



**IRRIGATION MANAGEMENT NETWORK
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Network Paper 6

**PROMOTING A SMALLHOLDER-CENTRED APPROACH
TO IRRIGATION: LESSONS FROM VILLAGE IRRIGATION
SCHEMES IN THE SENEGAL RIVER VALLEY**

Geert Diemer, Boubacar Fall and Frans P Huibers



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PROMOTING A SMALLHOLDER-CENTRED
APPROACH TO IRRIGATION:
LESSONS FROM VILLAGE IRRIGATION SCHEMES
IN THE SENEGAL RIVER VALLEY¹

by Geert Diemer, Boubacar Fall and Frans P Huibers²

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¹ This article is based on our submission to the International Conference on the Crisis in African Agriculture, organised by the Cheik Anta Diop University in Dakar from 17-23 December 1988.

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FOREWORD

Many planners and technicians feel that the development of irrigation systems could offer a solution to the crisis in food production in Africa.

Irrigation seems to be an appropriate response to the harmful effects of irregular rainfall and frequent droughts. Moreover, irrigation seems to provide planners with the institutional means to channel smallfarmer production in accordance with national planning objectives. This is because current norms regulating the economic planning and technical design of hydro-agricultural schemes³ require centralised management of the hydraulic network.

In this paper, we examine the empirical validity of these norms. Having identified the trends common to colonial and post-colonial policy with regard to agricultural development, we briefly review the historical background to the emergence of the current design procedures for hydro-agricultural schemes. We analyse the sociological research dealing with the phenomenon of irrigation in Africa, from the point of view of its contribution to the analysis of the crisis in hydro-agricultural production. We then identify the factors which explain an isolated case of success, namely the village irrigation schemes in the middle regions of the Senegal river valley. We pinpoint two factors governing the viability of hydro-agricultural infrastructure, viz, the dynamics of the smallfarmer production system and the local political system. We conclude by presenting the changes needed in terms of planning and designing hydro-agricultural schemes.

³

The term 'hydro-agricultural schemes' is a direct translation of the French term 'aménagements hydro-agricole'. We use the term as it is appropriate for interventions in the wide range of indigenous water management practices in African hydrological environments. These include flooding, and flood recession agriculture, as well as conventional irrigation practices.

1. IRRIGATION IN AFRICA: TWO DIFFERENT CONTEXTS

People who speak of a crisis in the development of irrigation systems in Africa should confine their remarks to projects which are not generated from within local societies. These interventions may be contrasted with the perfectly viable schemes set up by the Taita, Chagga, Meru, Pokot and many other peoples in the Rift Valley, East Africa. Other examples are the polders established and managed by Baga, Balanta, Diola, Mandinka and other smallfarmer societies in the marshlands of the Atlantic Coast and the gardens set up in the dunes by Wolof smallholders, to mention but a few. In other words, the crisis shows itself in irrigation schemes designed and managed by technicians from the outside.

Like African hydro-agricultural techniques and any other techniques, these irrigation interventions were developed in specific contexts for specific purposes. The irrigation techniques in the 'land of water' - the Netherlands - were not a result of the fight against the encroaching sea, but a legacy from the colonial conquest of the island of Java in present-day Indonesia. To be more specific, they have their origins in the development of sugarcane as a cash crop. Irrigation schemes covering hundreds of hectares were set up and managed by a single owner: the sugar company.

French irrigation techniques date back to the 1820s in Senegal, where irrigated plantations for the production of rice and dye-producing plants were established in the Senegal river delta. These techniques were then transplanted to Morocco, to develop commercial agriculture for the colonial settlers, and to the interior delta of the Niger river in present-day Mali. Schemes along the Niger were intended to produce cotton for metropolitan industry, like the schemes established by the English on the banks of the Nile in present-day Sudan. These irrigation techniques were thus developed in situations with two specific characteristics: domination of the local people and the intention to mobilise resources (water, soil and labour) in the pursuit of aims foreign to rural society.

2. SOME CHARACTERISTICS OF THE ORIGINAL SCHEMES

Let us look more closely at these two schemes on the banks of the Nile and Niger rivers. Their aims were identical: on the one hand, to reduce the burden on the colonial power by generating income for the administration and, on the other, to strengthen the market economy by supplying raw

material (cotton) for the textile industries. In both schemes, food crops were envisaged only to provide subsistence for the farmers. In Mali, the farmers were supposed to grow rice, although their staple diet was millet and sorghum. Moreover, they could only cultivate within the scheme; rain-fed crops were prohibited. In Sudan, rain-fed agriculture was impossible because of insufficient rainfall. Moreover, the extent of the schemes and their contiguous nature, an almost unbroken stretch of some tens of thousands, and then hundreds of thousands of hectares, made it impossible to associate irrigated crops with rain-fed crops or animal husbandry.

The areas under irrigation were contiguous as far as possible because this reduced investment costs per hectare, the main item of expenditure being the construction of dykes and canals. The expansion of these areas was designed to increase production and thereby the revenues of the colonial administration and the delivery of raw materials to the metropolitan industries.

The two schemes were managed by parastatal agencies. Before 1932, the Niger River Scheme (known as the Office du Niger) was managed by a cotton-growing company and then by a public body belonging to the French state. Both had Boards of Directors; in the case of the Gezira scheme, the 'Sudan Gezira Board'. Both agencies were the owners of the schemes and were judged by the economic and financial results of their means of production, i.e. the irrigation network and the labour power of the farmers. The latter were not allowed to own the land they cultivated. They were called 'tenants' and bound to the managing agencies by renewable annual contracts, although they also had to work for themselves. Such contracts stipulated that the tenants must obey the instructions of the agency's representatives and were liable to non-renewal of their contracts if they disobeyed.

The conditions under which such schemes were established, as well as their aims, meant that the managing agencies had to deal not only with the irrigation network, but also the management of the farms within it. The colonial power structure gave the managing agencies sufficient leeway to impose centralised management of the network. They could therefore, with the support where necessary of the colonial forces of law and order, ensure that their production objectives prevailed against those of the tenants.

3. CURRENT PLANNING AND DESIGN OF HYDRO-AGRICULTURAL SCHEMES

These first government attempts at hydro-agricultural development may be likened to the establishment and management of factories. The managing agencies resemble the management and board of directors of a private enterprise. The status of the tenant was less that of an autonomous smallfarmer free to choose his land, crops and methods than that of a worker obliged to produce a product selected by management, using methods also selected by the latter. The processed raw material - water - was distributed to the machines - the plots of land - in accordance with the theory of marginal costs. Economic performance was barely, if at all, measured in terms of income generated by the tenants, but rather in terms of the profitability of the investment.

This 'industrial' approach characterising Western irrigation techniques is reflected in current design methods such as the principle of selecting the crop in advance, the principle of sharing water between plots rather than between farmers, the stress placed on economies of scale, etc. These principles illustrate the fact that decision-makers and investors are seeking to introduce irrigation in the hope of meeting objectives not shared by the local society. An example in Africa would be that of planners wishing to reduce rice imports by stimulating in-country production.

As in the colonial era, irrigation engineers find themselves asked to design a scheme which will mobilise the resources of a rural society to attain aims pursued by elements from outside that society. Pedologists are sent to choose the soil and agronomists to select the varieties to be grown. The irrigation engineer is sent to calculate the plants' water requirements in accordance with the climate and the permeability of the soil. He then establishes the interval between irrigations and peak water needs. He orders a topographical survey to determine the sites and dimensions of the canals. All these engineers have to act as if the scheme belonged to a single owner. They work without having to consult the smallfarmers, as their responsibility is really to design a scheme against the single criterion of meeting the water requirements of the plant to be cultivated.

In this approach, the size of the network, the area to be irrigated and the choice of the crop and variety are closely linked. This 'industrial' approach also implies that farmers must sow during the period set by the engineers who design and manage the scheme and they must till, weed and harvest at

the times determined by the latter. The scale of the scheme and the impossibility of supplying more water than peak-period requirements make centralised management inevitable. This in its turn assumes the ability to direct and coordinate farming activities, i.e. the smallholders' agricultural work. The role of individual farmers is less important and they have no influence on the major decisions by which they will be bound. Moreover, the management of the scheme takes no account of their other economic and social activities. It is quite common for managers of large schemes to use coercion to direct smallfarmer behaviour.

The result is that the design of African schemes is dictated by the following norms, which are very rarely made explicit:

- the users must be 100% dependent on their irrigated plots for their food and cash income;
- the users must maximize the net production of their plots to offset the initial investment;
- the bulk of their production must be sold in order to comply with the policy of such schemes and meet the costs they involve;
- the management must sign the contract only with the person they see as head of household and not with other people involved in production, in particular a wife or wives;
- the earlier division of labour between men and women, young and old, is not relevant in the context of the scheme;
- the crop must be chosen by the investor;
- means of production must only be allocated to the head of the household;
- income from sales must be handed only to the head of the household;
- the plots to be irrigated must be contiguous so as to obtain the most favourable ratio between the area under irrigation and the length of the canals;
- the soil must be homogeneous;

- the irrigation turns must be designed to make the best possible use of the water.

One may conclude from this that the fact that hydro-agricultural planning and design techniques are expressed in physical terms does not make them neutral parameters. The principle of allocating water to plots is a good example of what we mean. This principle ignores the fact that the plots belong to smallfarmers, and consequently ignores their mutual political and organisational relationships. All these principles reflect the way planners and technicians think an agricultural scheme should be managed and an irrigated plot should be worked.

This suggests that irrigation is a social as well as physical matter. Let us now look at the insights obtained from sociological research into irrigation in Africa.

4. THE SOCIOLOGY OF IRRIGATION IN AFRICA

As far as irrigation is concerned, the social sciences have not hitherto been greatly interested in the problems and techniques of hydro-agricultural development. They have tended to ask questions which reflect their theoretical perspective. These fall into two categories:

- what effect do government irrigation projects have on rural societies?
- how do African farmers manage systems they have built and maintained for themselves and to what purposes do they put their plots?

The first type of research deals with the *transformations* effected within the society. In the 1970s, several sociological surveys considered the introduction of government schemes. Studies on Nigeria, Gambia and Ghana, were conducted by Wallace (1979), Dey (1982), Adams and Grove (1983), Jackson (1985), and Konings (1986). These writers studied developments in the agricultural landholding system; the influx of landowners from outside local society; the advent of new working relationships; smallholders' relationships with input suppliers and crop purchasers, public authorities, politicians, officials and irrigation service technicians; and their relationships with other immigrants. The authors approached these subjects from a theoretical perspective. For their

purposes, irrigated agriculture was the context within which they tested an anthropological or sociological theory.

Documentation dealing with endogenous irrigated agriculture tends to be of an ethnographic nature. There are also communities in Africa which have been practising irrigation since well before colonial times. Some systems have been described by sociologists, amongst them those of the Sonjo people in Tanzania (Gray 1963; Potkanski 1988), the Taita in Kenya (Fleuret 1985), the Ewe in Ghana (Grove et al, 1982; Chisholm, 1984), the Baga in Guinea-Conakry (Paulme, 1957), the Diola in Senegal (Linares, 1981; van der Klei, 1989) and the Mandinka (Haswell, 1963; Weil, 1973).

These researchers particularly studied the irrigation infrastructure and the political relationships within which these rural peoples managed their schemes. An analysis of this literature shows that management of the infrastructure was part of the local political system. Fleuret considered that management of the irrigation network was part of the daily political process for the Taita. Gray and Potkanski demonstrated that the key to the distribution of irrigation water was the balance of power between the three classes of free men recognised by the Sonjo. In a study of the legal system of the Chagga, Moore observed that this society comprises four autonomous entities: the market, the district, the lineage and ... the irrigation committee. The work of van der Klei and Linares established that the Diola do not recognise any chiefs at village level or in terms of managing their polders. Grove et al were more interested in relationships with the market. Fleuret, Gray and Moore stressed the integration of plots under irrigation within the system of resource use including dry farming and animal husbandry. Fleuret showed that the Taita use their hydraulic infrastructure to produce not only for subsistence purposes, but also for the market, like the Chagga who have become famous for their coffee.

These academic studies were backed up by work on what we might call the sociology of organisation. In this approach, researchers define their objective as developing more effective ways of organising the design and management problem. They study the development and operation of an irrigation project as a management problem. This approach originated in the USA during the 1970s, as a result of research commissioned by donors such as the World Bank, USAID, and the Ford Foundation.

These donors had become alarmed by the combination of high installation and operating costs with disappointing yields in South Asia, something which is also found in sub-Saharan Africa. Their concern was heightened by the fact that the yield of the new varieties of rice, developed with their financial assistance, depended on carefully measured amounts of water being delivered at the right moment. The research to be conducted by the sociologists dealt with relationships between farmers using irrigation, between the latter and the technicians and between the technicians. They were intended to design organisational principles enabling the new varieties of rice to receive an adequate supply of water.

Sociological research conducted within this framework takes the scheme and the irrigation service as the macrocosm. The picture which emerges is that of physical infrastructure (canals, plots, etc) constituting the 'hardware', and social relationships the 'software'. The sociologists' job is to put together a programme which will enable the engineers' hardware' to function (better). This approach does not call into question the assumptions which underpin the criteria used by planners and designers. It forms the core of papers in the book edited by Coward (1980), although he has been a key proponent of better understanding of local institutions. Research based on this perspective has so far been conducted primarily in South-East Asia.

What insights can be gained from these three viewpoints to overcome the crisis in the development of irrigation systems? The 'transformation' approach shows that the crisis is political and social as well as economic. The old power relations between farmers have been replaced by new ones which are sometimes more unequal. The division of labour between men and women, old and young men, almost ceases to be relevant within the schemes. Smallfarmers are often no more than mere tenants of people who live in towns. Researchers have shown that engineers restructure not only the landscape but rural society as well. In doing this, they meet not only the resistance of the land and the force of the water, but also the resistance of the production system and the force of the local political system.

The 'ethnographic' approach shows that the crisis in irrigation is confined to exogenous development. It provides the information enabling a comparison to be made between 'industrial' and indigenous schemes, even though the researchers do not themselves make such a comparison. It shows that amongst the Taita and other African peoples, planning and management of hydro-agricultural infrastructure are linked to the political system and that the use of the plots fits within the existing production

system. It implicitly reminds us that Western methods of design and management are also imbued with political and economic norms.

Finally, the 'organisational' approach originates from quite a different context than that of Africa. In South Asia, canals stretch over tens and sometimes hundreds of kilometres, irrigating hundreds of thousands of hectares. Managing such networks presents quite different problems to those encountered in sub-Saharan Africa, where few schemes cover more than ten thousand hectares. Still more importantly, in Asian systems, the farmers still control their own land. Farmers retain at least a degree of choice as to the crop they grow and their land is not confiscated, except for construction purposes. In Africa, on the contrary, farmers do not retain control of their land but are dispossessed. Along with their land, they lose all freedom to choose their crop. The management does its best to destroy their farming system and their internal organisation in respect of production and consumption, and does not consider existing gender relations. In stressing management of the network, the organisational approach fails to take account of the fact of there being little economic interest in irrigated agriculture for smallfarmers.

None of the three approaches identifies planning and design methods which would help to rescue official irrigation schemes from the present deadlock. So let us now, armed with our knowledge of the 'industrial' vision which inspires current methods of hydro-agricultural planning and design, and of the sociology of irrigated production in Africa, look at the factors responsible for the recent success of village irrigation schemes in the Senegal River Valley.

5. THE RELATIVE SUCCESS OF VILLAGE IRRIGATION SCHEMES ALONG THE SENEGAL RIVER

The number of village schemes had risen from zero in 1970 to over 700 in 1988, covering a total of 14,467 hectares (OMVS, 1988). What are these schemes like and what factors have led to their rapid spread?

A village scheme often covers about 20 hectares. It is managed by all the owners of the plots who were known as producers' groups until 1988, but which are now changing into 'economic interest groups' following a new law offering tax advantages. These groups generally have between 40 and 80 members, equivalent to the number of plots in the scheme. The members

own their plots. Plots within a scheme are about the same size, although the average size may vary from 0.2 to 0.8 hectares. In most cases, the owners live in the same village. The schemes are located close to a river or floodplain channel, usually less than 100 metres away. A motor-pump lifts up the water and pumps it back through pipes into the dispersal basin located on the levees. A basic network of open channels, regulated by an average of ten sluice-gates, carries the water to the plots.

The smallfarmers and a national agency⁴ share the construction of village schemes. When the village lands include areas close to the river or a stream, the group suggests the site to the agency which makes a technical assessment. Should the group's village not have any land close to a water source, it may negotiate with a neighbouring village to make land available in accordance with the laws governing national resources and rural communities. Should the technical assessment be favourable, the agency sends a topographical team and the villagers clear the land, which is often wooded.

On the basis of a plan worked out by the technicians from the agency, smallholders belonging to the new group dig the channels and shape the plots. They are helped in this to varying degrees by the earth-moving equipment of the agency. The sluice-gates/weirs are constructed by skilled masons paid by the agency. Once the scheme has been built, the peasants draw lots for the plots.

This extraordinary way of allocating land was introduced by the teams from the agency who set up the first schemes. These were initially designed to save the people from famine. In view of this, both the agency and the villagers were agreed that anyone who wanted one should be allocated an irrigated plot. This procedure corresponded to the desire of the teams to break the domination of the 'free', land-holding clans over the descendants of slaves. It was made easier by the fact that the newly-irrigated lands were not very significant within the farming systems at the time. It should be noted, furthermore, that this procedure of allocating by lot is still practised. However, it is now more common for the representative of the clan holding the land before the scheme was set up to receive additional plots.

⁴ The agency involved depends on location. In many locations, this agency is helped.

The next phase is to manage the scheme and bring the plots into production. The smallholders see it as natural and obvious that management of the scheme should be modelled on the organisational relationships to which they are accustomed in other fields. Haalpulaar villages, for example, have many associations, amongst them the 'youth association' for young people from the village. These associations seek to maintain the village, arrange construction or repair of wells, renovate market places, pay for the training of a village midwife or construction of classrooms, etc. They may also organise wrestling contests or other activities to make village life more agreeable. The associations sometimes manage substantial amounts of money, especially if their funds are topped up with remittances from migrant workers in France or other African countries. Associations also have procedures for monitoring cashflow.

The organisational model which underpins associations is learned in the 'age-sets'. Formerly, an institution for the initiation of boys, the age-set system has retained its function of socialisation. When children are between 8 and 12 years of age, their parents organise one age-set for boys and another for girls. Membership is for life. The children must elect a president, treasurer and so on. They may decide to pay dues in order to purchase sweetmeats, drinks, etc. In these age-sets, children learn to act as members of a group, take collective decisions and stick to them (or make sure others stick to them). Some children, particularly those belonging to dominant lineages, learn to dominate their peers, while the others, for instance the children of slave descendants, learn to obey. In the words of a Haalpulaar: "the *fedde* (vernacular for age-set) are our schools".

It is just as natural to replicate political divisions within the scheme. In the case of the Haalpulaar, there are three social classes, neighbourhoods/villages and political factions. The Haalpulaar divide themselves into free men, artisans and slave descendants. Until about 1980, village policy-making was the exclusive preserve of certain lineages of free men, with both artisans and slave descendants excluded. When it comes to selecting presidents or secretaries for irrigation groups, one generally finds free men rather than artisans or slave-descendants.

As a result of legislation, universal suffrage and migration, the gap between slave descendants and free men has shrunk to such an extent that, when irrigation schemes were established, descendants of slaves could join groups and own plots. The village now represents the local political unit. Inhabitants tend to see themselves as part of a particular village. When

villages have to manage a scheme together, they also tend to do this, i.e. to see the others as belonging to a different political system, with all its implications in terms of dependency and loyalty. When there is an equal number of members from two different villages, management is deadlocked, because there are no institutions at inter-village level to resolve disputes. When members live in a single village, i.e. belong to the same political system, disputes are generally settled in the context of shared dependency and loyalty.

This indicates that valley dwellers have copied the organisational model of their age-sets in managing their new infrastructure in the form of the hydro-agricultural scheme. Members' access to prestigious and leadership posts, the distribution of plots and the settlement of other issues do of course reflect the divisions found in the village political arena. The success of village irrigation schemes is partly due to the match between the local political system and the infrastructure, as well as the fact that valley dwellers were free to organise the management of their schemes along the lines of a model with which they were all familiar.

Getting back to the insights gained from an analysis of the ethnographic research, it is clear that management of village schemes resembles the way the Taita and others manage their hydro-agricultural infrastructure in that it is an integral part of the local political system.

The fact that the valley dwellers were willing to organise themselves to construct and manage the schemes indicates that the use of irrigation fitted within their production objectives. During the 1960s and 1970s, production and consumption amongst the Haalpulaar was organised at household or *foyré* level. The *foyré* comprised the husband and his wife or wives, their children and sometimes some married children, the father or mother of a spouse, and/or another relative. The average was around six people.

Within the *foyré*, the man was responsible for tilling the soil and weeding the millet and sorghum crops. (These were generally grown in association with cow-peas.) He was assisted by his wife only in bird-scaring, harvesting and transportation. The woman would grow cherry tomatoes, sweet potatoes and other vegetables in riverside fields, if she had inherited any. During the 1960s fewer and fewer men were available to grow cereals. Before that time, they used to migrate to the groundnut-growing region or major Senegalese towns, returning for the rainy season. As the French economy expanded during the 1960s, they began to migrate to Europe, whence they

could not return for the rainy season. By the 1980s, practically every *foyré* had at least one man who had been away for at least three months in the last twelve. The women stayed in the village, covering the cereal deficit by buying millet and sorghum in the village with the remittances from their husbands (Diemer and van der Laan, 1987).

Drought added to the problems caused by migration. Average annual rainfall dropped by 25%, placing the valley within the 150-600 mm range where before it had fallen within the 250-800 mm range (Van Driel, 1988). Rainfed crops failed, while the traditional fall-back of flood-recession agriculture was available to only a few valley dwellers.

TABLE 1: Division of Tasks Related to Date of Establishment of Schemes

	Number of Seasons (since establishment)	
	1-2	> 4
Men	58%	49%
Women	21%	32%
Children	21%	19%
All	100%	100%
	===	===

Source: OMVS (1980)

Village irrigation schemes were conceived in the light of these changes. The local people used them to bridge the cereal gap caused by the combination of drought and male out-migration. Households also adjusted their division of labour to the realities of migration. The socio-economic survey conducted by the OMVS (1980) indicated that women's participation in farming increased the longer schemes had been established.

During the 1980s, local people introduced several changes to this irrigated subsistence agriculture. Let us take the women first. Even in the 1950s, about two-thirds of valley dwellers had no access to the riverside gardens

where the women grow sweet potatoes, okra, cherry tomatoes, etc. (Boutillier, 1982). These gardens provided a small cash income for the women, as well as ingredients for the sauces to go with meals. As irrigated rice-growing was added to flood-recession cropping, irrigated gardening was added to existing riverside gardening. Women's associations in nearly every village now have an irrigated orchard, usually located near the village and served by a well.

Another change was the decrease in the intensity of cropping in rice-growing schemes. In the hope of increasing the proportion of rice sent to market, the national development agencies increased the size of plots over the decade. The average of about 0.2 hectares around 1980, had risen to about 0.3 hectares by 1989. The agencies assumed that the farmers, many of whom practised double cropping, would continue to do so, but the farmers decided otherwise. They took advantage of the increased size of their plots to grown all the rice they needed in one season. This meant that they did not have to cultivate during the dry season when pumping costs are greater because of the higher rate of evapotranspiration and the need to pump from a greater depth (Jamin, 1987; Bastiaansen, 1988; Diemer, 1990).

Irrigated rice-growing has become an integral part of the production system. The good rains which fell in the Sahel in recent years did not lead farmers in the mid-Senegal valley to abandon their schemes. On the contrary, the commitment to irrigation increased, with people trying to reserve fields close to the river for their children.

Very few groups have had to stop irrigating because they could not replace their worn-out pumping equipment. One reason for this is that SAED (Land-Use and Development Company of the Senegal and Falémé Delta) and SONADER (National Rural Development Agency), after some hesitation, made provision for depreciation costs. In the case of SONADER, a strict depreciation rate is applied which enables the motor to be replaced in five years. In the case of SAED, a more flexible rate is combined with less strict application, which means that many groups needing to replace their motor have only 80% of the necessary funds available. They get round this by allowing a local businessman/politician to supply the missing amount or by getting a foreign NGO interested in their plight. Even more frequently, the group whose motor-pump has broken down puts pressure on SAED to lend them a pump until the end of the season. This leads to almost interminable negotiations as a result of which the group

often succeeds in getting a considerable grant towards their new motor-pump.

To sum up, it is clear that the success of village schemes lies in their adaption to the local production system and, more specifically, to changes within it. In addition, the Haalpulaar were free to organise the management of their schemes according to their own organisational model and fit this into their political system. This is contrary to the industrial approach which is characterised by rejection of the production and political systems of the smallfarmers/tenants, together with the imposition of particular organisational relationships. The importance of the production system may also be deduced from the rapid spread of irrigated gardens and the decreased intensity of cropping practised by farmers over the decade.

6. POINTERS FOR MORE EFFECTIVE PLANNING AND DESIGN METHODS

How does identifying the reasons for the success of village irrigation schemes help us to develop more effective planning and design methods? We think this shows that planners and designers must devote more attention to the smallfarmers' production system and local political system. Study of the former should pinpoint the organisational criteria for designing the hydraulic network, while study of the latter should be undertaken with a view to identifying the criteria for allocating plots.

Let us first look at management of the infrastructure. As the impetus for the spread of village schemes came from the valley dwellers themselves, they organised in the same way to present their requests as they intended to do in managing their scheme. The point is that they found it natural and obvious to organise themselves on the basis of their belonging to a village. Although this was not made explicit, their planning and design practices were based on the relevant organisational unit and political affiliation. Their approach thus almost automatically matched the scheme with the local political system.

This is the opposite to current procedures. Comparison with developments in the Senegal river delta makes this quite clear. In the 1970s, schemes covering a thousand to two thousand hectares were designed. They were supposed to be managed by cooperatives including residents from different villages. The very fact that the president of the cooperative belonged to

another village led a good number of members belonging to other villages to mistrust him with regard to vital activities like payment of dues and selling the harvest (Waldstein, 1986). This mistrust was not unfounded inasmuch as the mutual dependency and loyalty which linked these dignitaries to the inhabitants of their own villages were stronger than their links with members of that new, foreign and more or less politicised and state institution: the cooperative.

The chosen management unit in villages was viable because it resulted from proposals made by the farmers themselves. During the sixty or so years which elapsed before village schemes began to spread in the valley, both the colonial and post-independence governments always avoided the mid-Senegal valley. This was in spite of the fact that the technical services often pointed out its physical hydro-agricultural potential. However, the plans submitted by the engineers did not fit in with local political realities. The 'controlled flooding' system, for instance, was designed for seasonally inundated depressions.

The land tenure arrangements in these depressions generally involve lineages of farmers along with lineages of fishermen and herders (Schmitz, 1987). Yet, these fishermen and herders found themselves forced out of their lands by these purely agricultural schemes. Moreover, these areas are often farmed by several lineages from different villages. Successive administrations were therefore afraid of encountering political resistance they would be unable to overcome (OMVS, 1980; Boutillier et al, 1962). This lack of suitable approaches led them to concentrate their investments in the delta. However, the success of village irrigation schemes suggests that viable ways of irrigating land in the valley could be developed so long as the local political system is considered not just as a constraint, but also as a potential management tool.

The Haalpulaar smallfarmers were able to impose their own management model. This is not due to the planning and design methods adopted by the rural engineering service, but rather to the fact that the government did not dare to impose its own management model on the smallfarmers. This historical accident shows us that the design of the hydraulic network should be based on the definition of the management unit. Feasibility and detailed pre-project studies should identify the most appropriate unit on the basis of field surveys and discussions with the smallfarmers.

The example of village-schemes indicates that the local political system should be viewed not only from the angle of what it precludes, i.e. as a constraint, but also from the angle of what it allows, i.e. as an opportunity. This same reasoning may be applied to the production system. The proposals for developing the hydro-agricultural potential of the valley made by the engineers implied profound changes in the political system as well as in the local people's production system. They were designed to realise the potential of the annually flooded depressions where the people grew their staple food - sorghum. The engineers were keen on these areas not only because of their clayey soil, suited to irrigated rice, but also because they thought they could channel water by gravity without pumping (for instance, by installing coffer-dams to control flooding, as mentioned above).

The schemes introduced a new risk in the sense that a tried and tested technique was being replaced by one which had yet to be adapted to the social and physical environment. The irrigation system which invaded the valley and is now predominant does not use the depressions. It is practised instead on the uplands situated either on the levees or half-way between these levees and the depressions. These lands were of only marginal in the production system, since they were rarely flooded. Bringing these lands under cultivation did not add a risk but created an additional resource. It strengthened a production system based on minimising risks, unlike the 'industrial' approach which generally expects that the tenants should depend 100% on their irrigated plots for their livelihood (see Richards, 1986).

Furthermore, the system which has swept all before it obtains water by pumping rather than gravity. As migration expanded rapidly during the 1960s and 70s, the market economy penetrated ever deeper into the smallfarmer production system. Demographic growth, drought and the stagnation of farming techniques were all factors pushing towards the use of resources outside the valley. Migration offered a way of minimising risks in this context of unfavourable changes. Moreover, it generated income. This income made possible the intensification of agriculture demanded by the combination of drought and more mouths to feed. While maintaining their production objectives, i.e. subsistence, the Haalpulaar introduced pumping into their production system (with financial support from migrants), once again contrary to the 'industrial' approach in which the cost of pumping is to be covered by agricultural sales.

We should also point out that households took advantage of new subsistence cropping to replace a division of labour which had become obsolete with

long-term migration. In the mid-Senegal valley, women began to undertake almost all farming operations. This again shows the gap between the industrial approach and smallholder practices. Many engineering reports mentioned migration, but it was seen as an obstacle to hydro-agricultural development because work on irrigated land was primarily seen as men's work. This (male) labour seemed to be lacking as a result of migration (FAO, 1983).

In parallel, it is noticeable that women are organising themselves to set up and manage market gardens which have their own pump or well and are not dependent on the irrigation scheme's motorpump. Women have organised themselves in virtually all villages to set up these gardens, as if replicating in the context of irrigated agriculture the kitchen gardens of yesteryear. As before, they sell about 25% of their produce and use the rest for preparing meals (Helsloot, 1988).

The particular features of this irrigated subsistence farming show that one cannot merely describe the production system. It is necessary also - perhaps especially - to analyse the system with the smallholders. By so doing, one may hope to identify inter-action between the components of the system which the scientific literature would not lead us to expect, and which opens up new avenues. Migration created new opportunities which the smallfarmers were the first to recognise. The later evolution of village schemes shows the need for such joint analysis.

The rapid spread of village schemes gives glimpses of several processes of change within the production system. As with the local political system, this must not be considered static. These changes did not stop when village schemes had become widespread throughout the valley. After the wave of irrigated cereal production, almost all villages established irrigated market gardens.

CONCLUSIONS

Analysis of the success of village schemes shows that the success of any physical infrastructure is dependent on its conformity with smallfarmer reality. To be precise, the characteristics of the plot (soil, surface area, distance from home, etc) must be matched with the smallholder production system and the water distribution network must be matched with the mode of political organisation. The fact that the motor-pump is imported is

unimportant. The main thing is that the farmers should be able to use it for their own purposes⁵.

This conclusion goes beyond the literature taking the 'transformation' approach. While this approach notes the gap between the schemes and smallfarmer society is noted, it is not identified as the cause of failure. The pretensions to universal validity of this agricultural science are accepted and, therefore, the 'transformation' approach seeks merely to make its impact on smallfarmer society less painful.

Our conclusion goes beyond the ethnographic approach in the sense that it transforms its main finding into a prescription for hydro-agricultural planning in Africa.

Planning and design of irrigation schemes in Africa are presently governed by norms which could hinder the development of irrigation. Norms relating to the place of irrigated plots within the smallfarmer production system and the appropriate form of organisation for managing the hydraulic network originate in an ethnocentric approach which we could describe as 'industrial'. They should be replaced with empirical norms. The study of hydro-agricultural schemes which are recognised as viable helps to build a picture of the gap between the 'industrial' and 'smallfarmer' perspectives. Current planning and design methods have hitherto started from the premise that the industrial approach was the only possible way. It was therefore deemed inevitable that the scheme should be imposed on smallholders (men and women) and that they should be obliged to adapt themselves to it.

Trained by educational institutes in the industrialised countries, or by their sister institutions established in African countries, these specialists in rural engineering design act according to a vision of irrigated production which may be classified as industrial. Like other agricultural sciences, methods of hydro-agricultural design are based on social and economic premises emanating from industrialised society which are not valid for the rural societies currently found in the African countryside.

If viable schemes are to be set up, methods of planning and design must be reversed. If the scheme is to be a tool in the hands of smallfarmers, it must

⁵ Witness the 2 hp portable pumps which irrigate the market gardens around Sahelian towns, as well as individual farmers' fields on the plains of the Niger and Benoué rivers in Northern Nigeria and the Mwea plain in Kenya.

be designed in accordance with their production objectives and models of political organisation. That is to say that planning and design must be based on norms identified through study of the local production and political systems. This study must be coupled with discussion, as both systems are constantly changing. They continually present the smallfarmers with choices that someone from the outside is incapable of making.

This is a challenge for sociologists, who should be studying the effects of village society on the scheme, at the same time as they look at the latter from the traditional angle, i.e. the effect of irrigation in relationships between villagers.

RECOMMENDATIONS

Analysis of the success of village schemes and the ethnographic literature suggests that the first thing to do is to reverse current methods of design rather than vainly seek to adapt male and female smallholders to the designers' assumptions. Smallfarmer production objectives and organisational relationships should be incorporated in design. This will be a tricky matter, as investments are made by the state and its donors, who have their own objectives. There should be a forum on irrigation, where smallfarmers and officials can negotiate the scheme's production objectives and management model. This should enable design parameters to be determined which faithfully reflect the balance of power between smallfarmers and state. This will prevent the construction of schemes which assume a higher degree of state control over the smallfarmers than is actually the case.

We therefore think that the terms of reference of consulting organisations responsible for designing schemes or assessing their feasibility should include: a detailed description of the production systems of the different smallfarmer sectors, indicating to what extent male and female smallholders consider that a better water supply would lift constraints; a detailed description of their political culture and its implications for the layout of the infrastructure and organisation of management; detailed reports of negotiations between smallfarmers and officials as to production objectives, and lay-out of the network and management model.

We also think that trainee rural engineers should be obliged to prepare theses in which, on the basis of prolonged stays in the villages, they compare

their training with smallfarmer practices. We do not of course think that the adoption of these recommendations will make the crisis in African irrigation a thing of the past. We also consider it vital that irrigation programmes should be integrated in overall national development policy, stressing research into appropriate technology while setting up a guaranteed price policy to stimulate production and use of inputs and realistic terms of trade.

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