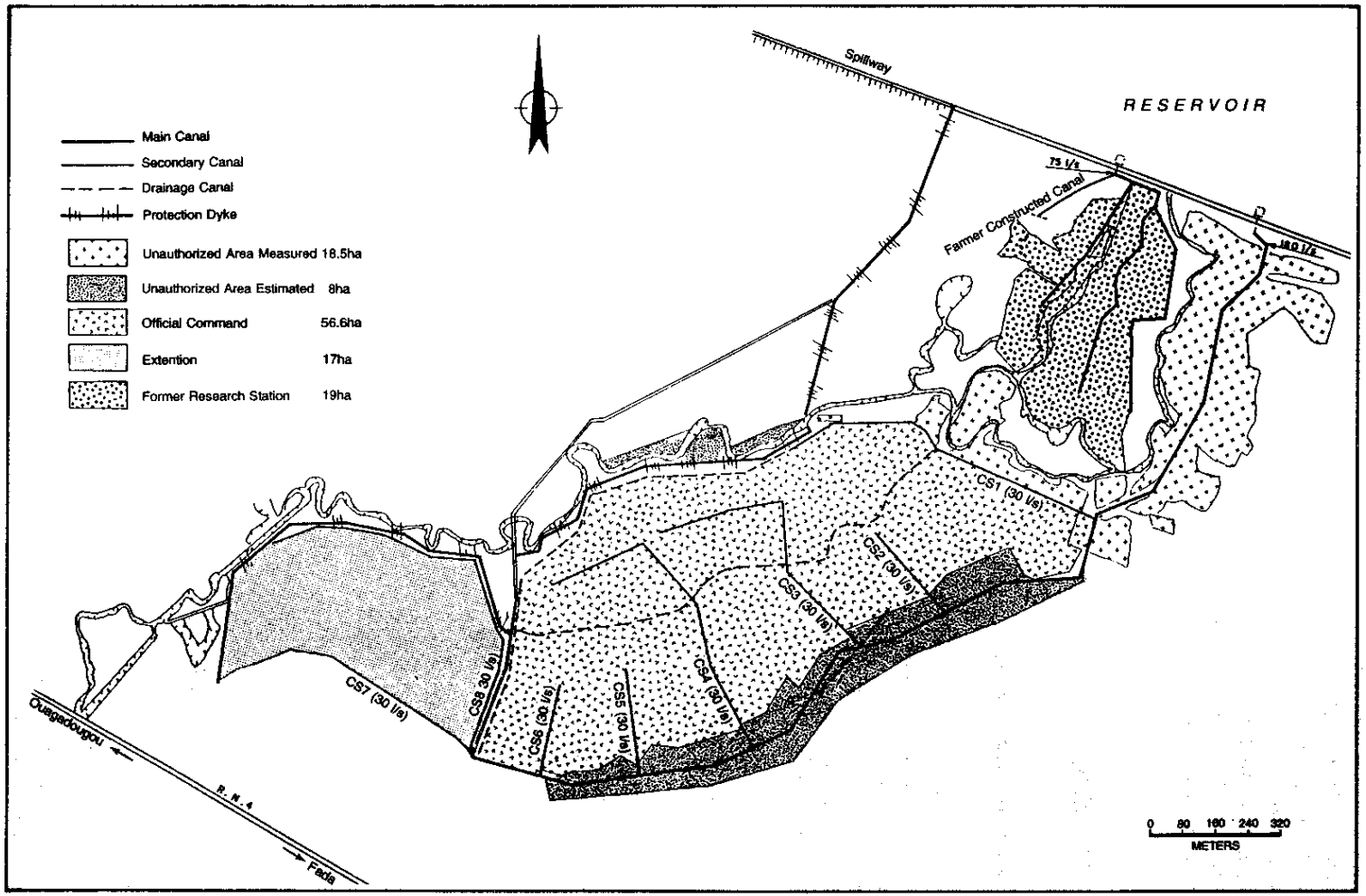
Figure 3.2. Average rainfall, pan evaporation and temperature, Mogtédo, 1971–80.



Note: Evapn = Pan evaporation.

The climate in the area is of the Sudano-Sahelian type with a single rainy season from May to September and mean annual rainfall between 700 and 800 mm (Figure 3.2). The hottest months

Figure 3.3. The Mogtédo Irrigation Scheme: Formal and informal irrigated areas.



are April and May when temperatures during the day can attain 45°C, whereas in January, the coldest month, minimum temperatures often fall below 10°C.

The Dam and Reservoir

The Mogtédo Reservoir was created by constructing a 5-m high earth dam, 2,600 m in length, across the Bomboré, a tributary of the Nakambé River (formerly called White Volta). Its catchment area is approximately 500 km^2. The dam is in good condition, apart from the loss of some riprap on the upstream face and a few traces of erosion on the downstream face. However, the 600-m long concrete spillway is threatened by progressive erosion of the spill tail channel which has already undermined the antierosive dike located immediately downstream of the main spillway.

The reservoir, whose capacity was assumed to be 2.9 million m^3 (until 1991-92), provides irrigation water to land on the left and right banks of the river. The official irrigated command area is made up of two blocks (57 ha and 17 ha) on the left bank side and a single 19-ha block on the right bank, developed progressively between 1964 and 1975. Large extents of informally irrigated land within and around the "official" command area have gradually come into being since 1985 (Figure 3.3) and add to the complexity of system management. Surveys conducted by IIMI in 1991 and 1992 have revealed that the extent of informal irrigation varied from sector to sector but was always of the order of 30 ha.

Irrigation and Drainage Network

A 2,500 m long, 180 l/s capacity, concrete-lined main canal conveys water from the reservoir through the left bank command area. Water is then distributed to the farmers' fields via a network of eight secondary canals (also lined) and 64 unlined tertiary canals. The first six secondary canals, S1 to S6, are equipped with calibrated distributors (or "modules") of 30 l/s capacity each. Regulation of water level in the main canal is ensured by a series of concrete weirs. The gates at the heads of the tertiary canals no longer exist. The irrigated area on the right bank is fed by 4 secondary canals taking off immediately downstream of a 75 l/s sluice from the reservoir.

Table 3.1 summarizes the characteristics and present state of the secondary canals of the left bank area, the primary focus of this paper.

The drainage network is practically nonfunctional and large extents of land in the central zone of the command area as well as low-lying areas in the "extension" remain waterlogged. Furthermore, some drains have even been transformed into irrigation canals!

Soils and Crops

The scheme was originally planned for double cropping of rice on the basis of soil surveys carried out in the early 1960s which indicated the predominance of hydromorphic soils (Gavaud and Pereira-Barreto 1961) in the area. Extensive in-situ tests carried out on the IRAT (Institut de Recherche Agronomique Tropicale) experimental farm established on the right bank area between 1964 and 1970 revealed that the first 40 to 60 cm of soil were in fact more permeable than was initially thought. Hence, diversified crops such as onion, tomato, chili and other vegetable crops

Table 3.1. Inventory of secondary canals in the left bank area of the Mogtédo Irrigation Scheme.

Canal	Length (m)	Discharge capacity (l/s)	Number of tertiary canals	Irrigated area (ha)	Present state of canal and structures
S1	810	30	9	15	* Subsidence of certain reaches * Deterioration of canal lining * Absence of control gates
S2	250	30	9	8	do.
S3	720	30	10	11	do.
S4	770	30	8	11	do.
S5	250	30	9	11	do.
S6	200	30	9	3	do.
S7 Extension	713	33	5	9	* Canal dilapidated due to poor quality of construction and frequent inundation * Demolition of canal lining * Absence of control gates * Seepage losses
S8 Extension	610	27	5	7	do.

were encouraged in the dry season. However, in certain low-lying zones, rice cultivation remains the only possible option in the dry season as well.

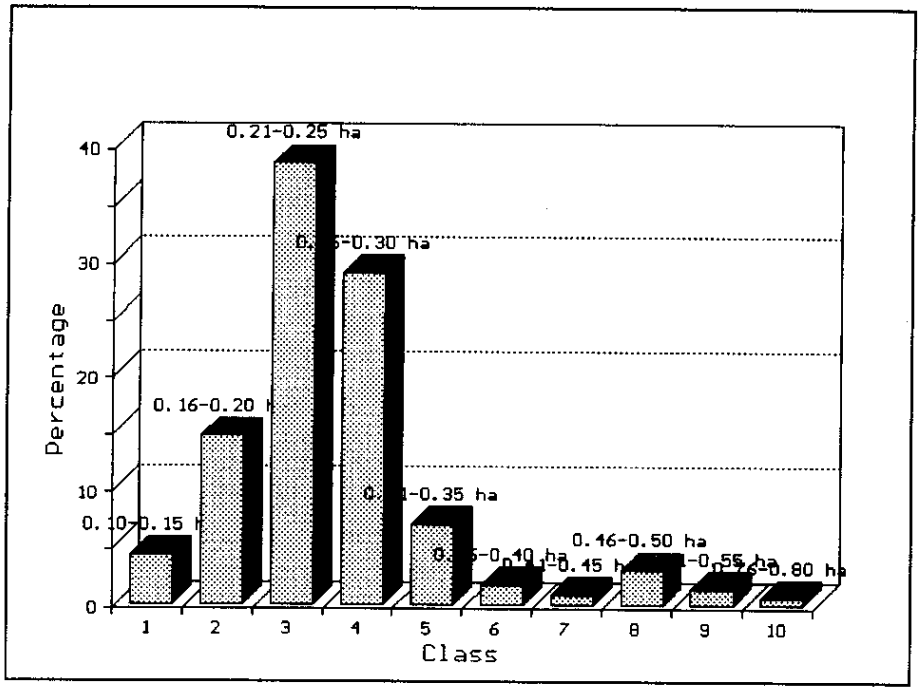
Landholdings

The size of the irrigated holdings is variable and relatively small. A survey carried out by IIMI in 1991 revealed that out of 374 landholdings, about 65 percent were between 0.20 and 0.30 ha in size. The size of the smallest holding was 0.10 ha, while that of the largest was 0.80 ha (Figure 3.4).

ORGANIZATIONAL STRUCTURE

According to existing legislation in the country, two distinct bodies are empowered to manage the irrigation scheme. One is, a *collective organization* made up of the beneficiaries to take charge of its day-to-day management. The responsibilities of this farmer organization, as described in the official texts, include organizing and carrying out irrigated agriculture, ensuring that technical norms and directives are respected, operating and maintaining the irrigation system, collecting user fees, facilitating the marketing of produce, and promoting a cooperative spirit among its members. The other body, a *management committee* made up of representatives of the provincial administration and the different state agencies with an interest in the scheme, and farmer representatives, is supposed to oversee the functioning of the farmer organization and to generally look after the interests of the state. This committee is entrusted with a consultative role concerning water distribution and marketing, and an executive role in matters relating to land allocations and land tenure.

Figure 3.4. Distribution of landholding size, Mogtédo, 1991.



In Mogtédo, immediately following the first round of land allocations in 1968, the farmer organization automatically obtained the status of a *cooperative*, headed by a Board of Directors. Although a draft constitution and associated statutes were drawn up to regulate its activities, they have not been formally adopted to date. In addition, the Management Committee too has hardly ever functioned effectively.

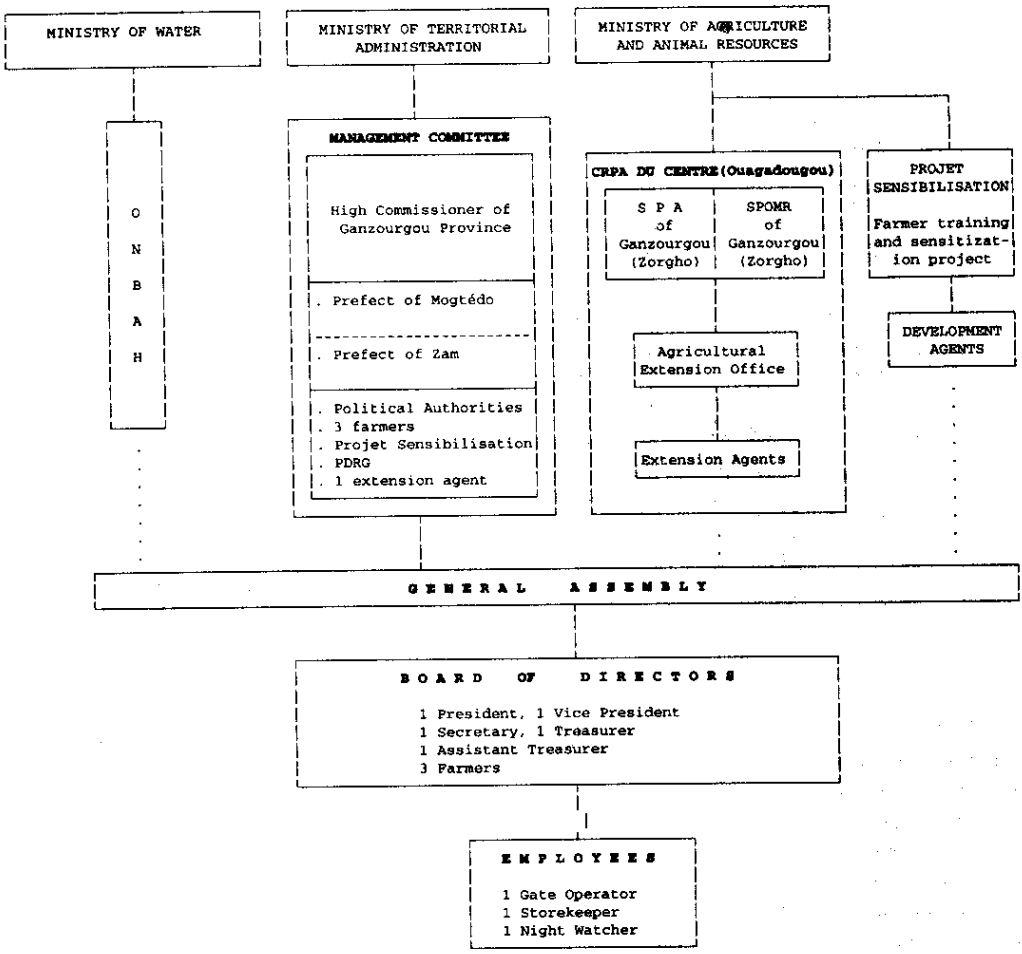
The Mogtédo Cooperative benefits from technical and administrative support from a number of agencies under the Ministry of Agriculture. Agricultural extension advice is provided by the Regional Agro-Pastoral Promotion Center (CRPA) which has two full-time field staff posted at the scheme, while the "Projet Sensibilisation" (a farmer training and sensitization project functioning under the same ministry) runs literacy programs and provides some training in administration and management. The National Development Bank and the National Agricultural Credit Agency extend credit facilities.

The principal focus of support staff from the extension services is on agronomic issues (e.g., ensuring supplies of seed, fertilizer and other inputs). Little attention is paid to optimum water use, doubtless because they lack technical training and skills in irrigation water management.

Actual system management operations are left in the hands of a farmer, employed part-time by the Cooperative as an *aiguadier* (a gate operator) and he carries out decisions made by the Board in this respect. In reality, his task is limited to opening of the main sluice in the morning and closing it in the evening (there being no irrigation at night) and to adjusting the setting of the calibrated distributors along the main canal.

The organizational chart of the Mogtédo Irrigation Scheme is presented in Figure 3.5.

Figure 3.5. Organizational chart of the Mogtédo Irrigation Scheme.



Legend :
ONBAH = Office National des Barrages et des Aménagements Hydroagricoles.
CRPA = Centre Régional de Promotion Agro-pastorale.
SPA = Service Provincial de l'Agriculture.
SPOMR = Service Provincial à l'Organisation du Monde Rural.
PDRG = Projet de Développement Rural de Ganzourgou.

EVOLUTION OF LAND OCCUPANCY

Land Allocation Process and Land Tenure

When the state decides to invest in an irrigation system, it takes over the land on which the scheme is to be built. No compensation is paid for the expropriated land. After construction, the land is redistributed to the people following certain criteria. Previous occupants usually get priority. But

the beneficiaries are neither granted title deeds to their parcels nor are they guaranteed leaseholds for any period of time. The parcels may be withdrawn at any time, usually for not respecting any of the regulations governing farming activities which are in force.

Land allocation in an irrigation scheme is generally decided upon by a special commission made up of representatives of the Ministries of Water and Agriculture, local administrative and support services (CRPA, SPOMR, ONBAH, etc.), the political authorities, and the traditional village chiefs. Among the criteria used to determine the eligibility of applicants are:

- Whether the applicant had participated in the construction of the scheme.
- Whether s/he was already farming on the area now taken over for the irrigation scheme.
- Whether s/he had given an undertaking to adhere to the farmer organization, to pay all dues, and to conform to all technical and administrative directives.
- Family size, notably the number of able-bodied members capable of actually contributing to farming activities.

In Mogtédo, it appears that none of these criteria were determining factors, given the very small initial demand (in 1967) for irrigated land. Interviews carried out in 1991 reveal that participation in construction work or a financial contribution of 1,000 CFA francs (about US$4) was sufficient to obtain a plot. There is no documentary evidence to prove that this was indeed the case, since no written records exist of the allocation proceedings. In the absence of records, it may be assumed that each beneficiary was only allocated a single plot, though it is highly unlikely that this rule was respected in the case of the subsequent extensions to the command area.

Formal and Informal Extensions

Being one of the earliest irrigation schemes in Burkina Faso, the growth of Mogtédo went hand in hand with the development of the political, legislative, and institutional frameworks governing irrigation development in the country. The attitudes of farmers vis-à-vis irrigated agriculture also evolved with time. Initial reticence, demonstrated by the fact that the allocation of land in 1967 only interested 38 beneficiaries, soon gave way to a great demand for irrigated plots. The progressive implementation of a number of formal and informal extensions to the irrigated area was a direct consequence.

Informal irrigation, obviously not conforming to any rational development plan, continues to expand in the absence of opposition from the Cooperative and of any supervision or control on the part of the Management Committee. This has led to the tacit acceptance of a variety of situations and practices which militate against the pursuit of sound irrigation management. Planning and monitoring become quasi-impossible in a situation where the extent of irrigated area is unknown because road and canal reservations and even drainage channels are cultivated. Unauthorized extraction of water from the main canal by pumping or siphoning takes place to the detriment of downstream water users, and water distribution does not follow any organized plan. The capacity of the existing canal network to cater to an ever-expanding area is limited. The indifference or inability on the part of the authorities (farmer organization as well as the state administration) to take effective remedial action clearly reflects the urgent need to correct existing weaknesses in the overall institutional framework related to the development and management of irrigation.

The different phases of development of the irrigation scheme are summarized in Table 3.2.

Figure 3.6. Updated blocking-out plan of the Mogtédo Irrigation System.

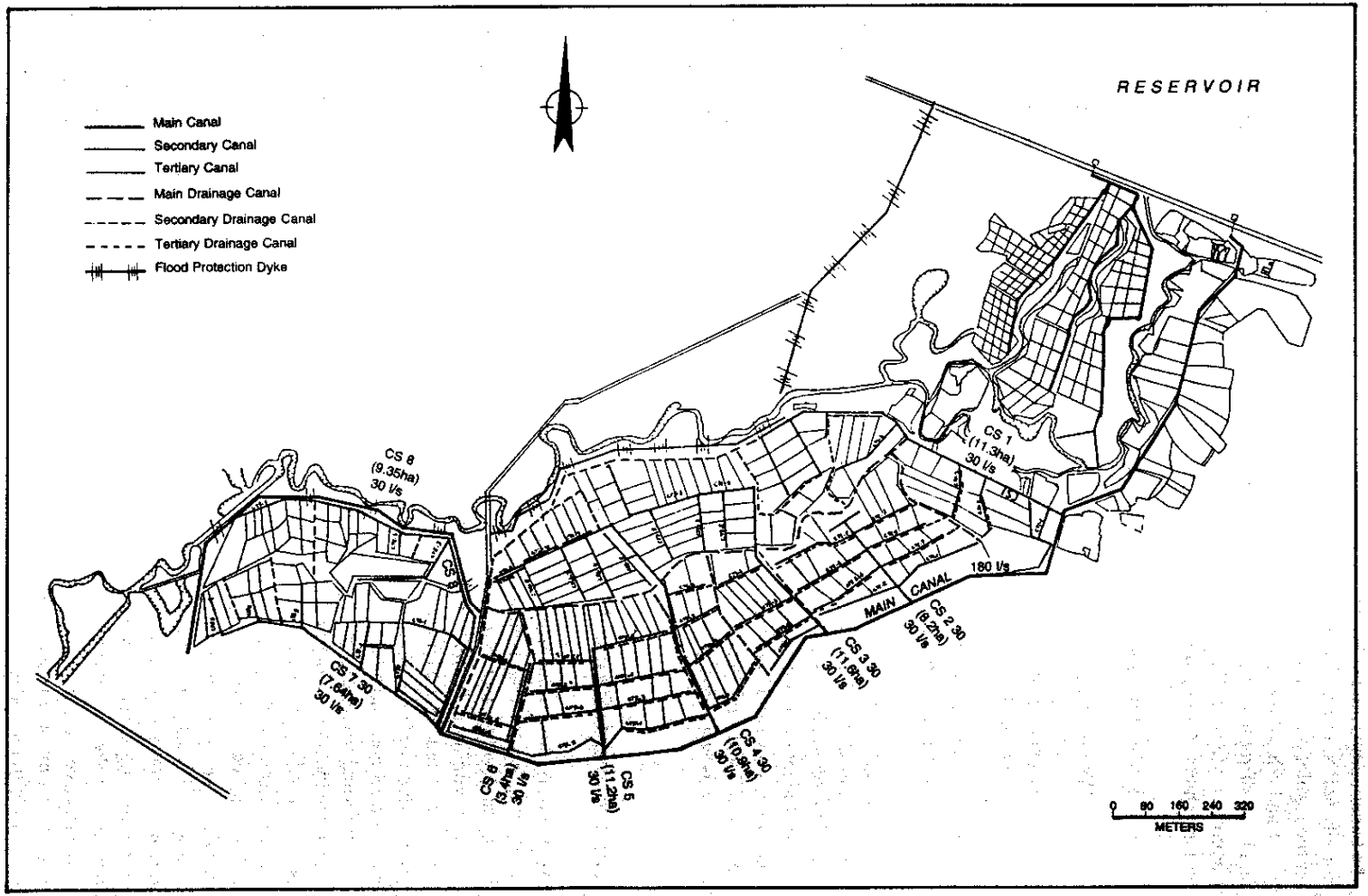


Table 3.2. Chronology of main events in the development of the Mogtédo Irrigation Scheme.

Year	Event
1963–64	Construction of barrage-reservoir; the reservoir is now known to have a storage capacity of 6.5 million m^3 (its capacity was initially thought to be 2.9 million m^3).
1964–74	Development of a 19-ha area on the right bank to serve as an experimental research station for the Institut de Recherche Agronomique Tropicale (IRAT). This area was blocked out and turned over to farmers after the closure of the station.
1967–68	Commissioning of 57 ha of irrigated command area on the left bank.
1974–75	Implementation of an extension of 17 ha at the tail end of the left bank system.
1984–85	Blocking out and turnover of IRAT experimental farm to farmers.
1985	Appearance of informal extensions along the head reach of the left bank main canal, along the main drainage channel, on canal reservations, around the reservoir boundary, etc.
1991	First attempt at quantifying magnitude of informal irrigation; IIMI survey in dry season, 1991, reveals an extent of nearly 30 ha, and more than 70 unauthorized pumping/siphoning locations. IIMI also carries out extensive topographic surveys to establish updated plan of canal network and irrigated area (Figure 3.6).
1991–92	Discovery (by IIMI) that accepted reservoir capacity is erroneous; subsequent bathymetric survey confirms reservoir capacity is 6.5 million m^3.

Some Likely Causes for Uncontrolled Extension

The construction of the reservoir and the development of the irrigation scheme not only attracted a large number of migrants but also gave rise to a variety of associated economic activities. This migration largely contributed to the increase in the population of Mogtédo. The national census carried out in 1985 revealed that there were nearly 3,500 people in Mogtédo (compared to a population estimated to be less than 500 in the early 1960s).

Increased pressure on arable land and deteriorating soil quality adversely affect returns from rain-fed farming (though, as discussed later, farmers do attempt to improve productivity through innovative practices). On the other hand, beneficiaries of irrigated plots themselves claim that the relatively small size of their landholdings (cf. Figure 3.4) oblige them to seek supplementary means of satisfying their requirements. Acquiring (or extending) farm land with a more or less assured access to irrigation water constitutes one possible response to both the above situations, usually rendered even more attractive by connivance on the part of those bodies charged with management responsibilities on the scheme.

Among other reasons which could explain this phenomenon of uncontrolled extension are:

- The non-delimitation of the zone of influence of the reservoir and the irrigation system.
- Ineffective supervision and control on the part of the farmer organization and the state agencies.
- The potential profitability of informal irrigation, especially vegetable cultivation during the dry season.
- Allottees' desire to increase the size of their irrigated landholdings.
- For those not already possessing an irrigated landholding, the obvious attraction of exploiting a farm plot with access to irrigation water.
- The need to diversify cropping in response to market forces and the consequent search for soils better suited for the crops in question.

Strength and Composition of Farming Community

A survey conducted by IIMI in 1991 with the aid of the farmer Cooperative revealed that there were 339 farmers of whom 312 had allotments within the "official" command area and 89 outside it. Of this latter number, 62 had holdings within as well as outside the "official" command area.

About 50 percent of the allottees are from the village of Mogtédo itself while the rest of the allottees originate from 15 other villages located within a radius of 100 km. This highlights the heterogeneity of the farming community in the irrigation scheme as a result of migration into Mogtédo.

All allottees are men with the exception of two women (who happen to be widows). This maybe explained by the fact that the land allocations were made to the heads of households, generally men. A certain number of village groups also benefited from the allocation of irrigated plots.

From the socio-professional standpoint, the majority of the beneficiaries are full-time farmers. Among the remainder are local businessmen and even some public servants working for state agencies providing support services to the scheme.

ANALYSIS OF WATER AVAILABILITY

The Mogtédo Reservoir not only supplies water to the irrigation system downstream but also caters to domestic and livestock needs. In addition, water is pumped directly out of the reservoir for informal irrigation around its fringes. In the latter half of the dry season, even parts of the reservoir bed and its inner slopes are cultivated! This practice, which has assumed considerable importance in recent times, tends to accelerate the sedimentation of the reservoir and increase the risk of pollution from pesticides and herbicides; water released from the reservoir is also used for drinking purposes.

A technical note on the construction of the reservoir (SOGETHA 1964) and all relevant documents available at the time showed the storage capacity of the reservoir as 2.9 million m^3. In

the course of its research, IIMI discovered an anomaly in the existing altitude-surface area-capacity curves of the reservoir. Computations based on the available information led IIMI to suspect that the reservoir capacity was at least two-and-a-half times the generally accepted value. The subsequent field survey commissioned by the Ganzourgou Prc vince Rural Development Project (PDRG) confirmed that the reservoir capacity was, in fact, 6.5 million m^3.

Figure 3.7 shows altitude-surface area curves as well as different altitude-capacity curves for the reservoir: (1) altitude-capacity curve shown in existing technical documents, (2) altitude-capacity curve reconstituted by IIMI in 1991 from existing altitude-area curve, and (3) altitude-capacity curve established after field survey in 1992.

It, therefore, appears that the water resource availability is greater than the initial assumptions which formed the basis of the design of the irrigation system. In theory, this situation opens up the possibility of further expansion of irrigated area. But an important precondition is the definition of a rational development strategy for the whole zone which also takes into account the integration of the "unauthorized" irrigated areas as well.

The irrigation scheme was designed for double-cropping of rice. Indeed, a study of very early project documents related to the scheme reveals that three development options were considered initially, two of which involved the development of approximately 120 ha on the left bank area. The final choice to limit the irrigated area to 57 ha was largely dictated by financial considerations. Considerable extents of land suitable for rice cultivation (within the system) or diversified crops (just outside the system) were thereby excluded from the "official" command area. It was on these very same lands that spontaneous, informal extensions originated. The fact that the reservoir was able to sustain this unauthorized extension may be attributed to its greater-than-assumed storage capacity. But the irrigation network, whose carrying capacity was not designed to serve this expanded area, cannot be overloaded beyond its present limit. Unfortunately, any attempts to reorganize water distribution making use of the existing canal infrastructure are rendered difficult due to the attitudes, influence and social status of most of the farmers resorting to informal irrigation.

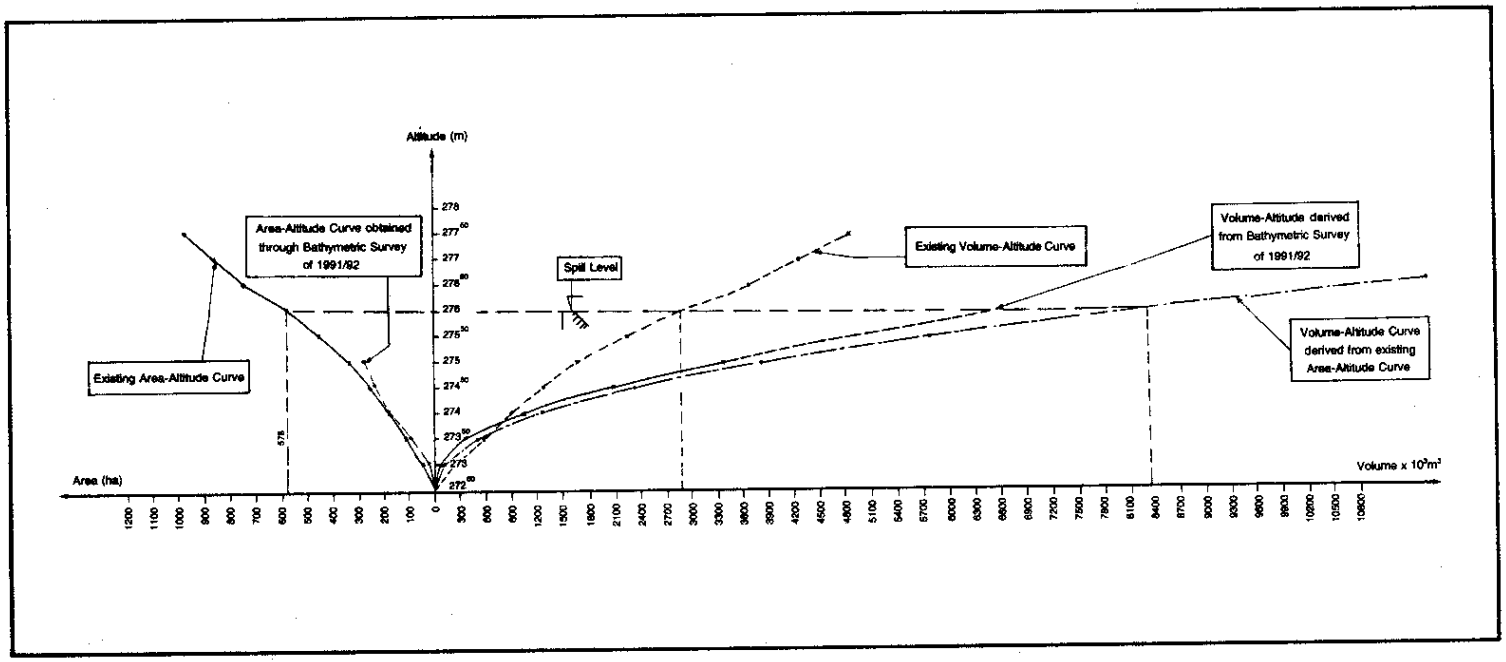
SOME ELEMENTS OF HYDRAULIC PERFORMANCE

According to the original design, the main canal and all the secondary canals were expected to run continuously during the daytime. Water was supposed to be distributed among the tertiary canals within a secondary block on a rotational basis. However, unauthorized extraction of water by pumping or siphoning from the main or secondary canals prevents the implementation of any operational plan. These "spontaneous irrigators" aggravate the "normal" deterioration of the system after nearly 25 years of existence by their attempts to gain access to water by (a) fabricating supplementary tertiary canals, (b) modifying or damaging the canal network, and (c) constructing temporary stone or brushwood weirs to raise water surface elevations and facilitate the operation of siphons.

It is difficult to accurately quantify the extent of unauthorized irrigation due to the rapid evolution of this phenomenon. The first attempt at assessing it was an extensive topographical survey carried out by IIMI in 1991 which revealed nearly 30 ha of unauthorized irrigation (Figure 3.6) and more than 70 points of unauthorized extraction of irrigation water. An inventory of nearly 40 diesel pumps which operate along the main canal was also established (Table 3.3).

It is important to note the existence of more than 10 pumps with a discharge capacity of around 15 l/s in the head reach. If all of them functioned simultaneously, nearly all the flow in the main canal would be intercepted, at the expense of downstream users.

Figure 3.7. Altitude-Capacity curves for Mogtédo Reservoir.



1. Altitude-Capacity curve shown in existing technical documents
2. Altitude-Capacity curve reconstituted by IIMI in 1991 from existing Altitude-Area curve
3. Altitude-Capacity curve established after field survey in 1992

Table 3.3. Inventory of pumps functioning along the Mogtédo Left Bank main canal.

Location on the main canal	Make of pump	Number	Nominal discharge (l/s)
Head reach	YANMAR TOMOS SUZUKI HONDA BERNARD-MOTEUR	6 7 2 3 2	8 to 16 8 16 8 to 18 8 to 16
Reach S1-S2	YANMAR SUZUKI HONDA BERNARD-MOTEUR	4 1 1 1	16 16 — —
Reach S2-S3	YANMAR SUZUKI YAMAHA	2 2 2	16 16 —
Reach S3-S4	—	1	—
Reach S4-S5	YAMAHA	1	—
Reach S5-S6	YANMAR	1	—

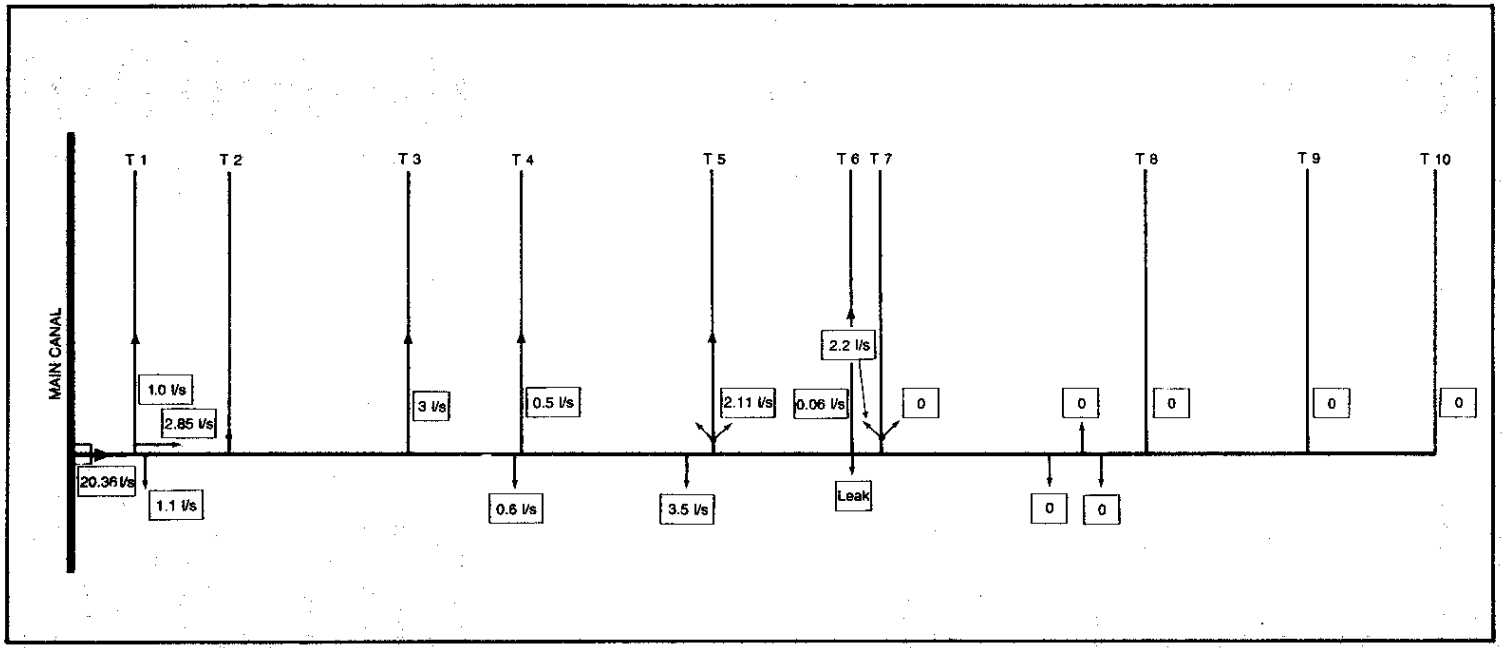
As a partial response to the advent of "spontaneous irrigators," mainly along the banks of the head reach of the primary canal, the Cooperative introduced rotations among the secondary canals in the dry season as follows:

- Monday and Thursday : Secondary canals S1, S2, S3
- Tuesday and Friday : Secondary canals S4, S5, S6
- Wednesday and Saturday : Extension
- Sunday : No irrigation

The farmers of the "unauthorized" plots are expected to respect the same rotational plan as those of the secondary canals located nearby. This plan, having been established without any technical basis, is not compatible with the existing canal regulation structures (static weirs) which had been designed to function under totally different hydraulic conditions (continuous flow). In addition to the difficulty of controlling the unauthorized extraction of water, the twice-weekly local market and various other social events also tend to disorganize the operation of the rotational plan.

During the rainy season, the main canal flows continuously. The farmers are expected to organize the water distribution within the secondary and tertiary blocks. Secondary canal flows generally vary from 15 to 20 l/s (compared to their design capacity of 30 l/s). Practically all the tertiary canals along a given secondary canal function at the same time and, in addition, farmers tend to irrigate more than one plot at a time within tertiary blocks. Flow measurements indicate that tertiary canal discharges rarely exceed 5 l/s. One such example is shown in Figure 3.8, indicating the distribution of water flow along secondary canal S1. Such low flows lead to an increase in irrigation duration — 8 to 10 hours to irrigate a plot of 0.25 ha. Water distribution performance is further affected by the fact that farmers usually pursue other occupations (notably

Figure 3.8. Distribution of water flow along Secondary Canal S1 between 0915 and 1155 on 22 October 1991.



rain-fed farming in the wet season). They are thus unable to be present throughout the day to supervise the irrigation of their plots. This task is sometimes entrusted to a child who is unlikely to be in a position to respond to the caprices of farmers located further upstream concerning access to water.

Integration of "Spontaneous Irrigators"

Any proposal for improving performance in the Mogtédo Irrigation Scheme should necessarily address the question of how to integrate the "spontaneous irrigators" (this term, less pejorative, is preferred to the term "pirates") into the mainstream of system management. One alternative studied by IIMI (Keita 1991) relates to the integration of the informally irrigated areas on either side of the first 800 m stretch of main canal, located between the main sluice and the first secondary canal. Currently, water is extracted directly from the main canal via pumps or siphons. It is envisaged that the informal plots be grouped into a fixed number of irrigation units in order to limit the points of direct extraction along the main canal and thereby enable better means of control and potentially less disruption to water distribution. For example, IIMI has studied the possibility of constructing six new secondary canals on the head reach of the main canal, three of them serving informal plots on its left bank and three serving the right-bank plots. The canals may be supplied via a "collective" pump; tertiary canals can thereafter deliver water to the farm plots by gravity, pumping or siphoning according to the prevailing local topographic conditions. The proposed canal capacities are 15 l/s each and night irrigation becomes necessary. Another alternative considered is the construction of an independent main canal to serve the plots of the "spontaneous irrigators."

AGRICULTURAL PRODUCTION

Traditional Production System and Rain-Fed Farming

Before the creation of the irrigation scheme in 1967-68, Mogtédo was a small, sparsely populated village of less than 500 people. Rain-fed agriculture (rice cultivation in valley bottoms, and millet, sorghum, maize, groundnut elsewhere) constituted the principal activity, sometimes supplemented by livestock farming. Hardly any fertilizer (neither organic nor mineral) was applied to the fields; the main method of restoring soil fertility was to periodically leave land fallow by moving to other land in the neighborhood.

The migration which followed the construction of the reservoir and the Mogtédo Irrigation Scheme increased the pressure on arable land. Itinerant agriculture gradually gave way to a more settled type of rain-fed farming. At the same time, the use of improved varieties, modest application of chemical and organic fertilizer, and the use of animal traction found their way into the rain-fed agricultural practices. However, productivity remained low, mainly due to the combination of unfavorable climatic conditions, poor quality soils, and a socioeconomic context which did not allow a higher level of intensification.

In the small irrigation schemes such as Mogtédo, irrigated agriculture has to be supplemented with rain-fed farming and/or other off-farm activities. The returns from irrigated agriculture do not permit the farmer to abandon rain-fed agriculture which, in addition, is a more deep-rooted rural tradition. A recent study (Projet Sensibilisation 1991) conducted on an irrigation scheme in the northeast of the country revealed that irrigated agriculture only accounted for around 6 percent

of the annual family revenue, during a year when rainfall was better than normal (in drought years, it maybe expected to contribute a higher percentage). Due to their relatively small size (0.15-0.30 ha), the total production from an irrigated landholding remains low, compared to that from rain-fed plots which are 3-5 ha in size; however, productivity (3,000-4,000 kg/ha) is very high compared to the 700-800 kg/ha from rain-fed farming. Moreover, rice, the principal irrigated crop, unlike millet or sorghum from the rain-fed farms, does not form part of the traditional rural menu and is considered as a commercial crop or is reserved for special occasions.

In the farmers' decision-making process and evaluation of risk, rain-fed farming takes first priority due to its dependence on unpredictable rainfall. A delay in commencing the irrigation season is considered less risky on account of the security offered by the storage reservoir (unless, of course, the season extends into December and January when the cold weather could cause reduction in yields). The lack of sufficient manpower to enable the simultaneous pursuit of rain-fed and irrigated farming is yet another constraint. All these factors tend to have an adverse effect on irrigation system performance. Besides the fact that optimum use is not made of rainfall, all phases of the cropping calendar, from land preparation through replanting to harvesting get delayed, resulting in the depletion of the water stored in the reservoir at the end of the rainy season. This, in turn, diminishes the extent of cultivation possible in the dry season (and hence cropping intensity).

Irrigated Agriculture in the Rainy Season

As stated above, the principal irrigated crop is rice. A large number of rice varieties are in use in the Mogtédo Irrigation Scheme of which the most popular are IR 1529 and IET 2885. The Gambiaka variety is appreciated mostly by farmers having landholdings in low-lying areas. However, variety 4456, currently recommended by the national agronomic research institute, is hardly cultivated by the Mogtédo farmers (see Table 3.4). Only a small minority of farmers use certified seed, the majority producing their own seed rice.

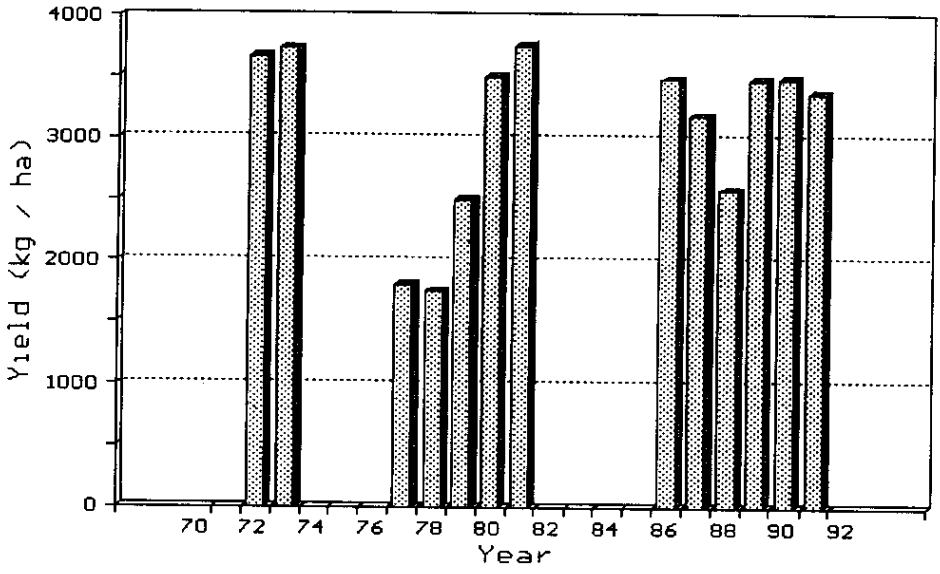
Table 3.4. Distribution of rice varieties and yields in Mogtédo in the wet seasons, 1991 and 1992.

Variety	1990			1991		
	Percentage of total area	Yield (kg/ha)	Total production (kg)	Percentage of total area	Yield (kg/ha)	Total production (kg)
IR 1529	76.4	3,797	279,573	58.7	3,533	198,504
IET 2885	16.8	3,296	53,626	32.0	4,169	127,742
GAMBIAKA	4.7	1,965	8,882	3.8	2,481	9,156
TOX 728-1	1.2	4,183	4,685	4.0	3,987	15,189
4456	0.9	3,589	3,155	1.5	3,464	4,954
Total (all varieties)	100.0	3,366	349,921	100.0	3,527	355,545

The average yield (for all varieties) of approximately 3.5 t/ha is low when compared to the potential. The highest yielding varieties are Tox and IET 2885 (≈ 4 t/ha), whereas Gambiaka

produces the lowest yield (≈ 2 t/ha). Figure 3.9 shows the rice yields in Mogtédo for some years during 1972–92, based on available records. Among the reasons for the relatively low and unstable yields recorded are acidity of the soils, imperfect land leveling, inadequate attention to weeding, and incorrect application of fertilizer. Some uncertainty also arises out of the method used to estimate yields — weight of unhusked rice (based on the number of 80-kg bags declared to the Cooperative) divided by the area cultivated — because farmers do not declare their entire harvest to the Cooperative.

Figure 3.9. Rice yields in Mogtédo (data available, 1972–92).



With regard to the cropping calendar, nurseries are established quite late and extend over a long period (early June to late July), due largely to the competition from rain-fed agriculture. The size of the nurseries is smaller than accepted norms; the nursery area to farm area ratio is of the order of 1 percent on average, compared to the recommended value of 3 percent. Thus the number of plants available is often insufficient to plant the whole plot and some farmers are obliged to create a second nursery. This results in crops at different stages of maturity coexisting within a given plot. Replanting also extends over a long period, as shown in Figure 3.10, which depicts the progress of replanting of the rice crop in the rainy season, 1991, which extended to over two months.

DRY SEASON CROPPING

It is difficult to obtain accurate information on the spatial and temporal distribution of dry-season crops in Mogtédo, due to the significant extents of land cultivated outside the "official" command area. IIMI's best estimate of the total area of diversified crops (within and outside the "official" command) in the dry season, 1991–92, is 43 ha, distributed as indicated in Table 3.5. In addition,

Figure 3.10. Mogtédo: Progress of replanting the rice crop, wet season, 1991.

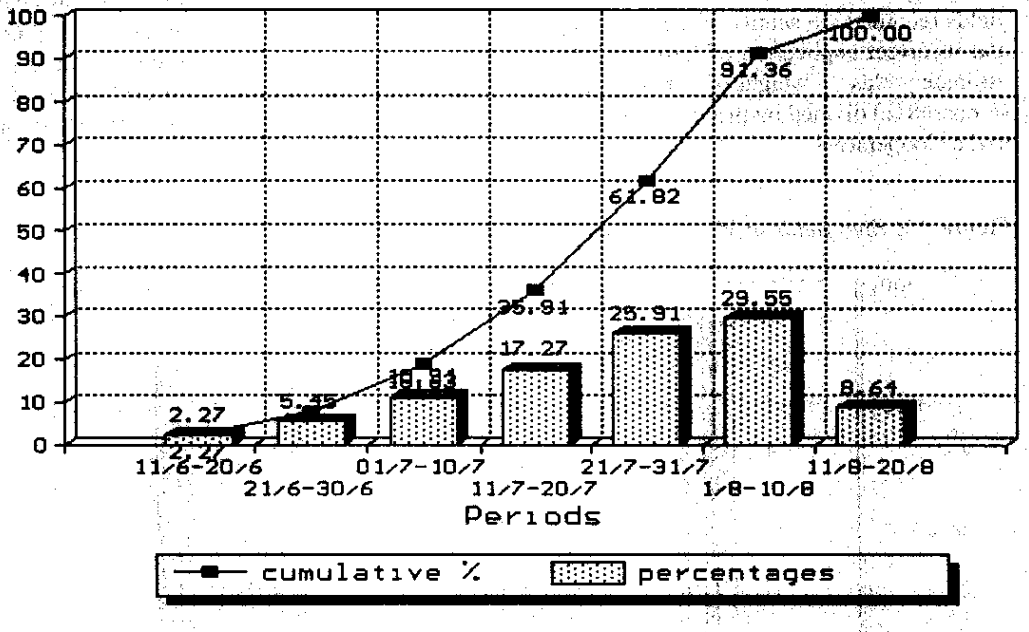


Table 3.5. Distribution of crops other than rice in Mogtédo, dry season, 1991/92.

Crop	Area cultivated (ha)		
	"Official"	Informal	Total
Onion	2.7	11.1	13.8
Tomato	4.5	6.7	11.2
Egg-plant	2.3	7.0	9.3
Others	2.5	6.0	8.5
Total	12.0	30.8	42.8

there was significant rice cultivation (generally confined to the "official" command area), estimated to cover nearly 30 ha.

Of the crops other than rice, onion was, in general, the most extensively cultivated variety. Tomato cultivation took precedence on the heavier soils which are less favorable to the development of onion bulbs.

It is noteworthy that more cropping has occurred outside the "official" command area than within. One argument made by the farmers in support of this practice is that there is a high incidence of still unidentified pest attacks within the "official" command area.

Another remarkable feature this year has been the large extent of rice cultivation during the dry season, even on the nonhydromorphic soils. This phenomenon may be explained in part by the significantly greater water resource available in the reservoir this time compared to the previous dry season. Investigations are underway to understand the real motivations of farmers to grow rice in the dry season. If water was not a constraint, would farmers prefer to grow rice, even during the dry season? Or, is it because of the possibility of growing other crops outside the "official" command area?

The area occupied by each crop on a given parcel is small (0.01 to 0.18 ha) but as there is generally an association of different crops within a given parcel, each farmer finally cultivates a total area comparable to that of rice in the wet season (0.20 to 0.44 ha).

The quality and origin of the seed used are unknown. Some farmers produce their own onion and tomato seeds. Accurate information on yields is not available as the Cooperative is not involved in marketing the produce (vegetables as well as rice), unlike in the case of the wet season. The intensity of the extension and support services is less than in the wet season but this does not appear to seriously handicap farmers' performance. On the contrary, their remarkable capacity to adapt and innovate appears to yield (at least for some of them) high returns, as demonstrated by their ability to invest in pumping and siphoning equipment.

As in the case of rice cultivation, the crop calendar extends over a long period of time; for example, nursery preparation stretches from October right through to January or February. Harvesting gets delayed till May or June, and enters into conflict with planting activities in the rain-fed lands at the start of the rainy season. The end result is yet another delayed start to the next rice cultivation season.

SOCIAL ORGANIZATION OF THE IRRIGATION SCHEME

In this section, the objectives and strategies of the principal actors within the system are analyzed with a view to understanding the social and organizational dynamics of the scheme. The distribution of power and authority and the nature of the interactions (affinity, opposition, etc.) among the actors are highlighted.

Management Committee

The composition and responsibilities of the committee have already been described in the section on the organizational structure. Unfortunately, it does not appear to have functioned in a particularly consistent manner — at times it has acted rather hesitantly while at other times it has acted very vigorously. But on the whole, it has been a forum for endorsing the decisions made by the Board of Directors of the Cooperative. Members meet occasionally at the request of the Board or assemble for semiannual general meetings of the Cooperative. In effect, the Management Committee does not seem to have fulfilled the roles expected of it in the legislation. Otherwise, the illegal expansion of the irrigated area may not have continued to the point where it is today.

Board of Directors of the Cooperative

The Board of Directors of the Cooperative is composed of its President, Vice President, Secretary, Treasurer, Assistant Treasurer and 3 other farmers. The Board appears to function as an oligarchy, capitalizing on the social and economic standing of its members, some of whom are politically influential as well. Based on interviews of some its members, it came to light that the Board does not meet regularly but that instead, decisions are often made by a core group made up of the President, Secretary and the Treasurer.

The present Board, in office for the past two years, is nevertheless making a serious effort to redress the financial situation of the Cooperative resulting from the failures and errors of its predecessors. The Board also admits that it lacks technical expertise to effectively address questions related to water management and would welcome support in this field. On the other hand, reconciling the divergent interests in this area is difficult because, on the one hand, the Board is expected to exercise its authority to arbitrate conflicts and ensure that water management plans are respected, while on the other, it implicitly condones acts of water piracy.

The Gate Operator *(Aiguadier)*

The Gate Operator is one of the early settlers of Mogtédo. He officially took over this position in 1982. Though he has not undergone any formal training, he has acquired some notions about system management through on-the-job experience. Being a farmer himself, he cultivates a number of parcels, both within and outside the "official" command area, in addition to his gate-operation duties. His main tasks are opening the main sluice every morning and closing it in the evening, and also adjusting the settings of the calibrated distributors along the main canal. He usually does not intervene at lower levels of the system. He maintains good relations with the farmers in general and constitutes a link between them, the extension agent and the Board.

The Extension Agent *(Encadreur)*

Another long-standing member of the Mogtédo community, the encadreur, appears to have lost some of his technical credibility, and farmers believe that they have no need for further support from him. However, he remains particularly active in providing administrative assistance to the Board.

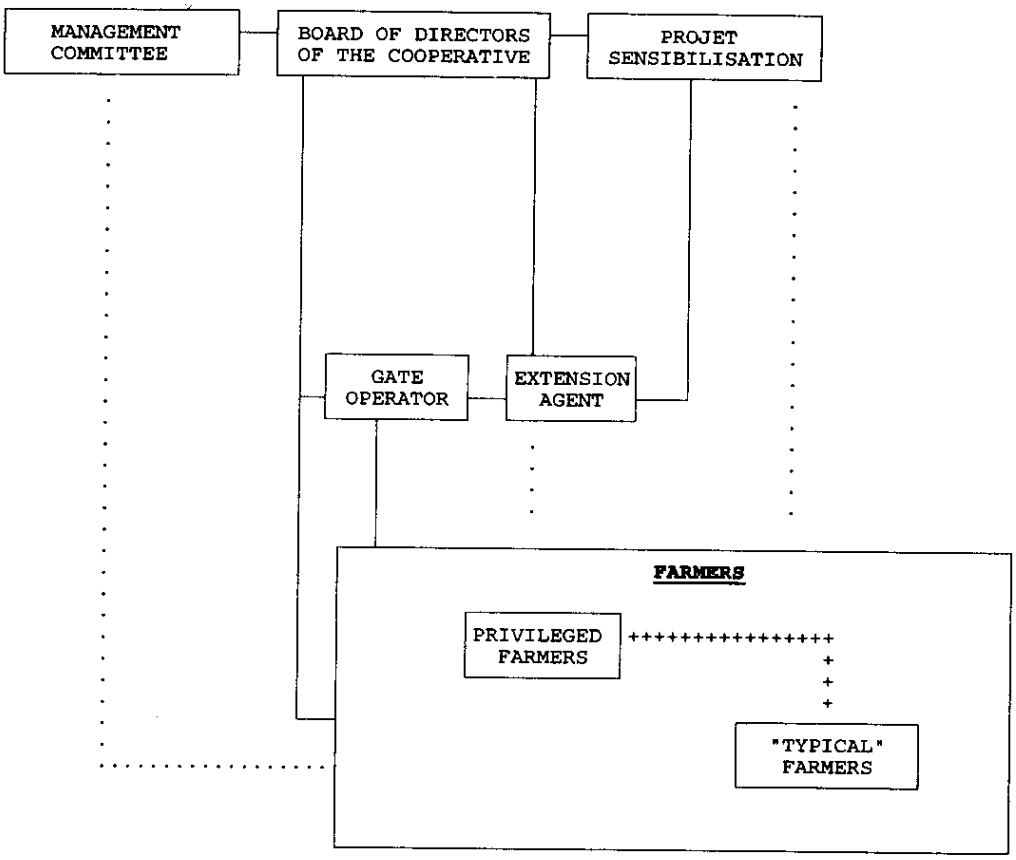
Farmers

The analysis in this instance is limited to two categories of farmers, namely, *privileged* farmers and *typical* farmers. Farmers belonging to the former category, though fewer in number (less than 20%), possess more than one parcel (within as well as aside the system) and enjoy a higher social and economic status. Nearly half of them possess pumps and the other half siphoning equipment for irrigating their "unauthorized" fields. As for the latter category, they generally pursue rain-fed farming in addition to irrigated farming. These farmers are the ones who suffer most as a result of the disruptive practices of the privileged farmers. They are often constrained to resort to irrigation

at night. Although they participate in collective activities, these farmers make little or no input to the decision-making process of the system.

The nature of the interrelationships which exist among the different actors in the irrigation scheme is represented schematically in Figure 3.11.

Figure 3.11. Sociogram of the Mogtédo Irrigation Scheme (schematic representation of relationships among the different actors).



Legend:

——— Collaborative relationship
. . . . . Weak relationship
++++++ Conflicting relationship

INSTITUTIONAL AND LEGAL CONSIDERATIONS

Nearly 20 legal texts dealing with the organization and management of irrigation schemes in Burkina Faso have been drawn up at regular intervals since 1960. A priori, this relatively large

number of texts could be interpreted as a measure of the importance attached to rural development, in general, and irrigation in particular. However, in reality, the legal framework was long characterized by (a) the absence of applicable decrees in the case of legislation which had been adopted, (b) the nonfinalization of a number of other legal texts which had not proceeded beyond the draft stage, and (c) the limited dissemination and lack of information relating to rules and regulations actually in force.

This fluid situation naturally led to decision making, on the part of state institutions as well as farmer organizations, which bordered on the arbitrary without regard to the provisions and guidelines laid down in the legal texts. In effect, one may rightfully wonder whether most of the deviations observed in the Mogtédo Irrigation Scheme could well have been avoided if the Management Committee, the state support services and the farmer Cooperative had carried out their respective supervision and management responsibilities more effectively. For example, the different forms of support received by the Cooperative over the years should have enabled it to develop a sense of institutional maturity. However, it must be admitted that even after 25 years of existence, although referred to as a "Cooperative," the farmer organization does not conform to all the legal requirements normally associated with this status.

Recent attempts at reducing the confusion in the legal and institutional frameworks have led to the review and revision of the different legal texts. Following the most recent initiative in 1991, irrigation schemes are now considered to be governed by three general legal texts dealing respectively with (a) agrarian and land reform, (b) the cooperative sector, and (c) the operation and maintenance of irrigated land. In addition, a certain number of other laws dealing specifically with the organization and management of irrigation schemes in the country are also supposed to apply. Further work needs to be done to overcome omissions and contradictions that still exist and to harmonize these different legal texts. IIMI, as part of its research effort, will contribute to achieving this goal.

However, the capacity of the farmers, who are key actors in this domain, to develop skills in organization and management, and to communicate and exchange information effectively is seriously handicapped by low literacy levels and the nonavailability of the various legal texts in the vernacular. The running of the Cooperative remains the preserve of a privileged few. Even though performance from the organizational standpoint may appear to be weak, this has not been the case in assimilating the technical aspects of irrigated agriculture. In effect, farmers give the impression that they have little to gain from continued technical assistance on the part of the extension agents. This, in turn, raises questions regarding the credibility, competence and overall quality of the support services.

Although the farmers attitudes vis-à-vis irrigated agriculture have gradually evolved over time to the point where there is a strong interest in obtaining an irrigated plot, they display little enthusiasm for managing the scheme in a truly cooperative spirit. Ideally, the guiding principle should be based upon solidarity, with all the members acting together to achieve a common objective and for mutual benefit. This egalitarian viewpoint is, however, incompatible with the rules of traditional rural societies which are dominated by ties of kinship, feudalism, deference to elders, submission of women, etc. By and large, farmers prefer to avoid entering into conflict with tradition, thereby strengthening the hand of the traditional authorities to take over the embryonic cooperative movement. It is, therefore, evident that without any form of external control or audit, the technical, administrative and financial management of the organization will be difficult to reconcile with the objectivity and transparency necessary for effectively managing a modern agricultural enterprise.

The development of irrigation facilities requires heavy state investment, which in the end is a cost to the entire nation. Present estimates put the costs at more than 5 million CFA francs (US$ 20,000) per hectare with total water control, not including the cost of the dam construction. The

state has a responsibility to continue to maintain a supervisory or regulatory role in the management of the irrigation scheme, and thereby ensure the sustainability of its investment. It is unreasonable that the national collectivity be ultimately called upon to bear the consequences of mismanagement on the part of an autonomous and supposedly responsible cooperative organization.

On the other hand, state law is often in conflict with customary land rights. The land tenure system, where the state expropriates and redistributes land within the irrigation system, and the relatively small size of the irrigated plots do not encourage the farmer to invest in and develop his allotment. The challenge is thus one of attempting to reconcile the rights of ownership of the state, as principal investor, with the need to offer some guarantee of medium-term or long-term tenancy to farmers (lease, contract, etc.) which would encourage them, in turn, to invest in improving the productivity of the land.

CONCLUSIONS

The Mogtédo Reservoir has been the nucleus of economic growth of the village and its neighborhood. But the development, largely triggered off by the initiative and innovative spirit of the local population, did not always follow a coherent plan. Uncontrolled expansion of the irrigated area within and around the scheme has today reached a point where it threatens the sustainability of the system. The physical infrastructure (irrigation and drainage canals, structures, spillway, etc.) is in urgent need of rehabilitation. Organizational and institutional weaknesses add to this perilous situation. On the other hand, the fact that the Mogtédo Irrigation Scheme has functioned for nearly 25 years without being rehabilitated amply demonstrates the farmers' capacity to adapt to situations and take the initiative to assume responsibilities when their own interests are at stake. This paper has attempted to identify the causes for this extraordinary situation.

The Cooperative does not appear to have succeeded in reconciling traditional social values with the principles of objectivity and transparency which should underpin the running of a modern agricultural enterprise. With little or no supervision on the part of the Management Committee, the Cooperative was taken over by personalities with social and political influence. Institutional weaknesses related to the dissemination of the relevant legal texts and enforcement of the rules have contributed to the inability, or unwillingness, of the authorities to exercise statutory control and supervision of the reservoir and the irrigation scheme.

Certain assumptions and information used in the initial design of the scheme have proved to be erroneous, such as the storage capacity of the Mogtédo Reservoir. This would account for the fact that the reservoir has been able to sustain the informal expansion of irrigated area to cover large extents of land suitable for rice cultivation (within the system), or diversified crops (just outside the system). These lands were initially excluded from the "official" command area due to financial constraints. Although the enhanced availability of the water resource theoretically opens up the possibility of further expansion of the irrigated area, the definition of a rational development strategy for the whole zone, which also takes into account the integration of the "unauthorized" irrigated areas already in existence, is an important precondition.

However, the existing canal network does not have the capacity to accommodate further extension of the command area. The canals and structures already have to cope with situations which they were not designed for. Water is either pumped or siphoned out of the main canal itself, to irrigate unauthorized extensions, to the detriment of water users further downstream. The theoretical operating rules no longer hold good. System operations result from the sum total of a number of individual operations rather than emanating from a coordinated collective strategy. Attempts to respond to the new situation making use of the existing physical infrastructure but

with different organizational arrangements have met with limited success because it is usually the most influential farmers who resort to "water piracy."

Personnel directly involved in system management (i.e., the extension agents or encadreurs) focus primarily on agronomic inputs. This attitude is partly due to their lack of training and skills in irrigation water management. Main system operations, in particular, are left to a farmer who also acts as a part-time gate operator.

Although farmers appear to assimilate technical issues quickly, they find it more difficult to reconcile the philosophy of the cooperative movement with traditional hierarchical rules governing rural society. Power and authority within the farmer organization tend to rest with a privileged minority, not entirely convinced by the merits of "democratization." Serious efforts need to be deployed to impart basic management and administrative skills to the farmers to prepare them to effectively take over the management of their irrigation system. One fundamental question that needs to be addressed is what role the state should play, if any, in supervising, regulating, and indeed strengthening farmers' management capabilities and ensuring that the process of management turnover does not threaten the sustained well-being of the irrigation scheme.

The existing system of land allocation and tenure is not conducive to improving irrigation performance. The introduction of appropriate measures to encourage farmers to invest in improving the productivity of the land demands a lot of political courage to reconcile state ideology with farmer logic.

The understanding and knowledge generated through the sociotechnical diagnosis of irrigation schemes undertaken by IIMI and its national partners will contribute to the creation of an appropriate technical, organizational, institutional and legal environment to develop and sustain improved irrigation performance.

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