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STRUCTURAL ADJUSTMENT AND IRRIGATED FOOD FARMING IN AFRICA: THE "DISENGAGEMENT" OF THE STATE IN THE SENEGAL RIVER VALLEY

by

Philip Woodhouse and Ibrahima Ndiaye

DPP Working Paper No.20

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STRUCTURAL ADJUSTMENT AND IRRIGATED FOOD FARMING IN AFRICA: THE "DISENGAGEMENT" OF THE STATE IN THE SENEGAL RIVER VALLEY

by Philip Woodhouse and Ibrahima Ndiaye

Summary

Structural adjustment policies implemented in Senegal over the past ten years have reduced the activities of state development agencies and encouraged their substitution by commercial enterprises. This paper examines the implementation of these policies in relation to irrigated rice production in the Senegal river valley, which has developed under state supervision for over twenty years, and which is central to the government's plans to reduce cereal imports. The paper argues that while the takeover of supply of agricultural inputs and services by commercial enterprises has been partially successful, irrigation infrastructure has suffered from state withdrawal. This, together with inadequate mechanisation, has had the consequence that the potential to grow two crops per year on irrigated land has not been realised. As a result, despite a rapid increase in the irrigated area, accompanied by intensifying competition for land, there has been no substantial increase in rice output in the valley since the state disengagement began.

1. Introduction

By the start of the 1990's, structural adjustment programmes linked to IMF and World Bank lending had been been implemented by the government of Senegal for ten years. Recourse to IMF lending was first made in 1980, after the government recognised that it could no longer finance the deficit on the state budget and the trade deficit which had emerged in the late 1970's as a consequence of rising costs of oil imports and declining income from the country's main exports, phosphates and groundnuts (Commander et al. 1989)

The IMF strategy has tried to reduce the budget and trade deficits by reducing consumption, particularly public consumption, and by stimulating exports through shifts in domestic price policy. The series of three World Bank structural adjustment loans adopted during the decade have also emphasised price policy and reduction in state expenditure, particularly through restructuring or abolition of parastatal organisations. The strategy has succeeded in reducing the budget deficit from 9% of GDP in 1980-81 to less than 3% of GDP in 1987-88. It has been less successful in eliminating the trade deficit, however, because exports are still strongly influenced by groundnut output, which since the mid-1970's has been reduced by low rainfall and falling area allocation (ibid, 1989).

In agriculture, structural adjustment measures have been dominated by an attempt to reduce the burden of parastatals on the budget and the associated withdrawal of the state from key functions. In particular, conditionalities attached to IMF Standby lending included liberalisation of domestic markets for cereals, the reduction of budget support for inputs such as fertiliser, seeds, and agricultural implements, and restructuring prices to eliminate

subsidies to consumers for food items. These policy orientations were embodied in the Senegalese government's Nouvelle Politique Agricole (NPA) published in 1984 (Afrique Agriculture, 1986; Commander et al. 1989) which established guidelines for four main areas:

1. Transfer of certain parastatal functions, such as crop storage, to producers - *responsabilisation paysanne* - linked to a reorganisation of cooperatives and farmers groups to allow them autonomy from parastatals.

2. Transfer of the agricultural input supply system from parastatals to the private sector.

3. Reduction in the activities of parastatal development agencies.

4. Changes in price policy to remove of all subsidies on agricultural inputs, and to establish domestic consumer prices at levels high enough to provide protection for domestic cereals production against imports.

The price policy for cereals was set out in the Plan Céréalier in 1986, whose objective was to increase domestic food production from around 50 percent of national requirements in the mid 1980's to 80 percent by the end of the century. In order to achieve this, the Plan proposed increased prices to cereals producers, an increase in consumer prices to allow a minimum 25 percent protection rate for domestic cereals against imported cereals, and an increase of 75 percent in cereal yields through higher input use (Commander et al. 1989).

In practice the most important element of protection was for domestic rice production. This is because rice was the largest component of food imports: constituting 77 percent of the 453000tons average annual commercial cereals imports between 1981 and 1984 (Afrique Agriculture, 1986, p25). Moreover, unlike wheat, rice formed a significant and increasing component of cereal consumption not only in urban areas, but also in rural areas, where average rice consumption accounted for over 25 percent of total cereal consumption in the early 1980's (Commander et al. 1989). This importance of rice in rural areas is accentuated because the staple cereal, millet, is grown under the same soil and climatic conditions as groundnut. Farmers' failure to increase groundnut areas in response to increasing relative groundnut prices in the 1980's has been attributed to a reluctance to reduce their areas of millet. In the absence of any immediate prospect of increasing yields of either millet or groundnut under Sahelian conditions (Matlon,1987), therefore, emphasis on domestic food security through increased millet output must be at the continued expense of groundnut, one of the country's main exports.

The emphasis on increasing rice production means that the Senegalese government's strategy to reduce importations of staple food is heavily reliant on developing irrigation for food production. Between 1986 and 1989 the government hoped to increase irrigated cereal output by over 80%, while rainfed cereal production was expected to increase by only a quarter. To this end, 75% of the agricultural investment budget in 1986-9 was to be used for irrigation development. Of this, two thirds, constituting 46% of all agricultural investment, was to be spent in the Senegal river valley (Afrique Agriculture, 1986, p29).

Although justification for irrigation development has been reinforced by the decade and a half of lower than average rainfall in the Sahel which began in the early 1970's, this major investment in irrigation in the Senegal river valley has been criticized as a continuation of a discredited colonial government policy (Engelhard et al, 1986,p115). The government's continued emphasis on the Senegal river valley rests on the belief that conditions for irrigated production would be dramatically improved by two factors:

- *l'Après-Barrage*: the completion of two dams, one at the top of the river basin, at Manantali in Mali, and the other close to the estuary at Diama which allow year-round irrigation along the whole length of the valley ;

- *le Désengagement*: the withdrawal of the state from the supply of agricultural inputs and services to allow provision through commercial markets .

With the completion of the dams in 1987, *l'Après-Barrage* became a reality, and the rapid growth awaited in irrigated food production has come to be regarded as dependent upon the pace of state withdrawal. This paper describes the extent of this withdrawal in early 1989. Based on field work carried out from January to March 1989, it attempts to identify emerging trends in irrigated farming and to use these trends to assess the effect of the "disengagement" process on agricultural output. The paper is organised in four sections. The first section provides a brief account of of the development of irrigation in the Senegal river valley, and in particular the experience of different models of irrigation mangement. The second section documents the way in which irriagtion can be seen to have affected conflicts over access to land and water in the valley. A third section describes the way in which state disengagement has taken place and some immediate consequences, while the fourth section discusses how the altered economic climate will influence irrigated food farming in the valley.

2. Irrigation in the Senegal river valley

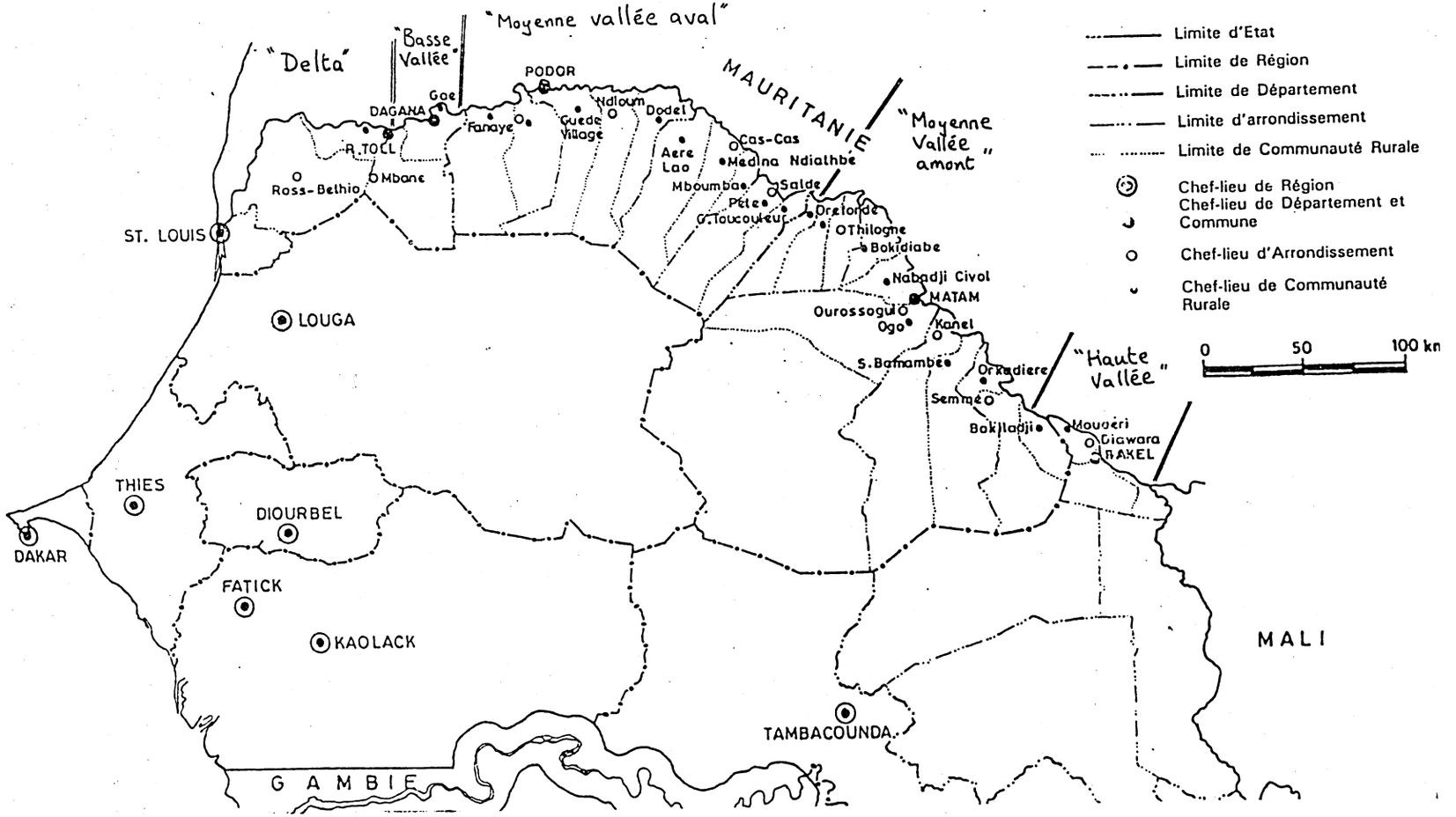
2.1 Geographical and historical background

The Senegal river flows along the southern limit of the Sahara Desert, forming the frontier between Senegal, on the south bank, and Mauretania on the north bank. The river is derived from three main tributaries: the Bafing and the Bakoye in Mali, and the Falemé close to the Senegal-Mali frontier. In 1972 the governments of Mali, Senegal and Mauretania formed a river basin development organisation (OMVS- Organisation pour la Mise en valeur de la Vallée du Sénégal) which, with foreign financial and technical assistance, has drawn up plans for a total of over 300 000ha of irrigated agriculture in the valley, of which 224 000ha are on the Senegalese bank (Flavigny and Cousin, 1982) with which this paper is concerned.

Farming conditions vary considerably along the length of the river, due to climate and topography, and OMVS has divided the river basin below Manantali into six geographical regions, illustrated in the map (OMVS, 1988). For the purposes of this paper, I shall divide the Senegalese side of the valley into only three regions:

3(a)

: RÉGION DU FLEUVE SÉNÉGAL



the *delta*, which extends from the coast to a point a few km upstream from Dagana (hence including both the OMVS regions "delta" and "basse vallée"), has been heavily influenced by the intrusion of seawater, which, before the construction of the Diama barrage, reached as far upstream as Podor during the dry season, and the resulting salinity of much of the soil made crop cultivation impracticable. The Delta was therefore sparsely populated before the advent of irrigation.

the *middle valley* from Dagana to Dembakane (hence including OMVS regions "moyenne vallée amont" and "moyenne vallée aval"), where traditional agriculture has centred on the use of the "cuvettes" - low-lying parts of the floodplain which are covered for a month or more by the annual flood of the river. Customary land rights on the cuvettes are distributed between three main caste groups, involved, respectively, in fishing, pastoralism and crop cultivation. The latter plant sorghum on the clay soil (locally known as *hollaldé*) of the cuvettes as it becomes uncovered by the receding floods. Access to the cuvettes is tightly controlled through village hierarchies, as described by Schmitz (1986), Bleeker (1987) and others.

the *upper valley*, from Dembakane to the Senegal-Mali frontier (the same as the OMVS division "haute vallée").The valley is narrower than in the middle valley and opportunities for flood-recession farming are more limited. However, average rainfall (600mm per year) is higher than downstream, and rainfed crop production, particularly of millet and groundnut on the sandy soils (*dieri*) on the outer margin of the valley, is important in this area, although considerably restricted by drought since the early 1970s. Detailed accounts of farming by Soninké communities in this part of the valley have been given by Adams (1977, 1985).

2.2 Small versus large scale irrigation

The history of irrigation development in the Senegal river valley has been set out in detail elsewhere (OMVS,1984; Engelhard et al. 1986; Adams,1981; Diemer and van der Laan,1987), and is only briefly noted here in order to assist an understanding of more recent developments which are the main subject of this paper. The 1988 OMVS inventary of irrigated land in the Senegal river valley puts the total irrigated area at 39270ha on the southern (Senegalese) bank (a further 16 856ha was estimated for the northern, Mauretanian, bank), all of which obtains water by pumping from the river. However, this irrigation may be regarded as having one of two distinct origins.

In the first instance, following earlier, colonial, efforts to develop irrigated farming, particularly at Richard-Toll, large-scale schemes of 1000ha or more were established to grow rice for the national market. These schemes were originally constructed in the delta in the 1960's to grow rice under partially-controlled flooding, following patterns successfully used in Indochina. The characteristics of the Senegal river flood proved too irregular, however, and by the 1970's the perimeters (a term used here in the French sense of 'an area marked out for irrigation') were being modified by the addition of large electric pumping stations and tertiary infrastructure to allow improved water control.

In the second case, small-scale schemes (PIV - Périmètres Irrigués Villageois), each covering an area of 20-50ha, were established from 1975 onwards, with the principal objective of ensuring the food security of farmers in the period of lower than average rainfall which began in the early 1970's (Engelhard et al. 1986; Adams, 1981), which severely restricted crop cultivation dependent on rainfall (in the upper valley) or the river flood (in the middle valley).

With the exception of about 7500ha operated as a commercial sugar plantation, by the 1980's all the irrigated areas were divided into smallholdings, allocated to individual farmers by the irrigation management body: the village authorities in the case of small-scale schemes; the state management corporation (SAED - Société d'Aménagement at d'Exploitation des terres du Delta du fleuve Sénégal) in the case of the large-scale schemes. The state corporation SAED, formed in 1965, played a central role in both types of scheme, however, by undertaking design and construction of the irrigation work, provision of technical and input supply services including tractor hire, operation of the large pumping stations (large perimeters), and supply and maintenance of small pumpsets (PIVs). This had the important consequence that, while farmers' irrigation organisations were often formed on the initiative of farmers themselves, and in the Bakel area, even in the face of opposition from SAED (Adams 1981), their functioning has been shaped by conditions in which the state had responsibility for the supply of key factors of production. Therefore the withdrawal of the SAED from this responsability - le désengagement - implied a change in the functioning of farmer's irrigation organisations. Before considering these changes, a brief comparison will be made of large and small-scale irrigation as it was in 1984, on the eve of the withdrawal of SAED.

Large-scale perimeters are concentrated in the delta (with two exceptions, Guedé and Nianga, in the lower middle valley) on heavy clay soils, many of which are sufficiently saline to exclude all crops but rice. Water is supplied to units of a thousand hectares or more by large electric pumping stations, pumping from the main river course or from a secondary natural watercourse, the Gorom Lampsar. In the latter case double pumping is involved at certain times of the year when the level of water in the main riverbed is insufficiently high to supply the Gorom-Lampsar, which is then fed by a pumping station at Ronkh. Land distribution had been carried out according to the criteria of 0,5ha per *actif* and as a result household units frequently had total holdings of 1,5ha, rising to several hectares in some cases. The relatively large landholdings require mechanised tillage, a generalised use of herbicides for weed control, and seasonal hired labour during harvest.

Small-scale irrigation - the PIVs - is concentrated in the middle and upper valley, where perimeters of 20-40ha were typically constructed on the levees of the main courses of the river (thus avoiding conflict with traditional land rights in the cuvettes), which had soils of a lighter texture than the cuvettes. Each perimeter was irrigated from the river by a float-mounted diesel pumpset, the running costs (fuel, spare parts, operator) of which were met by those cultivating the irrigated plots. The size of individual holding on PIV's varies between 0,1 and 0,5ha, but is most commonly 0,2to 0,3ha, and practically all operations are carried out manually, including tillage.

table 1 comparison of cropping on large and small scale irrigation, in the 1982-83 and 1983-84 seasons (extracted from OMVS, 1985)

season:	total net irrigable (ha)	percent of irrigable area cultivated: rainy	cool dry	hot dry	total
1982-83					
large	8878	61%(rice)	6%(tomato)		67%
small	5761	58%(rice) +4%(maize)	27%(maize)	11%(rice)	100%
1983-84					
large	9056	79%(rice)	5%(tomato)		84%
small	7894	57%(rice) +5%(maize)	28%(maize)	3%(rice)	93%

Table 2 Comparison of large and small-scale irrigation, 1982-83 rainy season rice crop. (from Engelhard et al. 1986, p153)

	large scale		small-scale
perimeter:	Lampsar	Dagana	Matam
net irrigable area (ha)	1971	2400	2133
% cultivated (rice only)	94%	48%	56%
% harvested	84%	45%	54%
yield: ton per cultivated ha	4.4	3.8	4.9
yield: ton per participant	5.1	2.5	1.4
percent of paddy marketed	57	40	5
area per participant (ha)	1.2	0.64	0.28
peasants' production cost/ha	48681		38992cfa/ha
peasants' costs per kg paddy	11cfa		10cfa
total cost (incl. state costs) per kg paddy	85cfa		55cfa

Note: 50 CFA francs = 1 French franc
310 CFA francs = 1 US dollar.(1989 exchange rates)

Tables 1 and 2 summarise comparisons of the performance of the two types of irrigation. In table 1, data for two seasons shows the heavier emphasis on rice in the large perimeters of the delta. On the small perimeters, rice occupied a smaller proportion of the total irrigable area, with the remainder being largely made up by maize. Table 2 reproduces comparisons of rice production on small-scale and large-scale perimeters by Engelhard et al. (1986,pp252-9), which indicate that on PIV's production costs are lower and output per unit of land is higher. However, the percentage of output marketed is lower than on large-scale schemes. There is also evidence that on some PIV's the small area (and hence production, cf table 2) per cultivator is insufficient to grow enough food to support cultivators' families (Engelhard et al.1986, p258). Since much of the crop will be used by the cultivators' own household, the cash costs of production (mainly pump operation and

fertiliser) must be met from earnings from other sources, such as livestock, and not infrequently from remitted earnings of the 20-40% of the active population emigrant to Dakar, France and elsewhere (Diemer and van der Laan, 1987, p93). On both types of perimeter the direct production costs were covered by credit from the supplier of inputs and services: SAED. Farmers' failure to repay this credit has been linked to their lack of control, or even consent, in relation to the level of production costs - an issue documented in some detail by Adams (1981). By 1984 the accumulated debt arrears was 255 million frs CFA in the valley as a whole (SAED, 1986), with the the overall level of indebtedness running at a higher level on larger perimeters. This large unpaid debt was in turn a factor in persuading the state to withdraw from input and credit provision as part of the structural adjustment programme.

However, by the time such decisions were being taken in the early 1980s, experience gained in running large and small-scale irrigation had given rise to efforts to identify and implement measures to circumvent the disadvantages of both large and small schemes. Two sets of measures were set in train even before the decision to withdraw the state from direct supply of inputs and services. Firstly, the design and construction of "intermediate" schemes aimed to provide larger irrigated areas for participants of the PIVs of the middle valley, although this would require extension of the PIVs from the levees to the more extensive, but flood-prone, *cuvettes* - with attendant increases in cost (for flood-protection and mechanisation) and conflict with customary land tenure. Secondly, cooperatives, which had previously grouped about 400 participants on the larger schemes, were broken into smaller *Sections Villageoises* (SV), with a greater degree of managerial autonomy. The SV was further subdivided into *groupements*, which were to be the unit of irrigation management. Despite modifications during the SAED withdrawal, these initiatives continue to exert influence over the evolution of irrigation in the Senegal river valley, which we discuss further in section 5.

In this section we have outlined some characteristics of the performance of different "models" of irrigation in the Senegal river valley prior to SAED withdrawal. In the following section we review the ways in which irrigation has influenced social and economic relationships within rural communities in the valley.

3. Farmers in irrigation management

The role of farmers in irrigation management is conditioned fundamentally by their access to land and irrigation water, and we will therefore review briefly those terms operating in the Senegal river valley. This account will be restricted to those involved in irrigated farming, although it should be noted that the reduction in the annual flood of the Senegal river, which is the principal effect of *l'Après-Barrage*, has profound, if as yet unquantified, implications for livelihoods such as pastoralism and fishing, which traditionally make use of the annual flood (Scudder, 1989).

3.1 Land rights

With the promulgation of the land reform law in 1964, some 97% of the land in Senegal was nationalised, and traditional land rights were no longer recognised. Instead, the right to use

land in rural areas was to be allocated by the newly-formed "rural communities" through their elected rural councils. The new law in fact followed traditional land tenure in Senegal (and indeed in much of Sub-Saharan Africa) in its distinction between land ownership and land use, but aimed to improve equity of access to land through allocation by an elected body. In practice, representatives of traditional landholding families were often elected to the rural councils and "the modern law practically reinforced the local standing of the traditional chief by conferring upon him a new state function" (Engelhard et al. 1986, p62).

However, two further provisions of the law, and the subsequent decree of 1972, threatened to undermine this consolidation of traditional power. These were firstly the power of the state to declare an area a *zone pionnière*, in which the jurisdiction of the local rural councils were suspended, in order to implement projects deemed to be in the wider national interest, and secondly the provision that, while a rural council could reallocate land that it considered under-utilised by its current user, such reallocation required compensation to be paid by the new user(s) for any buildings or infrastructure on the land. Both these provisions were significant in the development of land rights in irrigated farming in the Senegal river valley.

In 1965 the delta of the Senegal river valley was declared *zone pionnière* under the the jurisidiction of SAED, which was extended to the entire southern side of the valley in 1980. In practice SAED found it politic to accomodate the wishes of the local rural councils when they defended traditional land rights. The strength of such rights varied from one part of the valley to the other. In the delta, where population was sparse prior to construction of irrigation, and where subsequent immigration gave rise to heterogeneous communities drawn from Wolof farmers and Peuhl pastoralists, traditional land rights were weak. In contrast, the villages of Halpulaar (Toucouleur) people in the middle valley and of Soninké in the upper valley were long-established and local land rights were well defined. Diemer and van der Laan (1987, p153-4) note that in the middle valley the nationalisation of land in 1964 remained effectively ignored as late 1975, and that some farmers cultivating sorghum on flood recession land were still paying unofficial rent to traditional landholders in 1984. In these areas establishment of irrigation infrastructure was sometimes opposed by traditional landholders who saw it as constituting an irreversible transfer of land tenure. With the arrival of *l'après-barrage* this identification of irrigation with land tenure has assumed increased importance throughout the Senegal river valley, an issue to which we will return in section 5.

In the middle and upper valley the potential for conflict over land rights was reduced because the PIVs were generally situated on the levees of the river to facilitate pumping, on land that was of less importance in traditional farming than the low-lying *cuvettes*. Once irrigation was established, rural councils or village councils played a central role in deciding the allocation of irrigated plots. How has this affected the potential redistributive effect of irrigation?

Diemer and van der Laan (1987, pp139-141) argue that in the Halpulaar villages of the middle valley the access to irrigated plots is more egalitarian than traditional land tenure. In particular their data shows that socially disadvantaged castes descended from slaves, who had no traditional land rights, have access to irrigation comparable to that of

descendents of slave-owning castes. However, in the same villages women have not been so fortunate. Gaudet (1988) states that by the 1970s the scope for independent cultivation by Halpulaar women had diminished to such an extent that their traditional economic autonomy had been replaced by dependence upon their husbands, for whom they provided labour for sowing and harvesting the flood-recession sorghum crop. Diemer and van der Laan (1987, p90) cite evidence that, despite massive migration of men from the middle valley, the proportion of work done by women in the sorghum crop (29-33%) was no greater in 1978 than in 1957. Their figures also indicate, however, that the proportion of work done by men in irrigated rice is lower (49%) than in sorgum (67-71%) (Diemer and van der Laan, 1987 p97). Thus a switch from flood-recession sorghum to irrigated rice, such as took place in the 1970's and 80's, would indicate an increase in the proportion of agricultural work done by women.

In the PIVs of the middle valley, women have no rights to cultivate irrigated plots independently of their husbands, and Engelhard et al. (1986, p336) note that at Podor, also in the middle valley, a proposal in 1984 by the Senegalese NGO, OFADEC, to allocate irrigated plots equally to the 57 male and 61 female participants of the Niandane III perimeter was opposed by the local rural council in favour of an allocation to heads of households. The matter appears to have been resolved by allocation of plots to male participants only. When visited in 1989, the perimeter was cultivated by 56 male and no female participants.

In Soninké communities of the upper valley women appear to have retained their independence as cultivators to a greater degree, largely through growing rainfed groundnut on the *dieri* soils at the outer margins of the valley (Adams, 1985), and this is reflected in their participation in PIVs as holders of irrigated plots in their own right. Thus, Blijdorp (1987) found that women accounted for some 60% of the participants in a sample of 13 PIVs in the Bakel area. However, women's plots tended to be smaller than those of men and accounted for only 40% of the irrigated area. More important, perhaps, all irrigation management was carried out by men, even on women's plots.

Restrictions placed on women's independent access to irrigated plots on the PIVs of the middle and upper valley appears to have produced a similar response: the formation of women's groups to develop women's irrigated agriculture. These initiatives have centred on the establishment of small areas of high-value vegetable crops. These "gardens" have often been established close to the river, from which water is carried in buckets to the crops. External support for specifically women's projects has raised the possibility of women acquiring pumpsets and operating PIVs of their own, and a perimeter of 12ha has been established in this way by 232 women at Moudery, near Bakel (Blijdorp, 1987). Elsewhere, on the Ile à Morphil external funding has provided pumpsets to women's groups who have thus been able to greatly expand the size of their vegetable-growing areas. Ultimately, however, the development of irrigated farming by women's groups depends upon the willingness of the men on village and rural councils to allocate land for this purpose.

In the delta, there is little to indicate that women's access to irrigation is any greater than in the middle and upper valley, but this issue is somewhat masked by that of access according to age. In the middle and upper valley the established source of income for young men

during the past 40 years has been migration to earn wages or to engage in trade in the large West African urban centres or in France. In the delta, however, long-distance migration is less common among young men. As a result, there is greater pressure among the youth of the delta to obtain access to irrigated land. Yet this pressure finds little relief in the tenure arrangements on the large-scale irrigation schemes. Land was allocated to heads of family groups according to the number of *actifs* within the family, but have remained unchanged since. Holdings are therefore concentrated in the hands of older men, who make up the membership of the *Sections Villageois*, providing younger men little scope for cultivation other than on their older relatives' land. This situation has motivated the development of youth organisations, or *foyers*, aimed at providing independent access to irrigated farming for young people. The first foyer was established at Ronkh in 1972, and this provided the lead for many others throughout the delta, which are now loosely affiliated to an umbrella association, "l'Amicale des Agriculteurs de Walo". The *foyers* have attracted support from foreign development agencies, particularly NGOs, which has assisted them in setting up in the delta small-scale irrigation using the same technology as the PIVs of the middle and upper valley. With the decline in opportunities to earn income through migrant wge labour, the numbers of young men seeking irrigable land in the middle valley is increasing. The case, noted above, of the OFADEC project at Niandane, Podor, indicates that while allocation of of irrigable land to younger men may conflict with the immediate need of heads of households to retain control of 'family' labour, rural councils seem more likely to make such allocations than to allocate land to women.

As the dams at Diama and Manantali neared completion, considerable publicity was given to the greatly improved potential for year-round irrigation, and, in line with the market liberalisation measures of the Nouvelle Politique Agricole, the government has encouraged individuals and groups to invest in irrigated farming. Since 1984 such investment has been made possible through the allocation of land in the delta (by rural councils) to wealthy individuals, and to associations of farmers (*Groupements d'Intérêt Economique* - GIE). As in the case of the *foyers*, these investments have taken the form of "PIVs" irrigated by small diesel pumpsets. The resulting proliferation of small-scale irrigation in the delta has apparently accelerated during the period of SAED disengagement, a phenomenon we discuss further in section 5.

3.2 Water management

A common feature of large-scale irrigation in the delta (at Lampsar and Grande Digue-Tellel-Kassak) and in the middle valley (at Nianga and Guedé), is that the large pumping stations aim to keep the water level in the principal canals at a constant level during the crop growing season. At this level the system design allows water to be drawn simultaneously into all parts (termed "modules") of the secondary system. Within each module (area 20-70ha) the water is insufficient to irrigate the whole area simultaneously, and delivery of water to each tertiary canal must be rotated. This rotation of water is the responsibility of a *Section Villageois*, which may cover one or several modules. The distribution of water to different plots from the tertiary canals is organised by the *groupements*. One *groupment* is usually responsible for a single tertiary canal, which will irrigate an area of 15-20ha, known as a *maille hydraulique*.

A major consequence of this design is that responsibility for the organisation of distribution of water between farmers rests with the farmers' organisations: the *Section Villageois* and the *groupement*. The water-management responsibility of the main system managers (in this case SAED) lies only in starting up the pumps at the beginning of the growing season and shutting them down at the end, and maintaining pump operation to keep the canal filled in the interim. In many respects the issue of water distribution among farmers on large-scale schemes is similar to that on PIVs, except that on the latter farmers also control the pumping system. However, whereas on PIVs the organisation of water distribution is integral to the operation of the PIV, this is not always the case on large-scale schemes in the delta, where farmers readily identify *groupements* which have agreed a sequence for irrigating individual plots, and those which have not.

Where irrigation of plots has been organised according to an agreed rotation, there is a feature noted by Diemer and van der Laan (1987, p133) on PIVs of the middle valley, which is found also in large-scale schemes. This is that the irrigation schedule stipulates only the sequence in which individuals can take water, not the quantity nor duration. Thus, each irrigator takes as much water as he or she wishes, before giving way to the individual next in the sequence. Diemer and van der Laan (1987) state that this system provides a very equitable distribution of water between participants on the PIVs. However, interviews carried out during my own fieldwork suggest that the system can give rise to serious inequity of access, particularly at the start of the growing season, if those at the rear of the sequence have to wait a long time for their turn. On the perimeter of Nianga, a delay of two weeks to a month was said to occur in completion of a complete cycle of irrigation. A delay of this magnitude at sowing time could easily reduce the potential yield of the crop. One reason given for such a delay was lack of maintenance of the tertiary canal system, which reduced flow rates and increased the time required to apply a given amount of water to the fields.

A second way in which existing water distribution systems may not achieve equity is of more importance on PIVs where variations in soil type give different rates of drainage for different plots. Under these circumstances, faster-draining plots require more frequent irrigation than slower draining plots, especially for rice. Where irrigation (pumping) intervals are adjusted to meet the demands of slower-draining plots, serious drop in yield could be expected on the plots that dried out faster. There were indications in at least one interview, at Dioude Diabé (Ile à Morphil), that a majority of participants in a PIV were unwilling to increase pumping frequency (and hence production costs) to supply water more frequently to a minority with faster-draining plots.

Whether these precise mechanisms operate in many cases or not, what is clear from my own fieldwork and the account given by Diemer and van der Laan (1987,p133) is that the productivity of different plots on PIVs in the middle valley varies greatly, and in a significant minority of cases (nearly a fifth in the PIV of Boké Mbaibé and Salsalbé in 1988) participants lose their crop. While on PIVs inequity of production can only be attributed to farmers' internal organisation, on large schemes deficiencies in the operation of the main system can exacerbate the potential for inequitable water distribution between farmers by delaying the arrival of water at the start of the season. A major reason for such delays is the

failure to keep the principal canal system free of weeds and silt, which on large irrigation schemes is the reponsability of the SAED management.

In this and the preceding section we have identified some of the main characteristics of the state-sponsored irrigation development in the senegal river valley. We may briefly summarise these as follows. The diverse organisation and scale of irrigation in the valley has been strongly shaped by local demographic, topographic, and socioeconomic differences. However, the introduction of irrigation has generally incorporated a principle of equity of access to irrigated plots for *households*. There is evidence, however, that the this formal equity masks substantive inequity, both in relation to traditional independent cultivation rights of individuals within households and in relation to the effective rights of households to irrigation water. The erosion of independent cultivation rights for women and young men as a result of irrigation development has resulted in the emergence of women's and youth organisations to seek access for these groups to land (from rural councils) and pumping equipment (from development agencies). In addition to this competition for water and land between different elements of rural communities, land for irrigation has been allocated to individuals and groups from outside the valley, as part of the government's policy of encouraging private investment in commercial agriculture. It is against this background of conflicting interests that the SAED disengagement has been implemented. In the following section we describe this process in more detail.

4. The Disengagement of SAED

4.1 The programme

The Nouvelle Politique Agricole (NPA), announced in 1984, stated that the SAED would begin a programme to terminate its activities over a period of five years in order that these would be taken over by "private operators and peasant organisations" (Afrique Agriculture, 1986,p27). The process was to be effected in stages. In the first stage, from 1984 to 1987, SAED was to withdraw from the provision of credit, the supply of inputs, and rice marketing. Preparations would be made to withdraw, in a subsequent phase from the operation of the rice mills, machinery repair and maintenance, and from the operation and maintenance of the primary infrastructure on the large canal systems. A first step in these preparations was the formation of four autonomous management units to run these continuing SAED activities until they could be handed over to commercial operaters. These units were: URIC to run the rice mills, UAC to run the central machinery workshops at Ross Bethio, UGE to manage the water supply to the large perimeters, and UARE to carry out maintenance on existing irrigation infrastructure and to to carry out new irrigation works. The last two were also based at Ross Bethio, in the middle of the delta area where the majority of large perimeters are situated.

Of the functions from which SAED was to withdraw immediately, agricultural credit was to be taken over by the Caisse National de Crédit Agricole de Sénégal (CNCAS), a mixed state and commercial bank set up in 1984. The supply of fertilizers and pesticides, together with the provision of agricultural machinery was to be undertaken by commercial enterprises. Marketing of paddy was to be the responsibility of the *Sections Villageoises* (SV), SAED merely paying for paddy delivered to the rice mills. The remainder of this section

summarises the implementation of this SAED withdrawal based on fieldwork carried out in January-March 1989. During this period, interviews were held with SAED officials, commercial traders, and members of farmers' organisations in the delta (on the large perimeters Lampsar, and Grand Digue-Tellel-Kassak), and in the middle valley (at Guedé, Nianga, and on the Ile à Morphil).

4.2 Credit

Although CNCAS was established in 1984, it was not until 1986 that a protocol was signed between CNCAS and SAED establishing the conditions for farm credit in the Senegal river valley. In the meantime SAED resorted to increasingly drastic efforts to recuperate accumulated debts from peasants on large-scale perimeters, culminating in the refusal to supply water and the effective closure of over 5500ha of the irrigation system in 1986 (Dieye,1988; SAED,1986,p7; OMVS 1987,pp4,21). The rainy season of 1987 was the first in which CNCAS credit was used to finance input purchases, with a total of 110 million cfa credit extended to farmers' groups in the delta considered to be creditworthy. Of this about half went to SV cultivating the large-scale perimeters, with the remainder going to a total of 12 *Groupements d'Interêt Economique* (GIE). These credits, together with smaller loans advanced for growing cool season tomatoes and a dry season rice crop, were all repaid in full, a total of 174 million cfa over the whole 1987-88 agricultural year. In the following rainy season of 1988, a total of 550 million cfa was advanced in credit for the rice crop, of which only 126 million was to farmers in the middle valley through CNCAS branches opened in Podor and Matam. The remaining 424 million was used in the delta, with approximately 40% going to SV, 40% to GIE, and 20% to *foyers*.

The terms of CNCAS credit are that, firstly the borrower must deposit 15% of the value of the loan, secondly that interest is paid at 14% on the loan, and thirdly that farmers organisations are collectively responsible for repayment. This last condition means that it is up to each organisation to recoup debts from its individual members. Under the protocol agreed between SAED and CNCAS, all applications for CNCAS credit must first be checked by the local SAED delegate and must carry written SAED approval. Given the large number of organisations with debt repayments in arrears with SAED, the CNCAS loans have frequently been granted on the condition that outstanding debts to SAED be repaid over a 3-year period. Some evidence emerged from interviews, however, to indicate that repayment priorities were likely to be given to (current) CNCAS loans, and that, if these were repaid, CNCAS was unlikely to press hard for the repayment of SAED arrears. At the time that field work was undertaken, final records of credit used and repaid were not available. Analysis of credit notes used to pay suppliers of goods and services (who later cash these at CNCAS), indicate however that about 75% of the credit agreed by CNCAS with farmers organisations in the delta was actually used, and that about 40% of this was used to pay for machinery hire, 45% for fertilizer, and the remainder for herbicide.

As indicated above, CNCAS credit plays a larger role in financing input purchase in the delta than in the middle and upper valley. This is for a number of reasons. Firstly, following the announcement of SAED withdrawal, a number of foreign development agencies involved in the construction and management of irrigation in the middle valley (e.g. FED-European Community in Podor, KFW-West Germany in Nianga, Netherlands government in Ile à

Morphil) financed the provision of a fund of working capital for each farmers irrigation group within their project area, thus reducing the need for CNCAS credit in some areas. Secondly, alternative income sources, from livestock sales and from non-farm (often migrant wage income) sources had previously played a significant role in financing input purchases, so that withdrawal of SAED credit was less important. Thirdly, mechanised tillage is not generally used on PIVs so that direct production costs are lower. Finally, on small-scale perimeters payments were often spread throughout the growing season because inputs were only purchased when they were needed.

Withdrawal of SAED from the supply of inputs such as fuel and fertilizer, seems likely to make credit more important, however, because although commercial suppliers may have facilities for storing fuel (where they also sell to transport operators, for example), it is unlikely that they will do so for fertilizer. Van Tilberg (1989) noted that grain traders in Senegal never make purchases in order to keep grain in store, and the experience of the 1988-89 season in the Senegal river valley suggests that this is largely true of traders in fertilizer (see below). Absence of local fertilizer stocks will mean that farmers' irrigation groups must order all their inputs from traders in advance, tying up more cash for the whole growing season. However, long lines of communication between the CNCAS in St Louis and the villages of the middle valley have caused delays in the release of credit. At least one village irrigation group contacted, that of Boké Mbaibé and Salsalbé, had, as a result of delays in CNCAS credit, sought and obtained an alternative source of working capital by negotiating to use cash deposits made under the world food programme (nominally reserved for capital investment projects) for this purpose. However, not all farmers in the village were prepared to accept the risk of paying for a whole season's fuel and fertilizer in advance, and only 10ha out of the total perimeter area of 18ha was to be cultivated. This highlights the important point that the withdrawal of SAED has shifted the burden of risk decisively onto farmers. It may also be noted that, since traders supply no goods on credit, the CNCAS loans paid for (in the form of interest) by farmers effectively increase traders' sales at no cost or risk to traders themselves.

4.3 Input Supplies

Following the initial announcement, in 1984, of its withdrawal from the supply of inputs, SAED decided to stop supplying pesticides immediately, as an "experiment" to assess the capacity of commercial suppliers and farmers to take over. The result was a collapse in pesticide use with serious reduction in yields, particularly in the tomato crop in 1985-86 (SAED, 1986). The following year SAED began supplying pesticides again, and continued to do so until the 1988 rainy season, which was the first occasion on which fertilizer and pesticides were supplied by commercial enterprises.

Fertilizers used in the principal (rice) crop in the Senegal river valley are urea (46% nitrogen) and diammonium phosphate (DAP: 18% nitrogen, 46%P2O5). DAP is manufactured by SENCHIM in Senegal, and imports are not permitted. Urea is imported, in theory by any organisation which wishes to do so. In practice SENCHIM is the only organisation that imported urea for the 1988-89 agricultural year. Interviews with the SENCHIM management in Dakar indicated that the annual fertilizer consumption of the Senegal river valley, excluding the sugar estate at Richard-Toll, was 6500tonnes, a figure

they consider less sensitive to changes in fertilizer prices than the consumption of fertilizer within the country as a whole, which fell spectacularly by 70 percent after the removal of fertilizer subsidies in 1984 (Commander et al. 1989). A question frequently posed is whether the withdrawal of SAED would significantly reduce the amount of fertilizer applied by farmers, with negative effects on rice yields. The available evidence suggests that this has not happened in general terms. Firstly, SENCHIM records indicate a total of 3450tonnes of SAED stock outstanding at the beginning of the 1988 rainy season, which are believed to have been sold, and a further 3375tonnes sold to traders supplying the valley, giving an overall total of 6825tonnes for the 1988-89 agricultural year. At the level of individual farmers or their organisations a more variable pattern can be discerned, in which fertilizer rates applied appear to depend on farmers' assessment of the other constraints on crop growth. Thus, where growing conditions are good (e.g SV Thilene, in the Lampsar perimeter) fertilizer rates are above those recommended, but where irrigation is problematic, as in the case of the SV Tellel Peuhl who occupy land at the tailend of the Grand Digue-Tellel-Kassak perimeter, fertiliser use is less than half that recommended, and in individual cases is zero.

As in the case of credit, fertilizer supply difered markedly between the delta and the middle and upper valley. In the delta, fertiliser availability does not seem to have been a problem for farmers growing the 1988 rainy season rice crop. The concentration of large-scale irrigation and the relatively short road distance (300km) to Dakar, presents traders with a good prospect of finding buyers for large consignments of fertilizers. In the middle valley, however, irrigated perimeters are small and dispersed, and access is limited by bad roads which may become impassible during the rainy season. Under these conditions few traders are interested in supplying fertiliser to individual villages, and in the Ile à Morphil, for example, the local SAED administration had to intervene to secure fertilizer supplies in the 1988 rainy season. It did this by organising contacts between suppliers and village irrigation groups, and by maintaining a local stock of 100tonnes of urea for cash sale to irrigation groups in the Ile à Morphil area. This is considered a short-term stop gap, however, and the Ile à Morphil SAED director feels that in future individual PIVs will need to combine their fertilizer orders and delivery points in order to make the deal sufficiently attractive to traders.

To summarise, therefore, the first season after the SAED withdrawal has seen a fairly ready development of commercial trade in fertilizers, and in the associated trade in pesticides, in the delta, but not in the middle valley, where shortage of agrochemicals may well constrain their use. Overall, there is no evidence of declining fertilizer use in irrigated agriculture, but there is a great deal of variability in fertilizer use which seems to reflect farmers' assessment of the potential productivity of their crop: where the potential is high, fertilizer rates are high; where potential is low or uncertain, farmers purchase less fertilizer. Two factors above all others seem to condition this potential: firstly the reliability of irrigation, and secondly - relevent in the delta rather than in the middle valley - the availability of agricultural machinery. The impact of SAED withdrawal upon each of these factors will now be considered.

4.4 Machinery Use

Mechanised tillage has always been practised on the large perimeters of the delta. In the middle valley farm machinery has been less important because the small plot size (0,2-0,3ha) and the lighter texture of the *fondé* soils of the PIVs meant that hand cultivation is feasible. The larger plot size of the new "intermediate" perimeters now coming into production at Dioumandou and SaldéWala makes it likely that the impact of mechanised tillage will soon be more widely felt in the middle valley, but the remarks that follow refer principally to the situation of the delta.

The withdrawal of SAED from the provision of agricultural machinery was implemented through two principal means. Firstly, the centralisation of all equipment operation and maintenance in the newly-formed Unité Atelier Central (UAC) at Ross Bethio to improve efficiency and to prepare for privatisation (SAED, 1986 p24); secondly a policy of reducing the work carried out by the tractor fleet in order to allow commercial tractor hire to take over. This latter policy was implemented by not carrying out repair work, but instead taking SAED tractors out of service when they required repair. In the 1988 rainy season UAC estimated that about 85% of tillage in the delta was undertaken by private tractor operators, which would correspond to about 10700ha. CNCAS credit notes indicate that about 60% of this was financed with CNCAS credit.

Although many individuals and organisations in the delta operate tractors, the bulk of the hiring is done by a few companies. One of these, SOGEC based in St Louis, operates a fleet of four tractors which were hired to cultivate a total of 3700ha for the 1988 rainy season. This corresponds to almost a third of the area cultivated in the delta. By comparison, SAED has some 30 tractors currently out of service awaiting repairs prior to transfer to the private sector. The precise form of such transfer was still under study in 1989, but two consequences of the present situation may be identified. Firstly the eventual re-entry into service of this equipment will have a major impact on the hire market, and, indeed, SOGEC managers stated that they were unwilling to expand their own fleet until the future of the SAED fleet had become clear. Secondly, the existing equipment for hire is extremely scarce, which makes it more difficult for farmers to carry out tillage at exactly the right time. Timing of tillage is critical because it must take place before the release of irrigation water into the main canals, usually timed for late July or early August (in previous years water pumping could only start when the river level started to rise at the beginning of the flood). Tillage carried out too early carries the risk of weed growth in the fields following early rains in July. Effectively, therefore, all tillage for the rainy season rice crop in the delta should be carried out in July. This, coupled with the shortage of tractors, has placed a strong emphasis on speed in tillage operations, and this has resulted in the abandoning of ploughing followed by harrowing in favour of a single pass with an offset disc harrow. Whether this has any detrimental effect on rice output is the subject of some discussion. Several of the farmers interviewed lamented that they would prefer to plough their fields, because, although twice as expensive (35000 cfa/ha instead of 17000 cfa/ha for a single offset pass), it would deal more effectively with perennial weeds, and in particular the *riz au rhizome* (*Oryza longistaminata* A.Chev.et Roehr) which had become so bad that whole fields had been abandoned to it. Research by WARDA/ADRAO indicates that the offset harrow may in fact be quite effective in controlling this weed , but only if used twice, with an

interval sufficiently long to allow the drying out of the rhizomes and their physical removal from the field (van Brandt, 1982). In short, a practice which requires considerable time and labour. Other farmers, notably in Thilene, pointed to another, more fundamental, factor causing weed infestation: reduced drainage. This results in greater moisture availability for weed growth outside the cropping season, and can keep the soil too wet for mechanised cultivation.

Until the SAED tractor fleet has been finally transferred to private hands, it will not be possible to see the final pattern of machinery use. Discussion within SAED centres on possible patterns of ownership and use of machinery, and a preferred option appears to be to equip the *Sections Villageioses* with their own machinery for hire to their own members, along the lines followed with some success for five years by the "Sections d'Utilisation de Machines Agricoles" (SUMA) on the Nianga perimeter (Podor). However, it is clear that irrigation and drainage conditions will have a major impact upon the efficiency of machinery use, and it is this aspect of SAED disengagement that we shall consider next.

4.5 Irrigation

Within the plans drawn up for SAED withdrawal, no timescale has been established for the transfer to the private sector of its management of the supply of irrigation water. Instead, the 3-year programme starting 1987 laid down that SAED should begin charging farmers the "true cost" of its services. Since the role of SAED in the supply of irrigation on large perimeters differs from that on PIVs, each case will be considered in turn. On the PIVs of the middle and upper valley SAED carries out the maintenance and supplies spare parts for the diesel pumpsets which supply water from the river. Farmers' organisations pay for the cost of all parts and materials (oil, filters etc) but not for the mechanic's time. There is little sign of change in this policy.

On the large perimeters SAED has a more central role in water supply, with responsiblity for operation and maintenance of the large pumping stations and the main water distribution and drainage canals. For this service farmers pay a fixed charge each growing season, which was increased in 1985 from 25000cfa/ha to 41000cfa/ha for rice.This increase coincided with a reorganisation whereby the operation and maintenance of water supply on large perimeters, previously the responsibility of managers at perimeter level, became centralised at delegation level. In practice this only affected the large perimeters in the delta, as the two large perimeters in the middle valley, Nianga and Guedé, were allowed to retain their autonomy. In the delta a Unité de Gestion d'Eau (UGE) was formed, with two principle divisions based at Ross Bethio: "Gestion Hydraulique", responsible for planning water distribution and invoicing farmers; and "Exploitation", charged with operation and maintenance of the large (electric) pumping stations supplying the canal network, and with planning the annual programme of canal maintenance. However, the execution of canal maintenance was to be contracted out to another Unité based at Ross Bethio: l'Unité de la Régie d'Aménagement et d'Entretien (URAE), into which had been gathered all the canal maintenance equipment previously under the control of individual perimeter managements.

As with the formation of UAC, the centralisation of earthmoving machinery into a central URAE appears to have been motivated partly by a desire to improve the efficiency of equipment use and partly by the intention of forming a unit suitable for privatisation.

However, whether through shortfalls in foreign funding due to a fall of the value of the dollar in 1985 (SAED,1986 p15), or to competing commitments to undertake construction of new irrigation, the outcome for canal maintenance appears to have been little short of disastrous, with weed growth so serious in the principle drains that farmers at Thilene (Lampsar) complained that their cultivable area was being reduced by waterlogging. The deterioration of drainage was felt particularely acutely in the 1988 rainy season because heavy rain increased the water to be drained. At Debi Mboundoum perimeter some 400ha were so waterlogged that the rice crop could not be harvested. Under these circumstances SAED acknowledges that it can hardly expect farmers to pay the "true cost" of canal maintenance - commonly given as 30000 cfa/ha in addition to the existing 41000 cfa/ha charge - which SAED is unable to guarantee will be carried out (SAED, 1986 p25).

4.6 Rice marketing

The major step taken in SAED withdrawal from crop marketing is to transfer to farmers the responsibility for loading and transport of paddy to the mills. SAED remains in charge of the three rice mills in the Senegal river valley, pending their refurbishment and transfer to the private sector. In principle SAED only buys rice delivered to the mills. However this principle is fully implemented only in the delta, where the farmers' organisations record the amounts marketed by individual members, put the paddy in sacks and hire transport to the mill. In the case of the PIVs in the middle valley, however, transport scarcity, and the relatively small quantities of paddy marketed by individual villages have meant that this element of SAED withdrawal has not been implemented. On the Ile à Morphil, for example, SAED buys paddy in the villages, and undertakes the transport to the mills.

SAED purchases paddy for 85frs cfa/kg, payment being made 10-14 days later. This price, increased from 66frs cfa/kg in 1985, leaves practically no milling margin with the consumer price fixed at 130frs cfa in April 1988, and thus reduces the scope for purchases by commercial traders. This, together with prompt payment in recent years, has sharply increased the percentage of paddy marketed through SAED. In earlier years, delays in SAED payments coupled with farmers' need to pay seasonal harvest labourers resulted in paddy sales to private traders for as little as 50 frs cfa/kg. SAED is able to pay the higher price for paddy because it receives 180frs cfa/kg for milled rice (38% above the consumer price) from the government Caisse de Péréquation et de Stabilisation des Prix (CPSP), which in turn finances its purchases from profits made on handling cheaper-priced imported rice. The SAED records of output and marketed paddy are given in table 3.

Table 3 Estimates of paddy production compared to records of official SAED purchases of paddy, 1982-1988.

season	paddy production tonnes	marketed paddy (SAED) tonnes	as % of prodn.
1982/3	54300	20115	37
1983/4	75411	25520	34
1984/5	77188	15695	20
1985/6	80955	21973	27
1986/7	80799	18969	23
1987/8	85371	30686	36

source: section suivi et evaluation, SAED.
N.B. paddy production data are estimates from crop samples.

In this section we have set out briefly how the State development corporation SAED has carried out its withdrawal from the provision of agricultural inputs and services in the Senegal river valley, and some of the immediate effects. These may be summarised as follows. Where the process has advanced most, as in the provision of credit, agrochemicals supply and rice marketing, there has developed a discernable advantage in favour of the delta, where communications are better. Here, a market in agrochemicals supplied by commercial traders has effectively been established, although all the cost of credit for this trade is paid (at 14 percent interest) by farmers. In the middle valley, however, the privatisation process has not yet generated a commercial alternative to intervention by SAED or development agencies, particularly for the PIVs. Where state withdrawal has been less complete, as in farm machinery rental and in the operation and maintenance of irrigation, there is evidence that that the pre-privatisation reorganisation of SAED has resulted in a deterioration and greater scarcity of provision of these services. This is particularly apparent on large perimeters, where inequity in access to water and, to a lesser extent, machinery, can be seen to cause great disparity in agricultural productivity.

In the following section we will discuss how these changes have influenced trends in irrigated farming systems in the delta and middle valley, and use them to assess whether the "disengagement" of the state is likely to achieve its objective of promoting a rapid increase in irrigated food output from the Senegal river valley.

5. Irrigated farming in the aftermath of state disengagement.:

5.1 Effects on farmers' irrigation organisations

Table 4 shows how the distribution of irrigated area between different types of perimeters has changed over time.

TABLE 4 Net irrigable area totals for different types of perimeter (data from OMVS 1988)

year	1976	1980	1984	1987	1988
large perimeters	7083	9465	12577	12989	12940 ha
small perimeters (upper/middle valley)	352	3577	7271	11991	12783 ha
small perimeters (delta)	691	1191	2191	4315	5853 ha
Total	8126	14233	22039	29295	31576 ha

Table 4 shows that while the area of large perimeters remained static between 1984 and 1988, small-scale irrigation was extended so that it now accounts for more than half of the total irrigated area on the southern bank of the Senegal river. Although the largest absolute increase in small-scale irrigation took place in the middle and upper valley, the fastest expansion rate (160% in four years) was in the delta, where small diesel pumpsets now irrigate an area corresponding to 45% of the total surface under large-scale irrigation. This is of particular interest because the organisations responsible for these small perimeters are generally *non-encadré*, that is, outside the responsibility of the SAED. This sector, which the policy of state withdrawal is intended to encourage, is made up of three different forms of organisation, which are distinct from the *Sections Villageoises* on SAED perimeters. They are: *foyers*, *groupements d'intérêt économique* (GIE), and private farmers. The last of these are often urban-based and/or with trading activities. Their farming interest centres on high-value fruit and vegetable production. The *foyers* and GIE seemed more often derived from rural communities, and more concerned with growing rice. The GIE are a variable form of organisation, the name being widely applied to any form of cooperative or business partnership (on closer inspection some GIE have occasionally been found to have only one member). In the three cases visited on the Grand Digue-Tellel-Kassak perimeter, the formation of a GIE to run small-scale irrigation was a means whereby wealthier members of the *Section Villageoise* provided access to irrigated land for their less wealthy or landless relatives.

The role of irrigation infrastructure in establishing "irreversible" land tenure was noted earlier (in section 3.1) in the context of the middle valley. It is possible to see in the recent proliferation of small-scale irrigation in the delta a similar and accelerating struggle for land tenure in which wealthy individuals from urban areas are active.

Many younger people participating in new irrigation through *foyers* or GIE are members of families which have plots in large perimeters. Therefore, a multiplicity of irrigation organisations may exist within a single village. The example of the village of Thilene may

illustrate this. The village has a Section Villageoise with 66 members with rights to farm 105ha of irrigated land within the (large-scale) Lampsar perimeter run by SAED. The village youth association (*foyer*), formed in 1976, acquired a perimeter of 20ha, irrigated with a diesel pumpset and with infrastructure constructed with SAED assistance in 1981. This was subsequently extended to 30ha and farming diversified to include tree plantations, bananas and market gardening, as well as rice production. Two years ago the SV and the *foyer* both invested in another small perimeter of 35ha, on which 32 participants occupied plots of 0,5-1ha each to grow rice in the 1988 dry season. Significantly, the arrangements for credit (with CNCAS), input supply (with traders), and rice marketing (with SAED) are formally handled for all three irrigation organisations in Thilene village by the SV, although the *peseur* - charged with keeping records of all purchases and sales by individual members - is in fact a member of the *foyer*. In this case the organisation of small-scale irrigation may be thought of as constituting additional autonomous *groupements* which, like the six *groupements* which are responsible for organising irrigation management on the large-scale perimeter, uses a single village-level entity (the *Section*) to administrate commercial transactions.

It is not clear that such a close link between large-scale and small-scale irrigation exists in all other villages, but the emergence of such an organisation suggests that to the logic of organisation for water management the disengagement of SAED has added a logic of organisation to meet financial objectives. Thus, a distinction is emerging on large perimeters of the delta area between the *groupement*, concerned primarily with irrigation management on areas of 15-30ha, and the *section*, concerned with administering the commercial activities of farmers at village level, thus embracing several *groupements*. A further development along the same lines is the SUMA on the Nianga (Podor) perimeter, where the *section* also has responsibility for operating and hiring agricultural machinery. While large settlements , such as Ross Bethio, may contain many *sections*, the separation within farmers' organisations of day-to-day irrigation management from input supply and crop marketing finds echoes in developments in the middle and upper valley: in the regional federation of small-scale irrigation groups in the Bakel area, and in the proposal by SAED director on the Ile à Morphil that villages should collaborate in groups of 10-15 to improve their bargaining power with traders and transporters over the supply of inputs and the marketing of paddy. Evidently, such collaboration between villages will be more difficult than the administration of the same activities within a single village, but, given the lack of interest on the part of traders, there may be no alternative if input supplies are to be secured in that area.

Counterposed to these trends towards greater collective organisation are two features of the disengagement process which may open the way for greater differentiation among farmers. Firstly, the available evidence, discussed earlier, indicates that present systems of distribution of water within the *groupement* do not ensure equity, to the extent that it is not uncommon for one or more members of a *groupement* on either large or small perimeters to lose their crop entirely because of inequitable water distribution within the *groupement*. With the advent of collective reponsibility for loan repayment, such inequity in irrigation is translated into indebtedness of disadvantaged farmers towards other members of the *section*. Failure to pay these debts can and does result in the debtors' loss of cultivation rights, which are generally taken over by somebody prepared to pay off the outstanding

debt. The question of whether such a process is leading to the accumulation of cultivation rights in the hands of fewer landholders requires further detailed study.

Secondly, the scope for inequitable accumulation is enhanced by reduced availability of both land and water caused by the deterioration of main canals on large perimeters in the delta, which was reported above to have taken place as a result of the reorganisation of SAED associated with its disengagement.

5.2 Production Costs

In this section we shall present data on costs of rice production obtained from interviews with farmers, and from comparisons with previous studies, which we will use to assess the impact of disengagement . In this discussion production costs will be taken to mean only *cash* costs (i.e. excluding family labour).

Table 5 summarises data for production costs on individual holdings, obtained in interviews with farmers on large perimeters. The data show particularly the large spread of yields obtained by different members of the same *Section Villageoise*. As a consequence, while production costs accounted for between 34 and 49 percent of the value of the crop on the highest-yielding holdings, costs equalled or exceeded the value of the crop on the poorest plots in every *Section Villagoise*. It should be emphasised that only a handful of farmers were interviewed on each perimeter, so that the incidence of low-yielding plots may be considered commonplace.

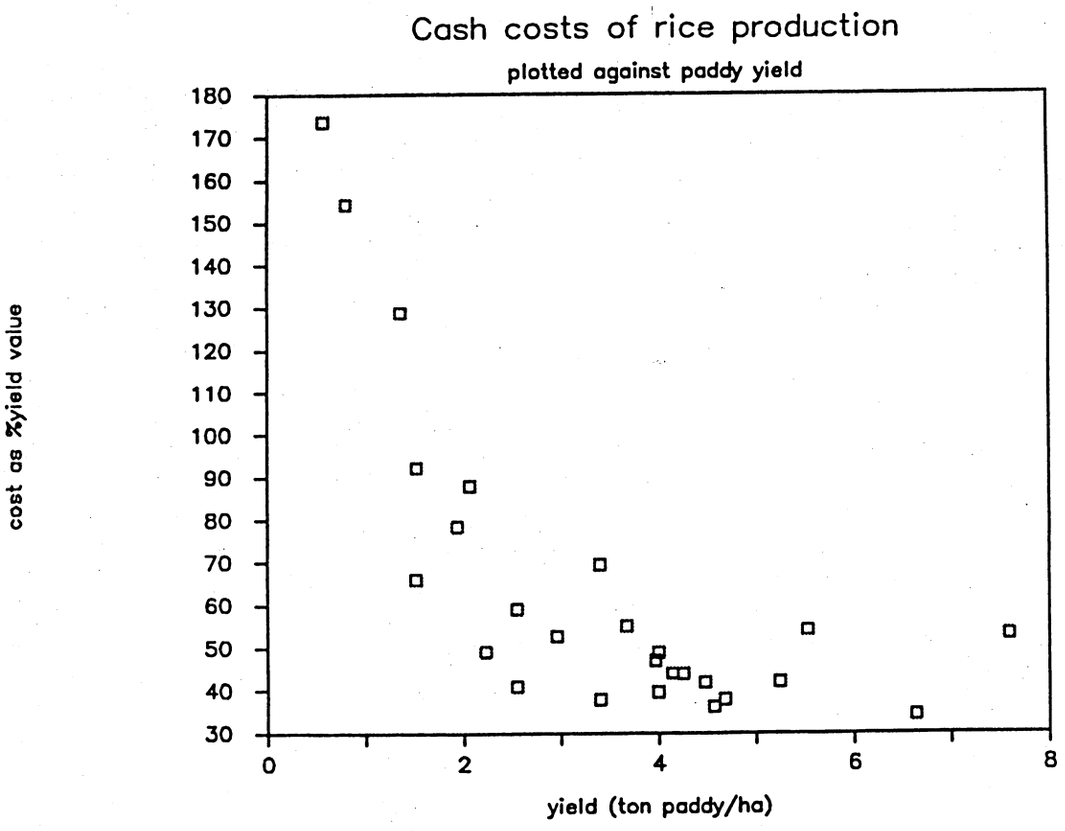
Table 5. Breakdown of direct cash costs of production of irrigated rice in four different Sections Villageoises on large perimeters in the Senegal river valley, 1988 rainy season.

Section Villageoise	Cost Breakdown: CFA Francs/hectare							Yield	(paddy)	Costs as
	water	agrochem	machin	seed	harvest	interest	Total	kg/ha	value cfa	% of yield value
Tellel-Peuhl II										
(Grande Digue-Tellel-Kassak Perim.)										
mean (of 5)	41000	9901	20600	9838	15624	0	96963	2171	184595	52
highest	41000	11550	35000	12390	34500	0	134440	3995	339575	39
lowest	41000	13083	17000	9916	2666	0	83666	566	48166	173
Diagambal										
(Lampsar Perimeter)										
mean (of 5)	41000	45869	17000	20032	15187	7076	146166	2678	227696	64
highest	41000	61425	0	14160	42420	7309	166314	4000	340000	48
lowest	41000	20270	17000	21048	1655	4435	105409	804	68344	154
Thilene										
(Lampsar Perimeter)										
mean (of 6)	41000	41958	17000	14191	53843	7148	175143	4202	357200	49
highest	41000	59725	17000	21013	45000	9130	192870	6636	564143	34
lowest	41000	29295	17000	10170	16666	5509	119641	1525	129679	92
CUMA-Pilote										
(Nianga Perimeter)										
mean (of 3)	41000	43565	15666	9085	52819	0	162136	3758	319464	50
highest	41000	43250	15000	11900	75720	0	186870	5241	445541	41
lowest	41000	45128	17000	7628	38000	0	148757	1358	115476	128

In figure 1, the costs of rice production on individual holdings on large perimeters have been expressed as a percentage of the value of paddy produced and plotted against yield. The scatter of points indicates a fairly consistent pattern in which farmers' margins over costs seem little related to yields until yields decline below about 2.25t/ha.

In order to illustrate this further the same data was grouped into three classes according to yield, and the mean values for each class are given in table 6. Total costs in the highest yield class (over 4.5t/ha) are on average 77 percent higher than in the lowest yield class (less than 2.25t/ha). Despite this greater absolute magnitude, however, the cost of producing a yield of more than 4.5 t/ha accounted for an average of 42 percent of the yield value, compared to 90 percent for yields of less than 2.25 t/ha. The reason for this can be found in the individual components of production costs, which include fixed elements, such as water charges (paid to SAED) and tractor hire. Further, even inputs on which farmers can economise, such as fertilizer, are not reduced in proportion to yields. It is also of little compensation that a major reduction in costs is achieved in lower harvest expenses on low-yielding plots.

Figure 1.



Comparison of these data with those of earlier studies of production costs, also given in table 6, prompts two main conclusions:

Firstly, comparing production costs for similar yields, these account for a higher proportion (42 percent) of yield value in 1989 than they did in 1982-83 (26 percent). However, most of this relative increase is found in only two cost components: agrochemicals, whose share of crop value has more than doubled, and harvest expenses. This latter may indicate a higher degree of mechanisation, or a higher proportion of seasonal labour paid in cash, than in 1982-83. The other cost components (irrigation charges, seed, machinery hire) have shown little increase relative to the increase in the cash value of paddy.

The second point to emerge from the comparisons in table 6 is that low yields seem not to have figured in previous studies of rice production costs. The implication of the "high input" and "low input" alternatives posed by Martin (1988) are that yields are driven by input levels, and that there are no serious constraints to the effectiveness of such input use. The data presented here, although not quantitatively representative of large-scale irrigation in the Senegal river valley suggests that considerable numbers of farmers produce yields so low that they are unable to even repay their production costs. The analysis above, taken with additional information collected in interviews suggests that the major factor determining such low yields is inadequate, or delayed, supply of irrigation water.

Table 6: Breakdown of direct cash costs of production for different levels of yield of paddy on large irrigation schemes in the Senegal river valley
Data from 1988 rainy season and from previous studies (1,2)

Production costs: CFA Francs/hectare								Yield/ha		cash cost/kg
Data source	water	agrochem.	machin	seed	transp+ harvst	intrst	Total	kg paddy	Fcfa value	paddy
1988 rainy season (1989 Fieldwork)										
Yield class										
<2.25t/ha	41000	27132	17000	11315	15320	3203	114972	1501	127627	76
% of yield:	32	21	13	8	12	2	90			
2.25-4.5t/ha	41000	38649	25170	16132	24064	4927	149944	3474	295322	43
% of yield:	13	12	8	5	8	1	50			
>4.5t/ha	41000	47819	16200	14049	78841	4867	202778	5742	488098	35
% of yield:	8	10	3	2	16	1	41			
ENDA 82-83(1)										
Lampsar	25245	8506	9396	9285	1351	0	53783	4950	254925	10
% of yield:	9	2	3	3	0	0	21			
Dagana	23796	9684	9222	8269	5118		56089	4186	215579	13
% of yield:	11	4	4	3	2	0	26			
Martin/MSU 86 (2)										
large perimeter										
high input	41000	42300	12800	10000	36555	0	142655	5000	425000	28
% of yield:	9	9	3	2	8	0	33			
low input	41000	15068	12800	12000	29755	0	110623	4000	340000	27
% of yield:	12	3	3	3	8	0	32			

(1) data from Engelhard et al. (1988), pp159 and 169.
(2) data from Martin (1988) anex 3.1

Data on costs of production in small-scale irrigation have been assembled in table 7. The information on current production costs covers small perimeters in the delta and PIVs on the Ile a Morphil (Middle valley). Data from previous studies covers only the PIVs of the Middle valley.

The present study produced fewer records of production costs on individual holdings on small-scale perimeters than on large-scale schemes, and the analysis is necessarily less detailed. The data in figure 7 indicate the different cost structure of the small perimeters in the delta, compared to those in the middle valley. The main difference lies in the larger plot size (about 1ha) in the delta, with consequent higher costs for mechanised tillage and herbicide use. With the exception of water pumping, the technology on small perimeters in the delta is the same as that on the neighbouring large schemes, and overall cost levels are comparable.

Table 7 Breakdown of direct cash costs of production of rice on small-scale irrigation in the Senegal river valley. Data from 1988 rainy season, and from previous studies.

	PRODUCTION COSTS: CFA Francs/hectare									YIELD		
	amortizn		running				transport+			kg	Fcfa	cash cost/kg
Data source	pump	perim. repair	pump	fert	mach	seed	harvest	interest	TOTAL	paddy	value	paddy
1988 rainy season												
delta: (with pump amortization)												
GIE/R.Bethio II	22727	5000	29909	26900	18500	15340	24727	0	143103	5254	446636	27
% of yield	5	1	6	5	4	3	5	0	32			
PIV Thilene	20000	6000	31500	15400	17000	12757	40540	7604	150801	5743	488175	26
% of yield	4	1	6	3	3	2	8	1	30			
Foyer Thilene	27270	0	44986	40743	17000	14160	10837	12828	167825	2302	195737	72
% of yield	13	0	22	20	8	7	5	6	85			
Average	23332	3666	35465	27680	17500	14085	25368	6810	153910		376849	
% of yield	6	0	9	7	4	3	6	1	40			
delta : (without pump amortization)												
GIE/R.Bethio I		3000	16182	28400	17000	14160	8670	0	87412	1020	86700	85
% of yield		3	18	32	19	16	10	0	100			
Foyer Diagambal		0	31862	34250	17000	18000	13928	9890	124931	2959	251584	42
% of yield			12	13	6	7	5	3	49			
Average		1500	24022	31325	17000	16080	11299	4945	106171		169142	
% of yield		0	14	18	10	9	6	2	62			
Middle Valley (Ile a Morphil)												
PIV Boké MBaibé-Salsalbé			60000	9375	0	8000	0	0	77375	2975	252875	26
% of yield			23	3	0	3	0	0	30			
GIE Saldé			32965	23669	0	14289	0	8109	79033	3500	297500	22
% of yield			11	7	0	4	0	2	26			
avge			46482	16522	0	11144	0	4054	78204		275187	
% of yield			16	6	0	4	0	1	28			
ENDA 82-83(1)												
PIVs in Matam												
(total 1207ha)	0		32853	8031	3896	2820	2078		49678	5160	265740	9
% of yield	0		12	3	1	1	0	0	18			
Martin/MSU(2)												
PIVs/Middle Valley												
(1986 season)	14250		42875	30013	1154	5000	36965		130257	5000	425000	26
% of yield	3	0	10	7	0	1	8	0	30			
Bastiaansen(3)												
1987-88 PIVs	8333	3000	45700	16250					73283	4000	340000	18
% of yield	2	0	13	4	0	0	0	0	21			

(1) data from Engelhard et al. (1986), p161.
(2) data from Martin (1988),anex 3.3
(3) data from Bastiaansen (1988)

The data in table 7 from the delta have been subdivided according to whether a provision is made for amortization of the pumpset. The lack of any such provision was explained in some cases (e.g. the *foyer* at Diagambal) as due to the fact that the pump was very old and had not cost the group anything to acquire. The figures show that when pump amortization

is included, the cost of providing water with a pumpset is between 50 and 70 000 CFAfrancs, which is greater than the irrigation charges paid on the large perimeters. In fact the amortization is usually calculated over only three years, whereas Bastiaansen (1988) gives an amortization period of six years for pumpsets in the middle valley, so that amortization may prove to be less onerous than present contributions suggest. However, the basic picture to emerge is that, whatever the reasons for small-scale irrigation development in the delta, it is not because it offers a cheaper option for growing rice than the large-scale schemes.

The data for the middle valley are less well defined because individual cultivators pay a uniform contribution to the groupment to cover all operating costs. However the overall cash costs for Boké Mbaibé and Salsalbé, and for Saldé agree with the contributions of 16250CFAfrancs and 14625CFA francs per 0.2ha plot paid respectively on the two PIVs in Dioude Diabe (not in table 7), which correspond to 81250 and 73125 CFAfrancs/ha. These figures also agree with that given by Bastiaansen (1988) for the PIVs on the Ile a Morphil (see table7). However none of these estimates include harvest costs. Martin includes an estimate of harvest costs as eight percent of the harvest. It seems possible that this could be an underestimate, as the charge for threshing paddy in the delta is ten percent. The yield figures obtained in the present study for PIVs in the middle valley exclude the share of the crop retained by the harvesters and hence underestimate the total yield by ten percent or more.

The evidence, though sketchy, suggests that for yields of 3.5 to 4 t/ha cash costs amount to between a quarter and a third of the value of the harvest (sold as paddy) on the PIVs of the Ile a Morphil. The overall cash requirement in the middle valley is about half that on small perimeters in the delta. The difference may be explained not only through the absence of mechanisation, herbicides , and paid seasonal labour for the harvest, but also to the fact that since pumpsets in the middle valley have been "inherited" from SAED, no amortization provision has so far been made.

Comparison of current production costs for rice on PIVs with those in 1982-83 recorded by Engelhard at al.(1986) is complicated by the much higher yield level given in the earlier study. If a similar yield level (5t/ha) is used with the current production costs given in table 7, then cash costs of producing paddy are more or less the same as in 1982-83 (18 percent of yield). That is, production costs and the price of paddy have risen by about the same proportion.

In summary, our analysis of production costs indicates that, although production costs have risen relative to the value of paddy, this is marked only on large perimeters, and on the small perimeters in the delta, where 1989 production costs represented upward of 40 percent of the value of the paddy crop at high levels of efficiency of input use. However, the data from the present study, indicate that that greatest problems occur for farmers not in the area of prices but in avoiding a disastrous drop in yields. We have indicated that variation in water management plays a central role in determining agricultural performance of individual farmers on both large and small perimeters. The disengagement of SAED has resulted in a deterioration in the delivery and drainage of water on large irrigation schemes

on large irrigation schemes which has increased the incidence of unfavourable moisture conditions and hence increased the number of farmers experiencing low yields.

5.3 Effects on the productivity of irrigation infrastructure

Table 8 compares the irrigable area and the area cultivated for rice production in the agricultural years beginning July 1984 and July 1987.

TABLE 8 Irrigable area and area sown with rice in 1984 and 1987, Senegal river valley, left (Senegalese) bank.

agricultural year, starting July:	1984	1987
total irrigable (ha)	21973	29295
area sown in rainy season	16959	13883
area sown in hot dry season	465	3852
Total rice area	17425	17735
rice area as % of irrigable area	79%	60%

(source: OMVS and SAED)

This indicates that rice area has remained static, and this underlies the relatively small (10%) increase in rice production over the period indicated earlier (see table 3). However, table 8 also shows that rice area is declining as a proportion of the total irrigable area, and that it is increasingly distributed over the two growing seasons. There are two principle reasons for this overall pattern. Firstly, the major redistribution of rice growing from rainy season to dry season is the direct consequence of the completion of the Manantali dam, which, together with the barrage at Diama, now ensures a year-round supply of fresh water for irrigation in the delta. Thus, the spread of rice cultivation to the dry season is an anticipated outcome of *l'Après-Barrage*. However, the decline in rice area relative to the total irrigable area indicates a second, unanticipated effect: that land is being used less intensively. This shift in cultivation intensity shows farmers on large schemes in the delta to be following a pattern of farming apparent several years earlier on the PIVs of the upper and middle valley, where dry season irrigation has always been less restricted than in the delta (cf table 1). Summarising this pattern for the PIVs of the Ile a Morphil, Bastiaansen (1988, pp13-14) observed that as irrigable land had increased, so the intensity of cropping had decreased. To illustrate this land use pattern more clearly, table 9 sets out the cropping history of different perimeters visited in 1989, for the previous three seasons.

TABLE 9 Proportion of land cultivated in three successive seasons in different irrigation perimeters, Senegal river valley.

season starting month		cool dry nov.87	hot dry mar 88	rainy july 88	total
perimeter	net irrigable	percent of area cultivated, and crop			
SV Diagambal (Lampsar)	350ha	11% tomato	55% rice	27% rice	93%
Guedé	343ha	44% tomato	16% rice	43% rice	103%
Ile a Morphil Zone Demet (18 PIVs)	421ha	40% maize	16% rice	65% rice	121%
Zone Pété (22 PIVs)	454ha	1% maize	36% rice	22% rice	59%

The table gives two examples from large perimeters (Diagambal and Guedé) and two of irrigation organised in PIVs. With one exception the irrigable land is fairly completely used , but is not cultivated all in the same season. Instead, part of the area is cultivated each season. In the case of the PIVs in the Ile a Morphil, it is more usual for an entire perimeter (15-40ha) to be cultivated in any one season. However, since a single village often has more than one perimeter, production may be undertaken in different perimeters in successive seasons. We can note that within this system farmers may also switch in and out of cultivation of rainfed crops (in the upper valley) of flood recession cultivation of the cuvettes (in the middle valley), whenever rainfall is sufficient.

It is important to note that this multi-season farming does *not* correspond to the double cropping (two crops per year from the same land) which *l'Après-Barrage*, through year-round provision of irrigation, was intended to promote.

Bastiaansen (1988 pp13-14) links the decline in intensity of land use in the Ile à Morphil to the increase in price of inputs in the early 1980s, which he feels was a disincentive to produce rice and which encouraged farmers to grow a cheaper (but less productive) crop of maize, particularly on lighter soils. However, there is evidence that farmers in the middle valley are interested in maize and sorghum not only because they are cheaper to grow, but also because they provide better livestock fodder than rice straw. Dry-season livestock fodder in the Sahel is more valuable than planners of irrigated crop production have recognised: farmers in Dioudé Diabé (Ile à Morphil) claimed that the sale of a single sheep could pay the pumping and fertilizer costs of growing rice on a 0,2ha plot on their PIVs.

As indicated in the previous section, from 1982 to 1988, production costs did increase relative to the value of the rice crop, particularly in the delta. But, as we argued above, this has not greatly reduced input use. More fundamental factors appear to be blocking the more intensive use of land. These are firstly that double cropping creates intense labour bottlenecks, and secondly that water management is insufficiently coordinated at local level to allow tillage of the soil within the very tight timetable required by double cropping. The problem is that if two rice crops are to be grown, the available rice varieties and seasonal

temperature constraints dictate that the dry season crop (sown March) must be harvested in less than a month to allow sowing of the rainy season crop in July. To place this in the context of current practice, studies by ISRA (Le Gal, 1989) indicate that the harvest of the 1987 rainy season rice crop took four months from the start of the first field to the completion of the last, using seasonal hired labourers and diesel-powered threshers. Dokit Thonon and Bruyere (1988) have suggested that complete mechanisation of the rice harvest (using combines) may be the only way to resolve the bottlenecks presented by double-cropping. In practice, farmers, unlike the developement agencies responsible for financing the irrigation infrastructure, are not primarily preoccupied with maximising the annual output from each plot of land, but rather with maximising the return on their investment of labour and cash in production. The advantage to farmers of dividing their available area and distributing cultivation over more than one season is that one crop does not need to be cleared from the field before the next crop is planted. This allows labour, and particularly family labour, to be used more flexibly and reduces the need to pay for extra seasonal labour. That is not to say that peak labour is not employed at present: seasonal labourers from the regions to the south of the river valley are employed in large numbers to harvest the rice crop, particularly in the delta.

The second factor that has received little attention in discussion of double cropping is the need to synchronise farming operations in adjacent fields, so that drainage can be carried out in time to dry the soil sufficiently to allow tillage for the next crop. Such synchronisation is difficult if irrigation is so slow as to create a substantial interval between the establishment dates of crops in adjacent fields. The need for tighter local coordination of farm operations (i.e at *groupement* level) implied by double rice cropping may therefore call into question the existing practice of simultaneous water supply to all modules on large perimeters in the delta. Further, as we have noted earlier, the deterioration in canal maintenance which has accompanied SAED disengagement has greatly reduced the control of water delivery and drainage on large perimeters, and this, coupled with the scarcity of agricultural machinery severely diminishes the prospect of farmers on large perimeters. growing two crops of rice on the same fields in a year.

A final point on the productivity of irrigation concerns the proliferation of small-scale irrigation in the delta, whose construction, while cheap is also rudimentary. When situated on the periphery of large perimeters whose own drainage system has deteriorated, small perimeters whose construction excludes any provision for drainage must assuredly increase the risks of secondary salinisation of the saline delta soils. Avoidance of this risk requires both a regulatory body to enforce adequate drainage measures, and engineers with the necessary skills and experience to advise farmers' organisations on irrigation design. The plans for the withdrawal of SAED as yet have no concrete proposals on this last point.

5.4 Summary

In our discussion of irrigated farming in the aftermath of state disengagement, we have tried to identify the main institutional and technological factors at work in a complex, diverse, and rapidly changing situation. We can summarise the main elements of our findings in the following manner.

As a result of SAED disengagement, farmers' organisations have become responsible for arranging credit, input supplies, and marketing of the crop, and this has created pressure towards collaboration between irrigation groups in order to improve their bargaining power with the credit agency, CNCAS, input suppliers, and transporters. This trend effectively reinforces throughout the valley the two-tier model of organisation set up by SAED on large perimeters in 1984. In this model, a *section* (now with financial, and in some cases machinery hire functions) coordinates the activity of a number of water management *groupements*. The development of a commercial input supply system is financed by credit paid for by farmers. The credit is unsecured, and the collective responsibility of farmers within a *section* for repayment of the loans offers a guarantee of repayment. However, this arrangement also provides a mechanism by which indebtedness may grow *within* a *section*, with the prospect of wealthier members eventually buying out the cultivation rights of indebted members.

This potential for loss of cultivation rights has been increased on large perimeters by the deterioration of infrastructure, which has increased the risk of crop failure within a relatively rigid cost structure. On the small-scale perimeters of the middle valley, there is less potential for this to occur because farmers generally have a more diverse income base, cash requirements to meet production costs are lower, and individual *groupements* have greater control over the water delivery system. However, on intermediate-scale perimeters currently starting production in the middle valley larger plot sizes will make mechanization necessary, and the need to share pumping equipment with other *groupements* will make conditions in the longer term similar to those on the large perimeters of the delta.

The generalised lack of double cropping on both large and small perimeters is attributed to intense labour peaks coupled with lack of appropriate mechanisation. The disengagement of SAED has done nothing to relieve this, and to some extent has made it worse: in the middle valley delays in planting have resulted from difficulties in obtaining credit or inputs; in the delta the deterioration in canal maintenance and reduced availability of tractors - both traced to measures to prepare for privatisation - have further limited farmers' capacity for timely land preparation and planting. The unregulated proliferation of small-scale irrigation at the boundaries of existing large-scale irrigation in the delta, as a result of encouragement of private sector investment in irrigation, raises the prospect of further cultivation difficulies due to inadequate drainage provision and soil salinisation.

6. Concluding remarks

We have noted that development of irrigation infrastructure has become the principal effective method of transfer of land tenure in the Senegal river valley, provoking the formation of irrigation organisations to gain access to irrigated land for different social groups within the communities of the valley. Under structural adjustment measures of the NPA, this competition for irrigated land has been greatly sharpened by government encouragement to entrepreneurs from outside the valley to seek land allocations from rural councils. The ensuing tension was documented in 1988, in reports in the Senegalese press (SudHebdo, nos 23 (20.10.88),24 (27.10.88), and 25 (3.11.88)) that competition for land

increasingly set the interests of one village against another, leading to violent confrontations between villages on both the Senegalese and Mauretanian sides of the river valley.

On the Mauretanian (northern) bank, the privatisation of land has been accelerated by racial and class conflict between the urban-based light-skinned *bidans* and the black population of the river valley (Horowitz, 1989), and in April 1989 (less than two weeks after the completion of fieldwork for the present study), this conflict erupted after two Senegalese farmers were killed by the Mauretanian military during a dispute over grazing rights in the middle valley. In the week that followed, riots in Nouakchott resulted in the death of several hundred Senegalese and black Mauretanians, while revenge riots in Senegalese towns resulted in the deaths of some 60 Mauretanians and the repatriation of a further 200 000 to Mauretania - many of them small traders who were entering Mauretania for the first time. The mass deportation of 90 000 Senegalese from Mauretania was accompanied by the expulsion of some 60 000 black farmers - most with Mauretanian nationality - from the northern bank of the river.

The presence of tens of thousands of refugees on the southern side of the Senegal river valley inevitably adds further pressure for the development of more irrigation, although it is too early to indicate what form this will take. It is by no means clear, for example, that refugees will all gain access to irrigable land, or, if they do not, whether they will constitute a source of labour for existing holders of irrigated land.

The early experience of state disengagement from irrigated agriculture in the Senegal river valley indicates that, in contrast to rainfed farming in Senegal (Commander et al. 1989), an irrigated food-farming sector can sustain a commercial input supply system, under conditions of good access (i.e. in the delta) and where the cost of credit is met by farmers. In the less accessible areas of the middle and upper valley it seems likely that farmers' associations will need to bear much of the organisational, as well the financial, load. in securing input supplies.

The hoped-for growth of cereal output through the production of two rice crops on the same land each year in the delta has for the most part not taken place, due to insufficient mechanisation and inadequate and deteriorating operation and maintenance of the large-scale irrigation infrastructure. As a result rice production has remained static, despite a rapid increase in the area of irrigated land. While commercial enterprises might in time ease the mechanisation constraint, it is by no means clear that they would improve irrigation infrastructure, whose decline is at least partly attributable to the disengagement process itself. Progress in the liberalisation of markets for agricultural inputs and services is therefore likely to be constrained in various ways by inadequate infrastructure - an issue which appears unlikely to be resolved simply by disengagement of the state.

Similarly, the disengagement of the state seems unlikely, to achieve the intensification of land use through double cropping, which the government hoped would provide the increase in production needed to reduce rice imports. However a further consequence, of more immediate relevance to the farmers of the Senegal river valley, is that the persistance of single cropping of the land will sustain the pressure to increase production through extension of the area under irrigation schemes, which will further inflame the competition

for land tenure. The events of 1989 have demonstrated how dangerous such an outcome may prove to be.

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