COMPARATIVE ANALYSIS OF RICE PRODUCTION COSTS IN SMALL- AND LARGE-SCALE IRRIGATED PERIMETERS IN THE UPSTREAM ZONE OF THE FLEUVE, MAURITANIA

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TO

MY FATHER AND MOTHER

FOR THEIR BLESSINGS

AND

TO MY FIANCEE, ZEYENABOU TANDIA,

FOR HER LOVE

ACKNOWLEDGEMENTS

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LIST OF ACRONYMS

BDPA: Bureau Pour Le Development De La Producton Agricole (French Office Of Agriculture Development)

CFA: Senegalese Monetary Unit: read Franc CFA ($ U.S.1 = CFA 350 in 1986)

CIF: Cost-Insurance-Freight

CSA: Commissariat a la Security Alimentaire.

CILSS: Permanent Inter-State Committee For Drought Control In The Sahel

Dferi: Sandy soils in which millet is mainly cultivated during the rainy season.

ECON: Economic

FAO: Food And Agriculture Organization

FED: Fond Europeen De Development (EEC)

FIN: Financial

Fleuve: Senegal River

FONDE: Light soils 10-30 percent of clay.

HOLLALDE:Heavy soils with more than 60 percent of clay

OMVS: Organization De La Mise En Valeur Du Fleuve Senegal

RAMS: Rural Assessment And Manpower Survey

SONADERSociete Nationale De Development Rural

U.M.: Unite' Monetaire (read : Ouguias): In 1980 $ U.S.1 = U.M.46
It is between 75 and U.M.85 in 1986.

USAID: United States Agency For International Development

Walo: Clay soil which contains more than 60% of clay. It is flooded from June to September.

WARDA: West Africa Rice Development Association

War And Want: A British non Profit Organization

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CHAPTER I

INTRODUCTION

While many African countries have faced food shortages during the past decade, Mauritania has been particularly hard hit. In response, the government has given priority to irrigated rice development. Both small scale and large perimeters have been implemented. This study evaluates the financial and economic costs of these alternatives and draws policy implications for future irrigated rice development.

1.1 The Problem

Today, Mauritania faces a food crisis. Cereal production has declined sharply since the 1960's, when Mauritania produced an average of 90,000 metric tons per year--over three times the current average level of 27,000 tons. In 1984-85 total food requirements were estimated at 280,000 tons of cereals. Even in normal rainfall years, local cereal production supplies only 21 percent of the total needs, but in 1984-85 domestic production accounted only for a mere seven percent of total requirements (USAID, 1984). The projected cereals deficits on the basis of maximum needs is illustrated in Table 1.1.

This drop in production is strongly associated with the drought. The 1973-1974 drought dramatically affected the rural sector. Total cereals production declined by 68 percent during this period, and more than 41 percent of the livestock died (Club du Sahel, 1977). However, there have been other limiting factors, such as weak and under-funded support institutions and pricing policies which were unfavorable to producers.

Without adequate resources to generate foreign exchange, the country has highly depended on food aid to fill the current food gap. Food aid imports represent over 50 percent of the total cereals supply in Mauritania in 1985 (World Bank, 1985). From the standpoint of long-term food security, the current level of food aid is worrisome. First, it is difficult to imagine that donors will always be in a position to provide Mauritania

TABLE 1.1 PROJECTED CEREALS DEFICITS PER TYPE OF CEREALS ON THE BASIS OF MAXIMUM NEEDS IN MAURITANIA (THOUSAND TONS). 1982-1990.

	SORGHUM AND MILLET			RICE		
YEAR	NEEDS	PRODUCTION	DEFICIT %(a)	NEEDS	PRODUCTION	DEFICIT %(a)
1982	69.9	39	44.1	110.2	9.7	91.2
1983	71.5	42	40.5	113.1	13.2	88.3
1984	73.2	45	38.5	116.2	16.4	85.9
1985	75	40	46.7	119.4	19.7	83.5
1986	76.5	41	46.4	125.6	23.6	81.2
1987	78	42	46.1	132.2	26.8	79.7
1988	79.6	42	46.5	139	30.1	78.3
1989	81.2	42	48.3	146.4	33.5	77
1990	82.7	37	57.5	154	36.8	76

SOURCE: F. Martin. 1982

a) Author's calculations

DEF: Deficit

with so much sustenance. Second, low food aid prices and the high volume of food aid tend to reinforce a "dependency mentality" which is undesirable in the long run. Finally, food aid is contingent upon surpluses in the donors countries and political good will-neither of which can be assured.

The strong preferences of urban consumers for rice and the increase in sedentary life (i.e. settlement of nomadic herders) since last drought have constituted a major problem for the government. Nouakchott, the capital city, has experienced the most rapid growth in Africa, from 135,000 in 1976 t0 350,000 inhabitants in 1984. Urban population represents the major source of political pressure, so the government has to satisfy their rice consumption needs.

Mauritania's fourth economic and social development plan (1981-85) placed priority on 1) achieving national food self-sufficiency by the year 2000, 2) increasing rural incomes , and 3) stopping the process of environmental degradation as a first step to gradually restoring the natural environment. To achieve these goals , the government has sought to progressively reduce the food deficit by dramatically stimulating local production. After the last drought (1973-74), the goverment decided to rely heavily on irrigation as a major component in its strategy to achieve food security. The third plan (1976-1980) proposed to develop irrigation on 93,000 additional hectares to satisfy cereals needs in year 2000, with rice production alone occupying 65 percent of the land to be developed. To date, more than $U.S. 30 million has been invested in irrigation, nonetheless the government will have to accelerate land development to achieve the year 2000 target (Ministere Du Plan, 1976).

However, irrigation is a very costly solution to achieve food security in Mauritania. Land development costs per hectare in the Senegal River Valley in Mauritania are estimated to $U.S.3,500 to $U.S.21,000 (Club du Sahel, 1979) depending upon the type of irrigated scheme considered. The Mauritanian goverment is planning to intensify irrigation after completing the two dams (a salt water barrage downstream at

Diama in Senegal and an upstream storage dam at Manantali in Mali). Are there other solutions to reduce the dependency on food import with unstable rice prices on the international market? Key questions facing the government are : 1) how can costs of producing paddy rice under irrigation be reduced? and 2) what rice production techniques are most suited to Mauritania's socio-economic environment ? Of the two types of irrigation schemes "large-scale" capital intensive (more than 500 hectares) and small (15-25 hectares) scale labor intensive irrigated perimeters--which is most efficient for producing rice to met future demand?

1.2 Objectives of the Study

Some agricultural project analysts advocate that "small-scale" perimeters are more cost effective and successful than large ones. Patterson (1984) argues that the small scale perimeter is potentially conducive to development because of their smallness and their flexibility in term of innovations. Morever a recent survey irrigation in the Sahelian countries by Stryker, Gotsch, Mc Intire and Roche (1985), suggests that labor intensive schemes generally have better distributional characteristics than those that are more capital intensive. These advantages attributed to the small schemes have even biased some donors towards funding small scale perimeters.

Efforts to expand rice production and therefore to increase self-sufficiency can be analyzed in terms of their contributions to the three fundamental economic objectives: increased national income, more even income distribution, and increased food self-sufficiency. In the case of Mauritania, the main objective is to increase food self-sufficiency. As a Resources Assessment Manpower report (RAMS, 1980) stated, after 10 years of drought, loss of livestock and an increasing rate of food deficit, expanding irrigation is no longer an alternative, but an obligation.

This study will 1) compare rice production costs in the large and small scale perimeters in the upstream zone of the Fleuve in Mauritania, 2) highlight the advantages and disavantages of the large and small scale perimeters, and 3) draw some policy recommendations for future land development.

While the Mauritanian government has used irrigation since 1973 to increase food security, the cost has been substantial. Related issues that will be explored relate to Mauritania's comparative advantage in rice production. Is locally produced rice competitive with the imported rice ? For example rice produced and consumed in the same zone may be competive with imported rice delivered to this zone.

Finally, this study analyzes rice policies used by the Mauritanian government to increase real rural incomes. In particular, are existing incentives adequate to motivate farmers to continue to produce under the current rice policies ? Incentives to guide and reward farmers are critical component as once there are investment opportunities and efficient incentives, farmers will turn sand into gold (T.W. Schultz, 1976).

CHAPTER II

DESCRIPTION OF THE RIVER REGION IN MAURITANIA

This study focuses on agriculture in the fleuve region of the Senegal River. The area is inhabited by a diversity of ethnic groups practicing rainfed and irrigated agriculture. Irrigation development has been primarily managed by SONADER, a semi-autonomous public land development agency.

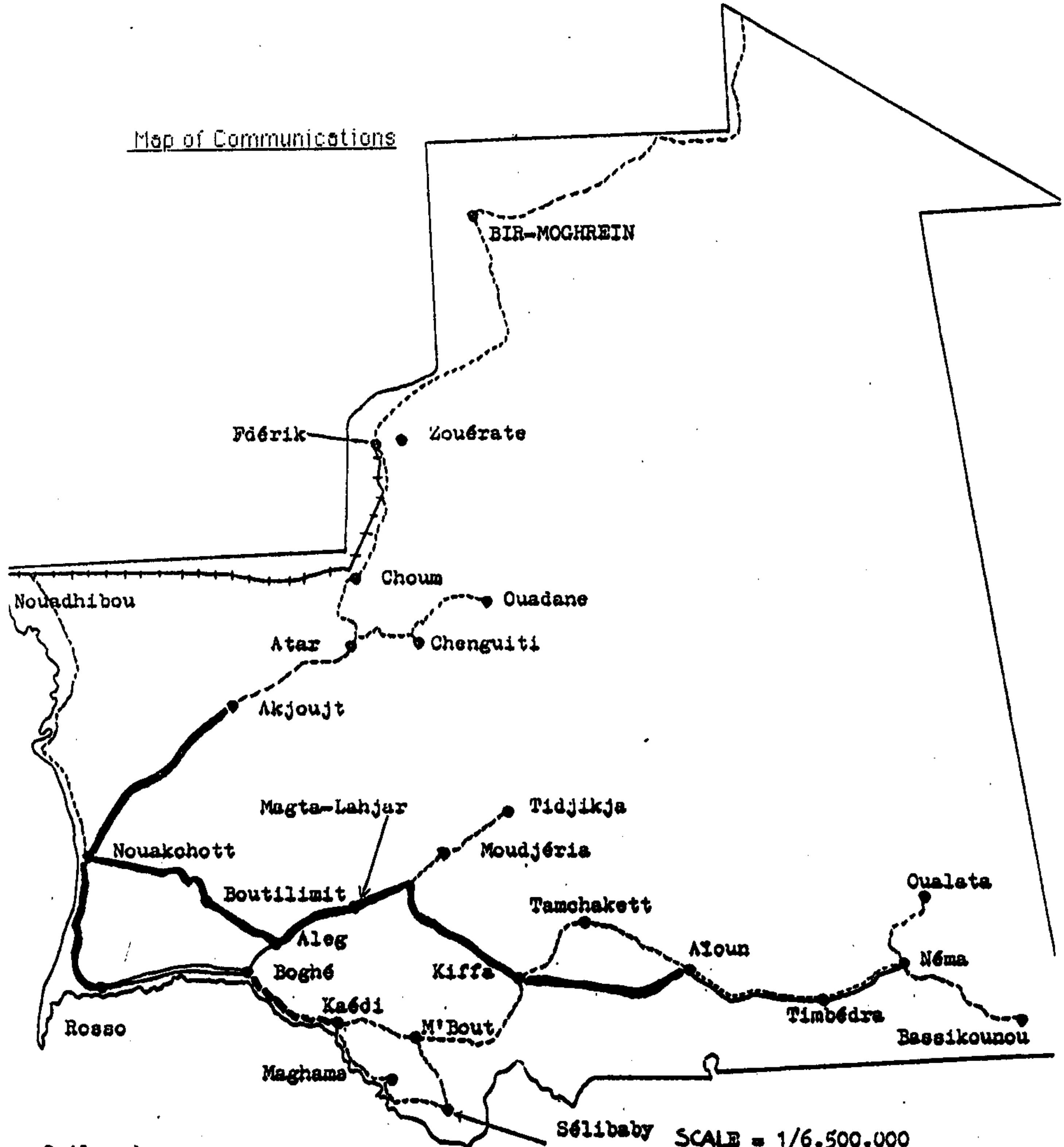
2.1 Geography

Mauritania is in the sahelio-saharian climatic zone (see Country Map). The southeast of the country (the Fleuve region) is the only area which receives an annual rainfall of at least four to six inches. Rainfed agriculture can be praticed in this area, but it is still vulnerable to rainfall variation. Besides the oasies's zones, it is the only zone where climato-pedological conditions are adequate to support crop agriculture.

The Senegal River, one of the longest in West Africa, is over 2,500 miles long. From the Mountains of the Fouta Djallon of Guinea, flow the Bakoye and the Bafing Rivers. These two rivers emerge in Mali to form the Senegal River . The Fleuve is often divided into four zones: the Upper Valley, the Middle Valley, the Lower Valley and the Delta. This division of the River is illustrated in Figure 2.1. This study concerns only the upstream zone of the Fleuve (the Middle and Lower Valleys).

The Fleuve defines the southern border of Mauritania. From June to September, it floods an important area of clay soils. In good years, the flooded area covers up to an estimated 60,000 hectares. This allows farmers to practice flood recession agriculture from October to May. The Fleuve region represents the future of Mauritanian agriculture. The regularisation of the Fleuve's flow after the building of the two dams by 1986 will allow the long term development of 140,000 hectares of arable land under irrigation in ecological conditions very favorable to cereal and forage production.

Map of Communications



Railroad

Paved Road

Road Under Study

Dryweather Track

Prepared Paved Road

Improved Tracks (under construction)

Towns

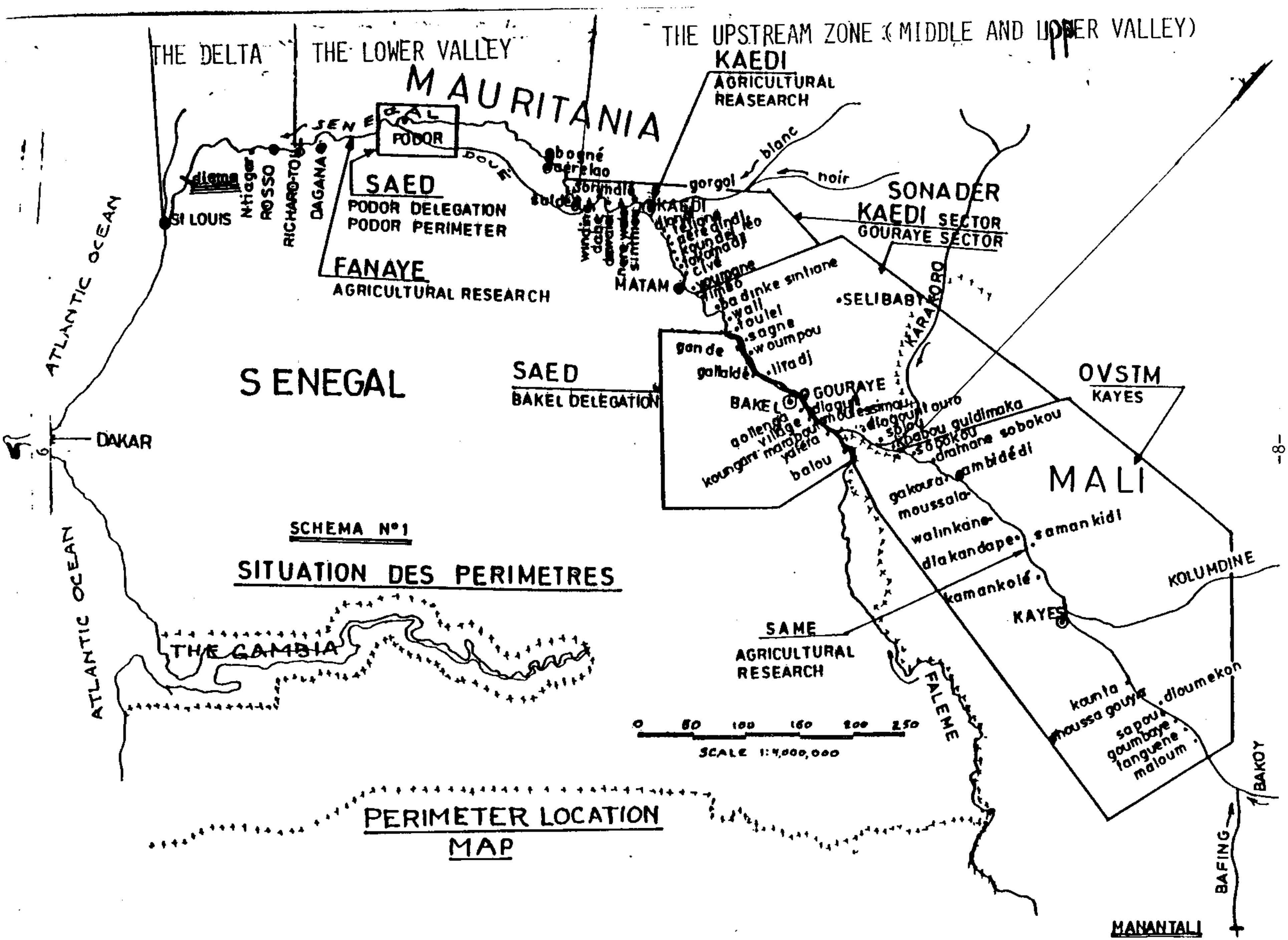

THE DELTA
THE LOWER VALLEY
THE UPSTREAM ZONE (MIDDLE AND UPPER VALLEY)
MAURITANIA
SENEGAL
MALI
ATLANTIC OCEAN
ATLANTIC OCEAN
DAKAR
ST LOUIS
Ntiager
ROSSO
RICHARD-TOLL
DAGANA
PODOR
SAED
PODOR DELEGATION
PODOR PERIMETER
FANAYE
AGRICULTURAL RESEARCH
KAEDI
AGRICULTURAL
REASEARCH
SONADER
KAEDI SECTOR
GOURAYE SECTOR
MATAM
SAED
BAKEL DELEGATION
BAKEL
GOURAYE
SELIBABY
KARAKORO
gorgol
blanc
noir
OVSTM
KAYES
KAYES
KOLUMDINE
SAME
AGRICULTURAL
RESEARCH
FALEME
BAKOY
BAFING
MANANTALI
THE GAMBIA
SCHEMA N°1
SITUATION DES PERIMETRES
0 50 100 150 200 250
SCALE 1:4,000,000
PERIMETER LOCATION
MAP

Figure 2.1

2.2 The Fleuve Region Population

The total Mauritanian population in the Fleuve (Senegal River Valley) was estimated by the OMVS socio-economic study (1977) at 360,0000 inhabitants In 1979. This represents almost 30 percent of the total Mauritanian population at that time. Agriculture is the main activity of this ethnically diverse population, which includes Soninke, Peul Toucouleur, Moor and Wolof.

2.3 Agriculture

The Mauritanian rural sector (crops, animals and fish productions) accounts for only for 30 percent of the total gross national product, even though this sector engages 80 percent of the total population (Club Du Sahel, 1985). Income per capita in rural areas was estimated at $ U.S.170 in 1982--40 percent less than the average per capita income of $ U.S.350 in 1979 (Club Du Sahel, 1985).. Livestock production represents the main income generating activity in the rural sector, as crop production accounts for only 10 percent of the total rural output. Since 1973-74, when drought killed more than 41 percent of the livestock, the government has given "the priority of the priorities" to crop production under irrigation in the hope of eliminating the food deficit by year 2,000.

The major constraint to agricultural expansion in Mauritania is water availability, as rainfall is limited and the Senegal River flood is often irregular. In addition, marine salt intrusion prevents double cropping for 200 kilometers up the Senegal River from the Delta (Figure 2.1.). The size of Mauritania and the very poor communications and transport infrastructure also serve as constraints to the dissemination of agriculture inputs and information and to the marketing of agriculture produce.

2.3.1 Rainfed Agriculture

The agriculture sector can be divided into two parts: rainfed agriculture and irrigated agriculture. Before the 1973-74 drought, rainfed agriculture was an important source of cereal production. Unfortunately, drought has sharply reduced rainfed crop production. The most dramatic and direct consequence of the climatic imbalance has been the decline of traditional rainfed-recessional sorghum that constitute the major food source for human consumption (Table 2.1). Irregular rainfall and Senegal River flooding have reduced average yields to 400 kg per hectare for millet and sorghum grown on flood recession lands and 300 kg per hectare for millet under rainfed conditions (RAMS, 1980).

Given the low amount of labor required, flood recession agriculture is competitive with rainy season irrigated rice. A sociological report (SONADER, 1982) indicates that net returns per manday to labor are 16 kg of sorghum and 9.5 kg of rice for flood recession agriculture (walo) and irrigated farming in the Fleuve region, respectively. This may explain labor bottlenecks experienced by farmers at the rice harvest time during the rainy season when rice harvesting overlaps with the start of the flood recession growing season. Labor bottlenecks are more important in the case of small scale irrigated perimeters where farmers have very small plots (0.1 to 1.0 hectare). As rice produced from irrigated farming is not enough to secure their basic food needs most of the small scale perimeter farmers continue to pratice rainfed and flood recession agriculture.

Some wheat and barley are also produced in oasis areas, though most of this is consumed on site. Finally, rainfed swamp rice is produced by women in the upstream zone of the Fleuve (Selibaby region), but drought has severely reduced the area under this system.

TABLE 2.1 CULTIVATED AREAS. RAINFALL. FLOODING. AND CEREALS PRODUCTION PER YEAR IN MAURITANIA.

YEAR	RAINFALL (mm)	FLOODED (AREAS) (HA)	CULTIVATED (AREAS) (HA)	CEREALS PRODUCTION SORGHUM (TONS)	MAIZE (TONS)	WHEAT (TONS)
1964	382	766.000	245.000	90.000	3.400	200
1965	502	123.000	123.000	100.000	4.000	300
1966	359	117.000	117.000	90.000	3.000	300
1967	393	140.000	140.000	100.000	2.000	200
1968	267	86.000	86.000	50.000	4.000	300
1969	403	95.000	95.000	100.000	4.000	300
1970	256	393.000	110.000	82.000	800	200
1971	772	350.000	101.700	50.000	4.200	200
1972	252	219.300	87.000	37.500	2.000	200
1973	224	NA	NA	25.000	1.500	100
1974	229	NA	NA	40.000	4.600	200
1975	377	NA	NA	32.000	3.100	300
1976	249	NA	NA	21.000	3.200	400
1977	224	NA	NA	30.000	3.300	400
1978	224	NA	NA	43.500	4.800	400
1979	227	NA	NA	21.200	5.000	200
1980	192*	NA	NA	31.000	4.400	200

SOURCES:

RAMS. 1981.

FALL. 1983.

NA: Not Available * Predicted figure

2.3.2 Irrigated Farming

Irrigated farming was first tried in the early 1800s. Yet, it was not until after independence that a sustained effort was made to develop large perimeters on the Mauratanian side of the Senegal River.

2.3.2.1 History of Irrigation in the Senegal River Valley[1]

The first attempt to develop irrigation in the Senegal River Valley dates from 1822 by the French colonialists. This project attempted to adapt European crops to the environment of the Senegal River Valley. The chain-pump irrigation technique was used- involving the development of a series of the small dams to provide water to plot. The project failed and was terminated in 1831, due to technical factors. In addition, sociological factors such as conflicts over land tenure and labor shortage contributed to the failure.

The next project was initiated in the 1940's. Several irrigation systems were developed using a "controled submersion" technique. This pratice involved "tiered waterbeds surrounded by dikes to keep water in the higher parts and to control the inundation of the lower parts. When the flood of the River was high, a system of flood gates allowed the water to enter the waterbed using the force of gravity" (Patterson, 1984). This technique was carried out by the Mission d' amenagement du Senegal at Guede, where 1,000 hectares were irrigated. While the focus was earlier put on growing cotton for export, the project concentrated its effort on growing rice in order to lessen the shortages of colony's rice supply during World War II.

More recently, in the 1960's Senegal used water control techniques modeled on the controlled flooding polders of Indochina. Models developed in monsoon Asia proved to be totally applicable to the semi-arid conditions of the Senegal River Basin during drought

1. This part draws heavily on the N'diame Master thesis.

years. Flooding was late or inadequate, salt water intrusion from the sea posed major problems, and numerous technical difficulties emerged. As a result of the problems, investments in irrigation were oriented toward total water control systems involving pumping and leveling. While these systems are more reliable, they are expansive to construct and operate.

2.3.2.2 Irrigation Experiences on the Mauritanian Side of the Fleuve

The history of locally irrigated rice goes back to mid-60's, when the French Office of Agriculture Development (BDPA) constructed small perimeters at Winding and Dar El Barka (Figure 2.1). The relative success of these first perimeters, combined with the declining production trend in the walo (flood recession lands), established in the mind of the local authorities the soundness of irrigation. In 1971, ten more perimeters were built. Since then the number of perimeters has grown, with about 6,500 hectares (not counting private perimeters'area) under irrigation today.Irrigation in Mauritania has directly utilized a complete water control system (tertiary development) as illustated in Figure 2.2. It involves four phases: 1) peripheral diking and pumping water for complete water control down to the quaternary canals, 2) leveling of interior paddy lands, 3) construction of numerous small dikes, ditches and bunds to separate parcels and to allow for internal water control, and 4) pumping water up from the River and accumulating it in a cement stilling basin. From there, water is channeled through an earthen canal system. Minor ditches divide the system into 100 square meter sections.

2.3.3 Agricultural Institutions

The major institutions supporting irrigated agriculture are SONADER, the National Office of Agriculture, the National School for Agricultural Education and the National Committee for Food Security.

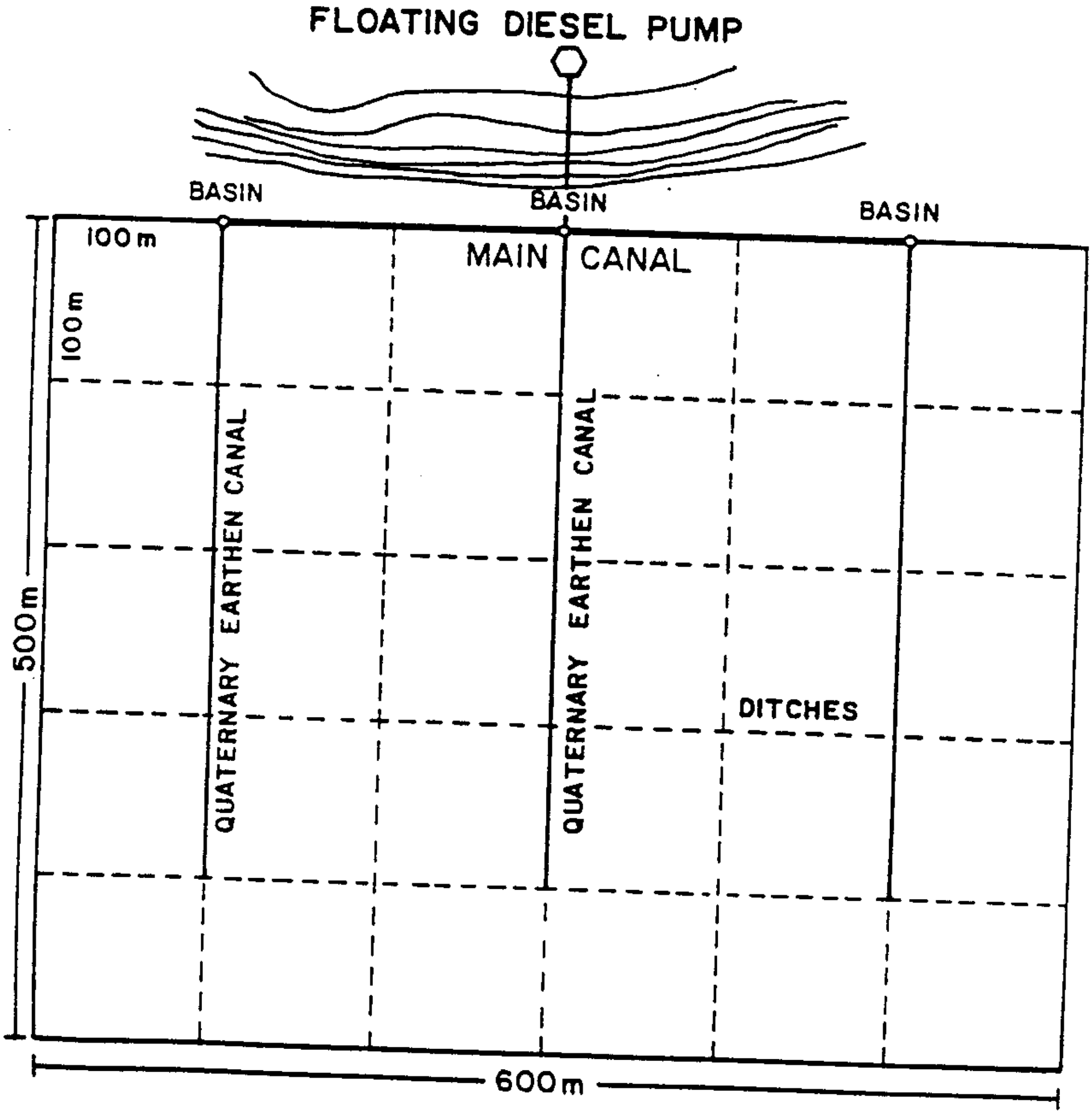


FIGURE 22 COMPLETE WATER CONTROL (TERTIARY DEVELOPMENT)

2.3.3.1 SONADER

SONADER , a public, semi-autonomus land development agency, was established by decree no.75237 on July 24 1973. It has been the engine of rural development, particularly in the irrigated sector, since the terrible drought of 1973-1974. Its responsabilities includes the study, implementation and control of infrastructure for hydro-agricultural projects; monitoring and management of operations; extension services and training of farmers; supply of of production inputs; major maintenance of perimeters, facilities and equipment; and supervision of private sector perimeters, as requested by the government.Construction. SONADER performs all land clearing and diking in large-scale irrigated perimeters, whereas these operations are done by farmers in small-scale irrigated perimeters.

Inputs. SONADER provides the first pump at 50 percent of cost, to be repaid over three years at 8.5 percent interest per year. The second motor pump is subsidized at only one third the cost, while the third pump is not subsidized at all. For the first growing season, SONADER provides both inputs for production (seeds, fertilizers, chemical products) and for the pumps (electricity for the large pumping stations, diesel oil for the small ones, lubricants, and spare parts) free of charge. For subsequent growing seasons, inputs are subsidized at a decreasing rate. These inputs subsidies were established in 1980 to stimulate irrigated rice farmers to adopt the new production technology. While fertilizers and chemical products were subsidized at 50 percent from 1980 to 1984, farmers were required to pay the full cost after 1985. Diesel fuel is not subsidized but is exonerated from all taxes. Spare parts are also exonerated if they are bought with the pump, but later purchases are not.

SONADER is responsable for bringing all inputs directly to the perimeters. Yet, it experiences substantial difficulties in delivering on a timely basis. Part of the problem stems from causes beyond SONADER's control, such as poor access to isolated regions. However, much of the problem can be attributed to a bureaucracy that is too centralized and overburdened with many diverse responsabilities. However, recently, it seems that the input supply function has been assigned to another institution, the Fond National de Development.

Maintenance and Repairs. Although SONADER employs mechanics to provide maintenance and repair, the quality of the services is poor. Much equipment is broken down or in deteriorating condition. This leads to high recurrent costs. Agricultural projects recurrent costs are one of the major problems in the Sahelian countries (Club du Sahel- CILSS, 1982).

The fixed fee charged by SONADER to farmers for goods and services rendered at the end of each growing season is substantially below their real cost. It can be paid in cash or in kind with one percent per month interest charge on late payments. Reimbursement for debts owed on pump (small scale perimeter case) is also collected at the end of the season. Farmers who pay in cash before the growing season get a five percent discount. Those who do not pay at all do not receive any inputs the following growing season. SONADER has been very strict in enforcing this rule.

Marketing. Farmers are allowed to sell their output to whomever they wish. However, if they offer their paddy rice to SONADER for sale, SONADER is required to buy it. This is part of the contract binding SONADER to farmers.

2.3.3.2 Other Agricultural Institutions

National Office of Agriculture. Originally, this office was the single agricultural institution which give technical assistance to all the agricultural production activities in the country. Since the creation of the SONADER, its role has been limited only to rainfed agriculture.

Centre National de Recherches et de Development Agricole (CNRDA). This is the national research center which is responsible for all agricultural research in the country. It conducts applied research on all crops grown and screens varieties to identify cultivars adapted to the different ecological zones of the country.

Ecole Nationale de Formation et Vulgarisation Agricole (ENFVA). This is the sole agricultural school in the country . It trains extension agents that are used by the rural development institutions.

2.3.4 Producers Price Policy and Incentives for Increased Production

Official producer and consumer prices for cereals are set by the National Committee of Food Security (CNSA) which was formed in 1981. The official pricing system has responded slowly to changing market conditions, as few prices changes have ocurred in recent years (Table 2.2).

Table 2.2 Official (*) current agricultural producers floor prices (U.M./KG), 1979 to 1985, Mauritania.

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85**
Rice paddy	10	10(8.8)	12.5(10)	12.5(9.7)	12.5(9)	14(9)
Millet	8.5	8.5(7.5)	13(10.5)	13(10)	13(9.4)	21(13.5)
Sorghum	9	9(8)	13(10.5)	13(10)	13(9.4)	21(13.5)
Wheat	9	9(8)	13(10.5)	13(10)	13(9.4)	21(13.5)
Maize	11	11(9.7)	13(10.5)	13(10)	13(9.4)	21(13.5)

Sources: --Ministery of Rural Development Report, 1985.
--Author's calculation for real prices.

* These are real prices. The G.D.P. deflator (World Bank, 86) is used, and 79/80 is considered as a base year.

** These prices raised official production floor prices to 100% of import parity price for all coarse grains and paddy. This was in response to the World Bank recommendations as part of the IMF standby arrangement.

Lack of price changes make it difficult to assess the impact of the prices changes on cereal production. For dryland crops (millet and sorghum), there is a general consensus that rainfall is the single most important determinant of production. Determining the response of dryland crop production changes to prices changes is also complicated by the fact that official prices for coarse grains have generally been too low to clear the market. For example, until February 1985, the official producer prices for sorghum and millet were only 60 percent of import parity.

In the irrigated sector, output has possibly been more responsive to price changes. For example, in 1981/82 the official price of paddy was increased by 20 percent (from U.M. 10 - 12.5 /kg), bringing it to 100 percent of the import level. This price increase was followed by a rise in yield per hectare and an expansion in the area under irrigated production. The production of rice jumped 57 percent, from 5,900 M. tons in 1980/81 to 9,250 M. tons in 1982/83. The higher official prices are intended to keep a floor under cereal market prices. Only when the market prices in production zones drop to the floor price levels does CSA enter the market as "buyer of the last resort".

CHAPTER III

COMPARISON BETWEEN LARGE AND SMALL SCALE IRRIGATED PERIMETERS IN TERMS OF DESIGN AND MANAGEMENT

Rice production schemes can be roughly divided into two classes: 1) small-scale village level irrigated perimeters covering 20 hectares on average; and 2) large-scale irrigated perimeters covering over 500 hectares. These two types of irrigated schemes are designed and managed differently.

3.1 Small-scale Irrigated Perimeters

3.1.1 Perimeter Design

Two approaches have been tried by SONADER to establish village perimeters. In one approach, SONADER selects the site, undertakes all the preliminary perimeter preparation and provides the necessary equipment and supervisory personnel. A contract binds villagers to SONADER, stipulating the duties of the two partners. SONADER is required to supply all the services, including inputs, during a growing season. On the other hand, villagers are required to reimburse SONADER for these services after harvest. This contract is generally renewed before each growing season. The other approach, called the private village approach, refers to the village perimeters established without a prior feasibility study. Under this alternative, SONADER and other international organizations (WAR AND WANT, FAC, FED etc.) provide the technical assistance and occasionally material equipment. This study focuses on those perimeters designated with the first approach.

3.1.2 Charcteristics

Small-scale irrigated perimeters are labor-intensive schemes. Villagers are required to provide an average of 4,500 person days per perimeter (180 per hectare). Farmers participation basically includes land clearing, small dikes and canals, and leveling. To compensate their effort, SONADER gives food to farmers ("food for work"). This food is generally drawn from the food aid reserve.

The qualifier, "village-level", is frequently used in discussing a small-scale scheme to specify that it is a perimeter located close to a village and mostly worked by that village's farmers. It is established on elevated land (fonde). This approach results from consideration of factors such as:

1) proximity of the water supply to the river, which makes long water supply routes unecessary.
2) relatively light earth, which is easier to work by hand or using draft animals than the soil of the basins (Hollalde), and
3) land with relatively flat topography, which minimizes leveling work; and elevated land, which reduces the labor of building dikes for flood protection and allows for natural drainage toward the river of the neighboring basins.

3.1.3 Reasons for Success or Popularity

The small-scale irrigated perimeter has nine characteristics that rural sociologists frequently recommend as being conducive for development. First, averaging about 20 hectares, they are village based. Villagers consider the perimeter as their own as opposed to belonging to the government. Second, the water user's association (the perimeter cooperative) is a small group, averaging about eighty members per association. This group, led by a bureau composed of elected officers and other members, is responsable for the day-to-day management. Third, small-scale perimeters are established on fonde soils which are seldom used for flood recession cultivation since they are rarely flooded. Thus, there are seldom land tenure problems. Fourth, small scale perimeters are labor intensive instead of capital intensive. Fifth, the plots are allocated on the basis of households or foyre, the traditional productive unit. Sixth, "appropriate technology" is used for small-scale perimeters. The pump is designated to irrigate as many as 20 hectares. The pumps are not stationary, but float on the river so they can be used when the water level is high or low, as is illustrated by Figure 3.1.) Seventh the goal of the small-scale perimeter development is self-sufficiency, to produce rice for consumption in the village. Finally, funding commitments are easy to obtain from donors because they require a small investment.

3.1.4 Objectives

Government strategy to create small scale irrigated perimeters has two fundamental objectives:

1) to offer individual irrigated plots to the maximum possible member of peasants located in the Fleuve. This explains why family plots are only 0.1 to 1.0 hectare. Production from this plot represents a complementary food supply in good rainy years and the sole source of food supply during a drought period,
2) to train the Fleuve region's peasants to use the new agricultural technology package before the intensive land development that is planned to follow the completion of the two dams (Diama and Manantali) on the Fleuve.

3.1.5 Problems

In spite of their success and their popularity, small scale irrigated perimeters have shown many problems mainly related to the quality of their initial design and to the lack of maintenance. Small perimeters can be just as problematic as large ones if the design is faulty or technologies inappropriate. Small perimeters are built on fonde soils (10 to 30 percent clay). These soils are too porous for efficient irrigation of paddy rice. There

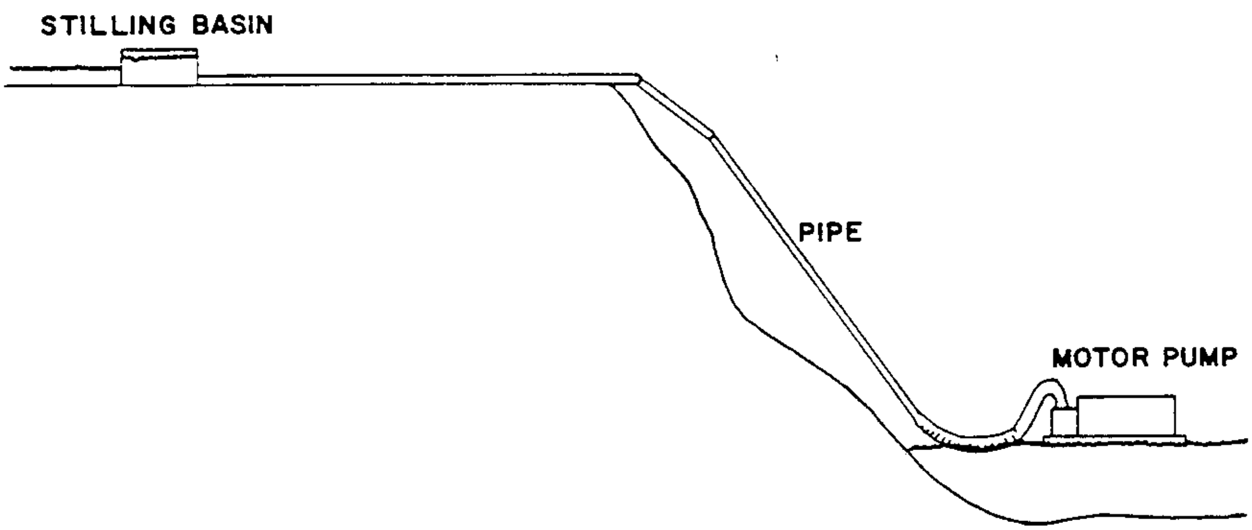


FIGURE 3.1 - PUMP FLOAT ON THE RIVER (SMALL SCALE PERIMETER)

Source: Patterson, William (1984)

is good drainage, but sub-surface leakage and percolation have resulted in large water losses. Canal leakage has been excessive in many perimeters as the water retention capacity is quite low because the soils are too sandy.

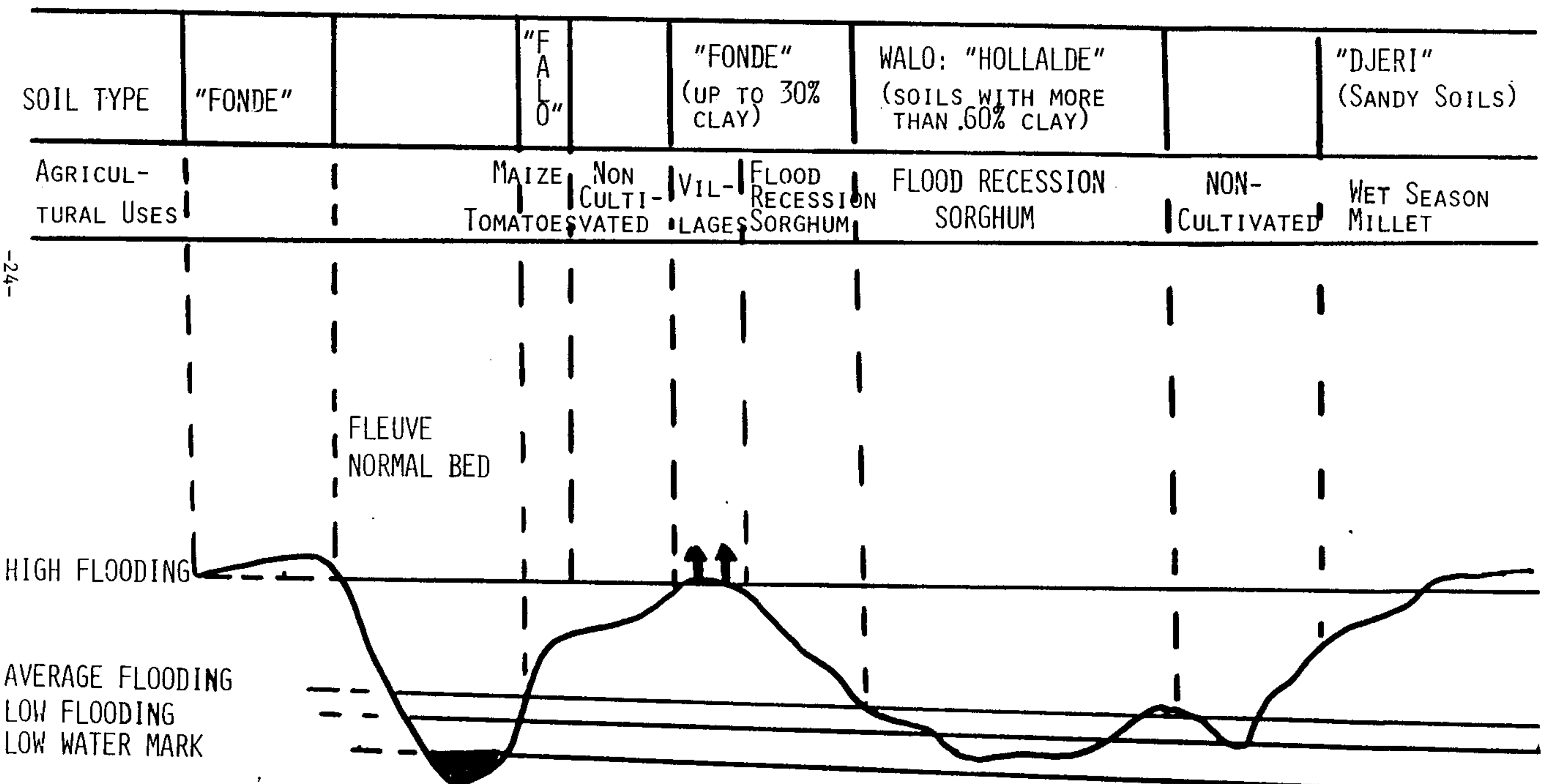
A better pumping system needs to be developed and leveling improved. These are operational problems beyond farmers' control. Often pumps break down at critical periods when paddy rice needs more water, causing yield reduction. Pump breakdown is more due to bureaucratic and unreliable channels of supply, than to the failings of pumps repairers in the field.

The major constraint to expanding small scale irrigated perimeters is the availability of suitable land. These perimeters can only be developed on fonde soils (Figure 3.2.) if the work has to be done manually by villagers. These soils represent a small percent of the total arable land in the Fleuve region. In addition, perimeters have to be constructed in zones where there is no major leveling work that has to be done by villagers. Small scale perimeters could be developed on Hollalde soils, but this would require constructing a peripheral dike for flood control and a drainage canal. These operations can be done only by heavy construction equipment. SONADER opposes using machinery to construct small-scale perimeters because it leads to high rice production costs.

As noted earlier, irrigated plot size varies between 0.1 to 1.0 hectare per family. A family includes an average of eight to ten individuals including three adult workers. Thus, production from this plot is insufficient to meet farm family food needs. This is why small perimeters farmers still pratice rainfed and flood recession agriculture. Many agricultural project analysts recommend that plot size should be expanded. But if there is no change in techniques used, labor shortages could constrain perimeter maintenance.

Maintenance has already been the weak link in many small and large scale irrigated perimeters. In the case of small-scale perimeters, the major handicap is the " common property" issue. Without a strong perimeter cooperative leader and a great committment

FIGURE 3.2 SPATIAL REPRESENTATION OF DIFFERENT SOILS IN THE SENEGAL RIVER VALLEY



SOURCE: RAMS (1980)

of all the cooperative members, the perimeter is maintained poorly. A lack of maintenance at the right time leads to the erosion and failure of physical works.

3.1.6 Costs

Existing small scale irrigated perimeters appear to be more productive per unit of investment than large ones. Levasseur (1980, p.4), an agricultural economist at WARDA, estimated construction costs per hectare averaged 215,000 ouguias ($ U.S.3,500) for small scale irrigated perimeters and 516,000 ouguias (about $ U.S.10,000) for large scale irrigated perimeters.

Some social scientists have been quick to claim that participative, small scale irrigated perimeters give a very high return to management and capital inputs. This claim probably assumes the labor input is free (a weak assumption). Perimeters are constructed in the dry season from January to May. During this period, villagers are still working on their walo plots and carrying out some minor maintenance on their earthern houses before the next rainy season arrives. During this time, farmers also try to do minor operations such as land clearing, preparation of new seeds on their rainfed plot.

Labor is the major cost component for a small scale perimeter construction. Excluding this cost may give a very high return to management and capital. Within the Sahel, project appraisal exercises have usually found that unless labor is entered as an unpriced "free" input, farmer have inadequate returns to repay scheme costs (WRS, 1984).

3.2 Large-Scale Irrigated Perimeters

3.2.1 Perimeter Design and Management

In contrast to the small scale perimeter approach, large scale perimeters are designed by the government without any initial association or committment from the peasants. After completion, plots are distributed to producers who fulfill certain criteria. A producer, who has a plot assigned to him, is required to pay SONADER for its services and is not allowed to pratice share-cropping on his plot. Plots vary between 0.5 and 3.0 hectares, and are grouped into hydraulic zones of ten hectares. This grouping of plots facilitates irrigation and mechanization of field operations.

Large-scale perimeters are managed without farmers' participation. Their size varies from perimeter to perimeter, depending upon their completion stage. The following four perimeters are in operation : 1)M'pourie perimeter in Rosso includes 1426 hectares. The perimeter is completed and is operating. This is the first large scale perimeter, and was implemented by the Peoples' Republic of China in 1967. 2) Gorgol perimeter in Kaedi covers 700 hectares. This perimeter is completed and is operating. c) Boghe perimeter in Gorgol will include 4,000 hectares, but only 385 hectares are cultivated at this moment. 4) The G Irrigation Projects in Foum Gleita has 552 hectares under cultivation. The objective is to develop 3,600 hectares by 1988. However, in this study data limitations restrict our study to the Gorgol perimeter in Kaedi.

3.2.2 Characteristics

Large scale perimeters are constructed with extensive use of machinery. The infrastructure and equipment for irrigation and drainage include: 1) dike works to protect against river flooding. 2) an irrigation network, ranging from primary channels to tertiary and water diffusion channels, with mechanisms to control water levels and distribute flows, and 3) one or several pumping station, which supply irrigated water and eliminate drainage water.

This is the structural framework found in all large scale irrigated perimeters. Differences involve only design details and different construction, such as covered or uncovered irrigation canals; different systems for regulating water levels and flows in the irrigation canals; and pumping units with internal combustion or electrical engines.

3.2.3 Objectives

The major objective of large-scale perimeters is to increase production at minimum costs. Their size may lead to economies of scale. The major advantage of this type of scheme is that it facilitates investment in equipment and more rapid diffusion of technical packages.

Large scale perimeters are also favored by both national governments and some donors to achieve political goals and for prestige. Some donors want to see big things bearing their name in large characters. Some national governments use these projects to solve their political problems (Bates 1981). A perimeter may be implemented in a region, not because of favorable socio-economic factors, but to maximize votes in this area. This is the case of Gorgol perimeter in Kaedi. Irrigation is associated with modernity, it impresses people . But these political goals and prestige may be achived at the cost of the economic efficiency. Perimeter location should be guided by technical-economic and social feasibility criteria. Otherwise, these projects will waste scarce national resources.

3.2.4 Problems

When project analysts design large scale perimeters, they focus on technical problems rather than on sociological problems. The Gorgol pilot project showed that sociological factors are one of the most important determinants of a large scale schemes success. These schemes have been implemented in very rich walo soils, which are at least partly flooded even in drought periods. Thus, farmers can expect to harvest sorghum from these lands--even in bad years. Using these floodable lands for irrigated perimeters conflicts directly with the land owners' interest in maintaining sorghum production.

The Gorgol pilot perimeter was completed in 1975 with 700 hectares cultivable. Yet, up to 1979 less than one half of the perimeter was cultivated. At that time, there was no national law regulating land holding rights in Mauritania. Therefore, land owners in the perimeter area demanded compensation from the government. They have requested bigger plots so they can share crop part of their assigned plots. This is against SONADER policy of giving the maximum possible number of farmers an opportunity to have their own plot in the perimeter. Also, the share cropper cannot earn enough revenues from his plot to cover his own production costs (mainly SONADER services) and give part of the production to the land owner.

Since 1979, before any perimeter is constructed, the government requires land owners to transfer their land rights to the government so the land can be developed for everyone. Gorgol perimeter's sociological problems have so sensitized planners that even donors require that sociological problems be solved before committing funds. Fortunately , the Mauritanian government passed an act stating that a land tenure survey has to be done before the implementation of any irrigated project (Water Management Synthesis II, 1985).

Because the creation of a water delivery system precedes the organization of farmers on large irrigated schemes and because of a mutual lack of understanding of each others' disciplines, neither water management specialists nor social scientists have clear ideas how technical and social system interface (Humphal et al., 1985, p.37). This situation could be avoided if "irrigation engineering" was an integrated field--combining element of design, construction, water management and agronomy within a single discipline.

The Gorgol perimeter experiences also illustrated that farmer participation at all the stages of perimeter design significantly contributes to successful implementation at later stages. National agricultural project analysts have, since the Gorgol case, advised against designing very large and compact block perimeter without farmers' participation. Instead, medium size perimeters which are irrigated by separate pumping stations should be developed. Each perimeter would include many different villagers, so that each village would correspond to a hydraulic zone. This would make the whole system easier to manage since each hydraulic zone would be cultivated by a homogeneous group of individuals. The goal is to develop a prototype perimeter that will combine the positive aspects involved in the large perimeter with the more effective incentives offered by the small perimeter.

3.2.5 Costs

The main system subdivisions, which often require the services of contractors with different levels of skill and specialities, are summarized as follows: general diking work; irrigation and drainage networks, with associated trails, pumping station; development of each parcel; agricultural buildings and various facilities; facilities for storage and transformation of harvest; and actual farming equipment.

Land development costs for large-scale perimeters are very high, averaging $10,000 per hectare developed, and could be even higher in some projects. For instance, in the case of the Gorgol irrigation project (World Bank funded project) at Foum Gleita, land development costs were $ 21,000 per hectare (Club du Sahel, 1977), but this is an extreme case where a water storage dam had to be built. High land development costs are explained by the fact that competition between contractors has been limited to a small number who have been established for many years in the Fleuve region and enjoy nearly monopoly. Perimeter implementation is started once donors give their funding commitment, but construction is spread over several years during which the unit prices of land development increases due to inflation.

Contractors are mostly French companies which charge high unit prices. These high contractors give the following reasons for explaining the unit prices: First, few materials are locally produced. Most of the materiels used for these perimeters's establishment and operation have to be imported using foreign currencies. Second, most of the roads are not good--increasing transportation costs. Third, there are few laborers specialized for large scale perimeters construction. Finally, financing sources impose conditions (like "buy French") which discriminate against the participation of compagnies authorized to submit bids by the State.

These prices can be lowered by encouraging the creation of national companies specialized in this type of work or at least which are able to do part of the work. To reduce costs, SONADER has itself started to undertake itself work such as leveling and parcel development, which seems to substantially reduce land development costs. Indeed, an OMVS/FAO study (1978) showed that the uses of local mechanized equipment units, able to do part of the work, can reduce land development costs by 20 to 40 percent. Lowering land development costs deserve a great deal of attention since the government plans to rely heavily on irrigation after completing the the two dams on the Fleuve. Since the Gorgol perimeter, farmers' participation is now required in establishing future large scale perimeters as in the case of the B perimeter.

CHAPTER IV

METHODOLOGY

The primary objective of this study is to estimate the economic and financial costs of rice production in small and large irrigated perimeters in the upstream regions of the Fleuve. For this comparative analysis , data representing the average small perimeter and the Pilot Gorgol large-scale scheme are used.

4.1 Calculating Economic Costs and Benefits

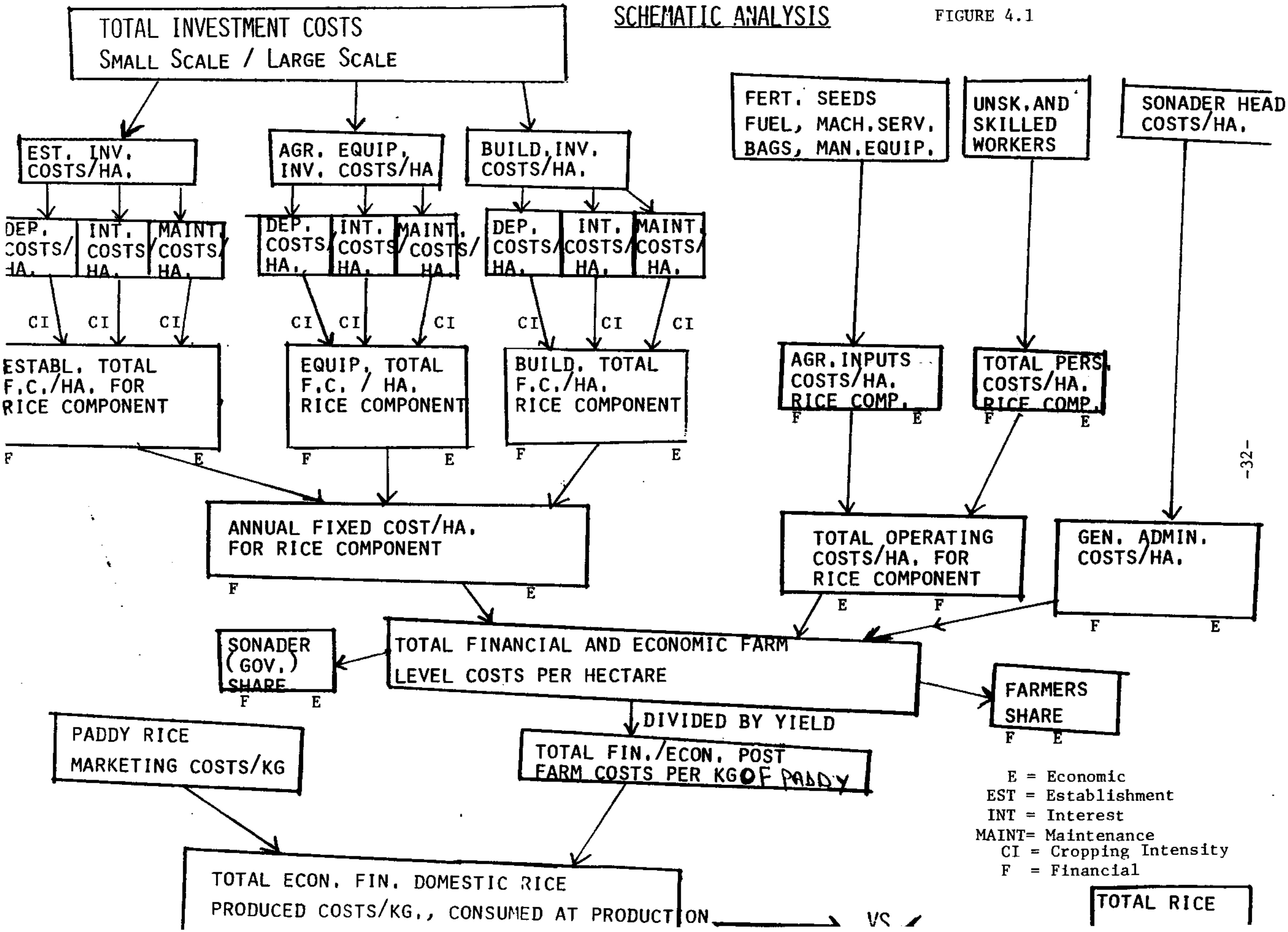
The methodology for evaluating the economic cost and benefits of the two irrigated rice perimeters is presented in this chapter. Figure 4.1 provides an overview of the analytical model used to guide the calculation of financial and economic costs and returns. However, before presenting the methodology, we will point out the major differences between financial and economic analysis.

Financial analysis of the project looks at the costs and the benefits from the viewpoint of the project participants who could be farmers, private sector firms, or public corporations. A major objective for farm financial analysis is to see how attractive a project is to the farm families participating in the project. Prevailing prices are used to measure the costs and the benefits.

Economic analysis on the other hand, determines the likelihood that a proposed project will contribute to the development of the total economy. It measures the costs and the benefits that accrue to the nation as a whole. For instance, income transfers such as government subsidies and export taxes are excluded in an economic analysis. However, financial and economic analysis are complementary. In economic analysis, market prices that do not reflect opportunity costs may be changed so that they represent the social and economic values of inputs and outputs. These adjusted prices are called "shadow" or "accounting" prices. Squire and Van der des Tak (1979, p. 26) define

SCHEMATIC ANALYSIS

FIGURE 4.1



E = Economic
EST = Establishment
INT = Interest
MAINT= Maintenance
CI = Cropping Intensity
F = Financial

. Shadow prices are defined as the value of the contribution to the country's basic socio- economic objectives made by any marginal change in the availabilities of the commodities or factors of production. Thus, shadow prices will depend on both the fundamental objectives of the country and the economic environment in which the marginal changes occurs. The economic environment typically will be determined by the physical constraints on resources and by various constraints that limit the government's control over economic developments. Any changes in objectives or constraints will therefore necessitate a change in the estimated shadow prices.

Two points should be made about this definition of shadow prices. First, these prices relate to an economic environment in which distortions may be expected to persist. They are not the equilibrium prices that would prevail in a distortion-free economy. However, this should not be interpreted as a passive acceptance of existing distortions. In fact, the estimation of second best shadow prices supplies important information that can be used as a basis for designing policies to remove the distortion. Second, those conducting the economic analysis should have a clear definition of the socio-economic goal of the government's development policy (Squire and Van der Tak, p.27)

Other economists define shadow prices as the value placed by the society on the opportunities foregone by using scarce resources for a given purpose. As such, they serve as a guide to how resources can be allocated to maximize social welfare. Shadow prices may differ from market prices because of a lack of competition among participants, externalities and distortions introduced by government policy. " Policy-induced distortions are perhaps the most pervasive, and at the same time the most complex, cause of divergence between market and shadow prices in less developed countries" . (Humphreys et al., 1981).

There are two main approaches to the social valuation of resources. First, shadow prices may be defined with respect to the objective of economic efficiency. Gittinger suggests this approach. The second approach is to build into shadow prices estimates the weights attached to various national goals. This appproch is recommended by Squire and Van Der Tak. In this case, the optimal policy mix maximizes net social benefits expressed in term of accounting prices that reflect these social weights. However, this analysis uses the approach that define shadow prices solely in terms of economic efficiency. This approach is chosen in this analysis because the other approach is quite complex analytically and involves a lot of arbitrary judgements on weights.

4.1.1 Shadow Exchange Rate

To adjust the financial account of a project to reflect economic values, we need to determine the proper premium that has to be attached to foreign exchange. The premium (overvaluation) for the Mauritanian currency (ougouias) has been determined by the World Bank in the case of this analysis. The World Bank estimates the overvaluation of the currency at 16-20 percent in 1980's. Therefore, 18 percent is used as foreign exchange premium in this analysis.

> The need to determine the foreign exchange premium arises because in many countries, as a result of trade policies (including tariffs on imported goods and subsidies on exports), people pay a premium on traded goods over what they pay for nontraded goods... The premium represents the additional amount that users of traded goods, on average and throughout the economy, are willing to pay for one more unit of traded goods (Gittinger, 1982, p. 247).

In economic analysis we can incorporate the premium on foreign exchange in two ways. First, you can multiply the official exchange rate by the foreign exchange premium, which yields a shadow exchange rate :

$$SER = OER\ (1 + Fx)$$

Where:

OER = official exchange rate

SER = shadow exchange rate

Fx = foreign exchange premium

This analysis uses this derivation of shadow exchange rate. Market prices (in domestic currency) of traded goods are then multiplied by 1.18. Applying the shadow exchange rate makes traded goods relatively more expansive in the domestic currency by the amount of the foreign exchange premium.

The second way of incorporating the foreign exchange premium in economic analysis is to reduce the domestic currencies values for nontraded goods items by an amount equivalent to the premium, sometimes called the "standard conversion factor". It is derived by dividing the official exchange rate by the shadow exchange rate or by taking the inverse of (1 + Fx). Market prices or shadow prices of nontraded items are then multiplied by this conversion factor to reduce them to their economic values. So the derivation of the standard "conversion factor" would be the following:

$$SCF = \frac{1}{(1 + Fx)} = \frac{OER}{SER}$$

Where :

Fx = foreign exchange premium

OER = official exchange rate

SER = shadow exchange rate

This second way is recommended by both Little and Mirrlees (1979) and Squire and Van der Tak (1974). These authors also suggest that conversion factors be calculated in social prices by including distribution weights. If one does not include income distribution on weights, then both the shadow exchange approach and the conversion factor approach lead to the same results in terms of how the project affects national income. The difference is whether prices are measured in terms of national income expressed in domestic prices (the shadow exchange rate approch) or national income expressed in world prices (the standard conversion factor approach). Once again, this analysis uses the shadow exchange rate approach.

4.1.2 Shadow Wage Rate

Shadow wage rates are calculated for both unskilled and skilled labor.

4.1.2.1 Unskilled Labor

Labor is scarce in many countries in Africa. This means that the marginal productivity of labor is greater than zero. It can be very low, but it is still positive. In the case of irrigated rice perimeters in Mauritania, both family labor and hired labor used for rice production are withdrawn from the cultivation of traditional food crops, such as millet, sorghum and cowpeas. In fact, farmers have experienced labor bottlenecks at the harvest time of rice during the main season (the rainy season). This occurs because the rice harvest coincides with the growing season of sorghum in flood recession land on walo soils.

Gittinger considers the shadow wage rate (SWR) for unskilled labor as to the opportunity cost of a worker removed from agricultural production in the traditional sector. In addition, Unido includes any increase in consumption occurring as a result of his higher wage. Indeed, Unido considers that this increase of consumption is a cost to the economy. Given that the government objective is to increase food self-sufficiency, so the increase in consumption by skilled workers can be considered as a benefit to the Mauritanian economy. Thus, the shadow wage for unskilled simply equals the opportunity cost of a worker removed from agricultural production in the traditional sector.

A recent World Bank's appraisal report (World Bank, 1985) assumes an opportunity cost of unskilled labor of 100 ougouias (76 ougouias = 1 U.S. dollar in 1986) per personday. This report also points out that this wage rate corresponds to an observed market wage rate that varies little throught the year. In addition, an USAID/OMVS study done in 1982 along the Senegal River Valley used the same rate for unkilled labor. This study argues that labor market in the Fleuve region is very developed and integrated, with few imperfections at least as far as hired labor is concerned. It also says that family labor may be willing to work on farm for a lower wage. However, the findings of these two studies seem to contradict the experience of farmers who face labor bottlenecks during the main rice harvest. Indeed, the author has personally observed an increase of market wage up to U.M.200 per personday. Thus, this point will be taken into account in our sentivity analysis. The analysis uses U.M.100 per manday in both economic and financial analysis, and assumes that family labor is willing to work at this wage rate.

4.1.2.2 Skilled Labor

"In most instances, skilled labor in developing countries is considered to be in rather short supply and would most likely be fully employed, even without the project being considered" (Gittinger, 1982). Hence, the wages paid to workers such as mechanics, extension agents and perimeter managers can be assumed to represent the true marginal value product of these workers, and the wages are entered at their marked values in the economic analysis. But this convention of accepting market wages as good estimates of economic values may undervalue skilled labor. Indeed, like in most developing countries, Mauritanian wages are set by the government and are lower than the opportunity cost of such labor, even including taxes and transfers. This explains why graduates students hesitate to return home at the end of their training. Wages are not adjusted by the amount of the inflation rate.

In the case of the foreign labor, such as the expatriates used on these rice perimeters, the economic value to the society is the salary plus the housing and other benefits paid. Yet, the cost of these expatriates have to be shadow priced since they are payed in foreign currency (at least for most of their salary).

4.1.2.3 Division of Costs into Foreign Exchange, Unskilled Labor, Skilled Labor and Domestic Components

Tables 4.1 and 4.2 give the costs components (foreign exchange, unskilled labor and skilled labor and domestic goods) for each category of cost considered in this study. The

TABLE 4.1. FOREIGN EXCHANGE, UNSKILLED LABOR AND DOMESTIC COMPONENTS USED FOR ECONOMIC ANALYSIS IN THE LARGE SCALE PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(BY TYPE OF MANAGEMENT, IN %)

	FOREIGN EXCHANGE		UNSKILLED LABOR		OTHER DOM.COSTS	
	SONADER	FARMERS	SONADER	FARMERS	SONADER	FARMERS
INVESTMENT COSTS						
DIKES	62.0	62.0	25.0	25.0	13.0	13.0
ROADS	62.0	62.0	25.0	25.0	13.0	13.0
SLUICE GATE	62.0	62.0	25.0	25.0	13.0	13.0
PUMPING STATION	62.0	62.0	25.0	25.0	13.0	13.0
IRRIGATION CANAL	62.0	62.0	25.0	25.0	13.0	13.0
DRAINAGE CANAL	62.0	62.0	25.0	25.0	13.0	13.0
LEVELING	62.0	62.0	25.0	25.0	13.0	13.0
ELECTRIC EXCHANGE	75.0	75.0	12.5	12.5	12.5	12.5
PERIMETER BUILDINGS	75.0	75.0	12.5	12.5	12.5	12.5
HYDRO. DEVICES	75.0	75.0	12.5	12.5	12.5	12.5
TECHNICAL SUPERVISION	90.0	90.0	Z	Z	10.0	10.0
CONSULTANT SERVICES	90.0	90.0	Z	Z	10.0	10.0
FARMERS TRAINING	46.0	46.0	46.0	46.0	8.0	8.0
INTEREST ON CAPITAL	Z	Z	Z	Z	100.0	100.0
PERIMETER MAINTENANCE	33.0	33.0	50.0	50.0	17.0	17.0
OPERATING COSTS						
SEEDS	25.0	25.0	50.0	50.0	25.0	25.0
FARMERS SHARE OF LAND DEVELOPMENT	Z	Z	Z	Z	Z	100.0
FERTILIZER	80.0	80.0	12.0	12.0	4.0	5.0
ELECTRIC POWER COSTS	33.0	50.0	Z	33.0	34.0	50.0
BAGS	80.0	80.0	12.0	12.0	8.0	8.0
MACHINERY SERVICES	84.0	58.0	16.0	13.0	Z	29.0
SMALL EQUIPMENT	35.0	35.0	56.0	56.0	9.0	9.0
LABOR (FAMILY)	Z	Z	100.0	100.0	Z	Z

SOURCE: WARDA, ANALYSE ECONOMIQUE DE LA CULTURE IRRIGUEE EN MAURITANIE, 10 MARS 1980.

DOM.= DOMESTIC   Z = ZERO   HYDRO. = HYDROMECHANICAL

TABLE 4.2. FOREIGN EXCHANGE, UNSKILLED LABOR AND DOMESTIC COMPONENTS USED FOR ECONOMIC ANALYSIS IN THE SMALL SCALE PERIMETER IN THE SENEGAL RIVER VALLEY, MAURITANIA, 1980. (IN %).

COSTS COMPONENT	FOREIGN EXCHANGE	DOMESTIC UNSK. LABOR	OTHER DOMESTIC COSTS
INVESTMENT COSTS			
Farmers training	60	24	16
Perimeter establishment	0	100	0
Motor pump and other equipment(a)	90	10	0
Perimeter supervision costs for expatriates	90	0	10
Cooperative fee	0	0	100
Perimeter maintenance	0	100	0
Interest on capital invested	0	0	100
Car	100		
Food for work(b)	100	0	0
OPERATING COSTS			
Family labor	0	100	0
Seeds	25	50	25
Fertilizer	80	15	5
Small equipment	35	56	9
Water supply costs(c)	80	16	4

SOURCE: WARDA, Analyse economique de la culture irriguee du riz en Mauritanie, 10 Mars 1980.

a)Other pump equipment includes: floating ferry, spare parts, flexible pipe, aluminum tubs , joinings and accessories.

b) Food for work comes from food aid.

c) They represent fuel, pump operator salary, maintenance and spare parts costs.

foreign exchange and the unskilled components are the proportions of total costs made up by those two items respectively. For all goods and services used to construct and operate these irrigated rice perimeters, the economic costs are calculated by substracting government taxes from and adding subsidies to the financial costs. Taxes and subsidies are considered as "direct " transfer payments. Transfer payments only represent shifts in claims to goods and services; they do not increase or reduce national income. Hence, they are omitted when converting financial costs to economic costs. Economic costs are calculated as follows:

$$E\,C = \left[E\,C - T + S\right] * \left[\left(FEX * \frac{SER}{OER}\right) + \left(UNKL * \frac{SWR}{MR} + DOM\right)\right]$$

Where:

E C = economic cost

F C = financial cost

T = taxes

S = subsidies

SER = shadow exchange rate

SWR = shadow wage rate

MR = market wage

FEX = foreign exchange component

UNKL = Unskilled labor component

DOM = skilled labor/domestic cost component

In the case of irrigated rice projects, all the goods and the services used are exempt from taxes. Thus, in our analysis, taxes are equal to zero.

The following example illustrates the calculation of economic costs per hectare for a perimeter maintenance:

Assumptions:

Total cost = U.M. 6000

Foreign Exchange Component = 33%

Domestic cost = 67%

Subsidies = taxes = 0

SER = 1.18

Calculations of adjusted foreign exchange component :

U.M. 6000 * .33 * 1.18 = U.M. 2336

Domestic component: U.M. 6000 * .67 * 1 = U.M. 4,020

Economic costs = U.M. 6,356

4.2 Computation Simplifications

The basic concept underlying benefit cost analysis is to compare the costs and the benefits of alternative projects over time. When the project analyst is doing this kind of comparison, he confronts the problem of finding some ways to evaluate projects that last more than one year and that have future costs and benefit streams. The usual method of addressing this problem is through discounting. Indeed, future costs and benefit streams are discounted to reflect their present value.

The three discounted measures commonly used for agricultural projects are the benefit- cost ratio, the net present worth and the internal rate of return. However, when insufficient times series data are not available, a static comparison of costs and benefits for a given year is acceptable.

Data for the year 1980 is used in this analysis as it is the only available data. Fortunately, 1980 is at least the fourth year of operation of these selected perimeters. By the fourth year of operation, annual costs and benefits are expected to reflect the long term patterns. Surprisingly, time series data on yields show high yields for certain perimeters during their first operating year. This is explained by the fact that most of the farmers on the perimeters already had rice irrigation experience through the neighboring Senegalese rice perimeter. Thus, we assume that per hectare costs and benefits for the fourth year in these irrigated perimeters reflect long term averages and can yield reliable comparisons.

4.2.1 Investment Costs and the Opportunity Cost of Capital

Ninety five percent of the funds invested in irrigated rice perimeters are provided by donor agencies through the Mauritanian government as a grant or loans. These loans have to be repaid over a period of 30-50 years with a real annual capital recovery of .25 percent. However, we used 40 and 20 years as the expected life of large and small perimeters, respectively, in our analysis. Mr Marciniac, the Mauritanian contry economist at the IMF, says that the Mauritanian commercial banks charge a real annual interest of 7 -13 % on loan (personal communication). Hence, for the economic analysis we assume 8 percent as the opportunity of capital funds to the economy, regardless of the source, since this more accurately reflects the commercial interest rate.

In computing the annual fixed costs, we use the annualized.depreciation and interest charges on both the average annual investment and annual maintenance. In the case of the irrigation projects, maintenance and repairs of the physical plant are fixed costs since repairs on water gates, leveling and dikes are necessary to maintain the income generating capacity of the project.

We are not aware of the procedures used in repaying the invested funds and we do not know the successive annuities. Therefore, we calculate the average annual investment and compute the annual interest on it. The interest paid annually on the average investment is included in the analysis as a fixed cost because it is a real and permanent cost during the life of the project regardless of the level of activity of the perimeters. The average investment on the basis of which interests costs are calculated is computed as following :

$$AI = \frac{A + SV}{2}$$

Where:

AI = average investment

A = acquisition cost

SV = salvage value

This gives the mean annual value of capital invested over the the life of the project.

However, computing interest charges on the average annual investment this way does not include the effect of the differences between investments in the flow of investment, returns and accumulated opportunity costs of invested capital. This method underestimates the interest costs for a project with a larger proportion of its investment costs up front, as is the case with perimeters, relative to projects with a more dispersed pattern of investment. However, available data are not sufficient to construct a time series of benefits and costs. Consequently, the reader should keep in mind that real fixed costs of the large perimeter have been underestimated relative to the small-scale perimeters.

Depreciation is the anticipated reduction in the value of an asset over time that is brought about through physical use or obsolescence. "In accounting, depreciation refers to the process of allocating a portion of the original cost of a fixed asset to each accounting period so that the value is gradually used up (" written off") during the course of the asset's estimated useful life" (Gittinger, 1982,p.467). In the case of these irrigated rice perimeters, it measures the amount of an asset consumed in executing a project. Depreciation in this analysis is calculated in the following way:

$$Dep = \frac{AQ - SV}{N}$$

Where:

Dep = depreciation

A Q = acquisition or initial investment

S V = salvage value

N = life of the asset

This gives the mean annual depreciation over the life of the asset.

CHAPTER V

COMPARATIVE COSTS OF RICE PRODUCTION IN LARGE AND SMALL SCALE IRRIGATED PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA

5.1 Procedures and Data Sources

The objective of this study is to compare in this chapter the cost of rice productions at two levels: first, between SONADER and farmers participating in a large scale irrigation scheme - which cultivates rice on part of the large perimeter by mechanizing all operations and second, between large and small scale irrigated perimeters. Furthermore, we will compare in the following chapters farmers' costs of production (without subsidies) on the two types of irrigated schemes.

The Fleuve is divided into four parts : the Delta Valley, the Lower Valley, the Middle Valley and the Upper Valley. The Upstream zone (Middle Valley and Lower Valley) includes several small perimeters and the large scale Pilot perimeter of Gorgol. To compare the costs of rice production between types of perimeter, we took the average fixed costs of the small perimeters that grew rice in 1980 season. Even though rice is the main crop recommended by SONADER for the main season (rainy season), some farmers prefer to grow other crops such as maize or sorghum, depending on their food security objective. To simplify analysis , the average of all small perimeter in the upstream zone is assumed to represent a small perimeter, and the area cultivated on a large scale perimeter by SONADER and by farmers are each assumed to represent a large scale perimeter.

The division of the Fleuve into rice production zones corresponds to SONADER's effort to decentralize its intervention in rice production. Each zone has a local SONADER office headed by a manager. The manager has at his disposal a staff including an agronomist, a mechanic, extension agents and administration personnel. The staff also includes expatriates financed by the project.

To compare costs between types of perimeters, costs for each of the selected perimeters are divided into fixed and operating costs. Fixed costs are broken into establishment costs, agricultural equipment, and building costs. For each fixed cost component, average annual depeciation, interest on invested capital and maintenance costs are calculated per hectare for each of the four selected perimeters. Of the three cost categories, only maintenance costs contain labor charge. In the case of the small perimeters, data for fixed costs are available for the Upper Valley perimeters. These costs are an average 317 hectares of small perimeters constructed in the Upper Valley with World Bank funds and are derived from a World Bank evaluation team report. The perimeters operating costs are divided into : agricultural inputs (fertilizer, seeds, pesticides and fuel for irrigation), personnel and general administration costs. SONADER general administration costs are divided among perimeters for each cost category in proportion to the total number of hectares cultivated in each perimeter.

Each year SONADER double crops rice with other crops, such as maize sorghum and vegetables. Rice is the most widely grown crop in these perimeters. From June to the beginning of December (rainy season) rice is the principal crop. During the cool dry season (from December to March) in all perimeters except the Delta, part of the land is occupied by maize. During the hot dry season (March to June) few perimeters (except in the Delta) grow rice because of the high pumping cost. Thereafter, we assume that there is no rice grown during dry season in this analysis. In the Delta, from January until June the river contains salt water coming from the sea which makes dry season irrigation almost impossible. As salt free and usable water is very limited in the dry season, a very small part of the land is cultivated during this period. A SONADER report (SONADER, 1981) estimates an average cropping intensity[2] of 1.25 for both large and small scale

2. Cropping intensity equals total hectares cultivated per year divided by the perimeter's total area.

perimeters in the Upstream zone of the Senegal River Valley in 1980. Thus, all the fixed costs per hectare are divided by 1.25 to reflect the costs borne by rice component. In fact, we assume that maize and rice bear the same amount of fixed costs per hectare. This underestimates rice fixed costs since it has a longer cycle.

Gross revenue per hectare in each perimeter is calculated based on the average yield reported from surveys carried out by SONADER extension agents who, supervised by their manager, estimate yield per hectare at harvest time. This is done by randomly selecting two square meters for each five hectares. The total number of plants, the number of the ears and grains per plant are weighed to estimate area yield.

After computing the gross revenue, the net revenue per hectare is computed by deducting fixed and operating costs from gross revenue. Finally, marketing and rice processing costs for each perimeter are deducted before directly comparing the alternative production systems.

This analysis uses secondary data that were derived partly from SONADER reports. These report's data may be judged reliable as they are collected by SONADER on field. SONADERs' Office of Evaluation has permanent enumerators stationed in all of the perimeters. Their role is to fill out questionnaires designed by this office to collect data for ex-post evaluation of irrigated rice perimeters. At least once a year, the office chief visits these rice production zones to supervise the enumerators. Complementary data were found studies by the West Africa Rice Development Association (WARDA), OMVS studies, and in information obtained from the World Bank and from graduate students' theses related to the rice irrigation on the River Valley. In addition, the author worked three years as a perimeter manager and uses his own experience to evaluate rice policy in this paper.

5.2 Fixed Costs

5.2.1 Perimeter Establishment

Tables 5.1 and 5.4 show the capital investment required for establishing one hectare of land on large and small scale perimeters, respectively, in the upstream zone in Mauritania. Table 5.2 indicates the expected life of the investments and maintenance rates assumed for large and small perimeters. Tables 5.3 and 5.5 summarize fixed costs for each of the perimeters - given their respective capital investment costs, depreciation and maintenance rates. As indicated in the first section of this chapter, investment costs are divided by the cropping intensity to get the fixed costs borne by the rice component.

Comparison of tables 5.3 and 5.5 shows that wide differences in perimeter establishment costs exist between large- and small-scale perimeters. Financial costs and economic costs for the large-scale perimeter are seven times higher than those for small-scale perimeter. These wide cost differences can be explained by greater capital investment required for dikes construction, earthwork and the pumping station in large-scale perimeter. These installations are constructed by foreign companies using highly qualified personnel and sophisticated machinery; the companies accordingly charge very high prices (see Chapter IV). Fixed costs for the large perimeters are also high because annual maintenance repairs are required to keep the perimeter operating. Small-scale perimeters, on the other hand, are entirely built by farmers under SONADER technicians' supervision. These perimeters are constructed on light cley soils that do not require sophiscated machinery and peripheral dike.

5.2.2 Agricultural Equipment

All agricultural equipment for the large perimeters belongs to SONADER. In contrast, in the small perimeters agricultural equipment belongs to the farmers. The first

TABLE 5.1. Capital investment per hectare for establishing the large scale perimeter in the upstream zone of the Senegal River Valley , Mauritania 1980 (Thousands of ouguias)

Invesment category	FINANCIAL	ECONOMIC
Dikes	159	177
Roads	32	35
Sluice gate	74	82
Irrigation canal	51	56
Drainage canal	50	56
Leveling	68	76
Control costs of perimeter establisment	16	19
Engineering consultant services	41	48
Total costs	491	549

Source: Appendix III

Economic costs are calculated by determining the cost of each investment category using table 4.1 and then multiplying the foreign exchange component of the financial cost by the estimated foreign exchange premium of 1.18 and the unskilled labor component by the ratio of the market rate to the opportunity cost.

$ U.S. 1 = U.M. 46

TABLE 5.2. COEFFICIENTS ASSUMED FOR ESTIMATING DEPRECIATION AND MAINTENANCE COSTS FOR THE LARGE AND SMALL SCALE IRRIGATED PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980. (THOUSANDS OF OUGUIAS)

INVESTMENT	ESTIMATED LIFE	ESTIMATED MAINTENANCE (IN %)
LARGE PERIMETER		
Dikes	40.0	2.0
Roads	40.0	2.0
Building for perimeter	20.0	5.0
Sluice gate	40.0	2.0
Irrigation canal	25.0	2.0
Leveling	20.0	4.0
Pumping station	10.0	10.0
Electric exchange	10.0	10.0
Perimeter establishment control costs	40.0	0.0
Engineering services	40.0	0.0
Cars and Trucks	5.0	15.0
Drainage canal	25.0	2.0
SMALL PERIMETER		
Construction	20.0	2.0
Pump and pumping equipm	10.0	10.0

SOURCE: OMVS, Etude socio-economique du Bassin du Fleuve Senegal partie C: L' introduction de la culture irriguee CH V p. 25.

TABLE 5.3. ANNUAL FIXED COSTS PER HECTARE FOR ESTABLISHING LARGE SCALE PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980. (THOUSANDS OF OUGUIAS)

COST COMPONENT	FINANCIAL	ECONOMIC
Depreciation	15.9	18.8
Maintenance	10.0	11.9
Interest(a)	0.6	19.7
Total fixed costs for all crops	26.6	50.3
Total cost/cropping intensity(b) (Rice component)	21.3	40.2

Source:Tables 5.1 and 5.2

$ U.S. = U.M.46

a) The capital invested in irrigation is loaned by international donors for 30 to 50 years at an interest rate of .25 percent. In computing financial cost, .25 percent is used as the annual interest on invested capital. However, 8 percent is used as the economic cost.
Average investment over the life of the project is calculated as follows:

(Investment cost + salvage value)/2

b) The cropping intensity is equal to total cultivated area per year divided by total area of the perimeter. It is equal to an average of 1.25 for all perimeters in the upstream zone of the Senegal River Valley. To get the total fixed costs borne by rice component, total fixed costs are divided by 1.25.

TABLE 5.4. CAPITAL INVESTMENT PER HECTARE FOR ESTABLISHING THE SMALL PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980. (THOUSANDS OF OUGUIAS)

	FARMERS		SONADER		TOTAL	
Capital investment	FINANCIAL	ECON	FIN	ECON	FIN	ECON
Land clearing	0.9	0.9	0.0	0.0	0.9	0.9
Burning	0.2	0.2	0.0	0.0	0.2	0.2
Main canal	1.3	1.3	0.0	0.0	1.3	1.3
Filling up	0.8	0.8	0.0	0.0	0.8	0.8
Secondary canal	4.2	4.2	0.0	0.0	4.2	4.2
Small dikes	3.2	3.2	0.0	0.0	3.2	3.2
Plot leveling	3.2	3.2	0.0	0.0	3.2	3.2
Expatriates for supervision	0.0	0.0	20.0	23.0	20.0	23.0
Local personnel (skilled)	0.0	0.0	5.0	5.0	5.0	5.0
Cars	0.0	0.0	9.0	10.6	9.0	10.6
Food for work	0.0	0.0	8.6	10.0	8.6	10.0
Total costs	13.60	13.60	42.60	48.60	56.20	62.20

Source : Appendixes I and II, Table 4.2.

$ U.S.1 = U.M.46

The opportunity cost of skilled labor is assumed to be equal to market wage rate . Thus, the economic value and the financial cost have the same value for each category of investment. In constrast, expatriates, cars, food for work have to be shadow priced in economic analysis since they are imported goods and the official exchange rate is overvaluated by 18 %.

TABLE 5.5. ANNUAL FIXED COSTS PER HECTARE FOR ESTABLISHING THE SMALL IRRIGATED PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980. (THOUSANDS OF OUGUIAS)

Cost component	FINANCIAL	ECONOMIC
Depreciation(a)	2.8	3.1
Maintenance	1.1	1.2
Interest on invested capital(b)	0.1	2.5
Total costs for all crops	4.0	6.8
Total costs for rice	3.2	5.5

Source: Table 5.4

a) Good estimates of expected life and maintenance costs per hectare for the necessary capital are not available. The actual life of the investment varies from one perimeter to another depending upon the quality of the initial land development and the level of maintenance. We assume a 20 year estimated life with zero salvage value and 2 percent annual maintenance for all costs components for constructing small perimeter as listed in appendixes I and II.

b) The interest on invested capital is 8 percent for the economic costs and .25 percent for the financial costs.

$ U.S.1 = U.M.46

motor pump received by small perimeter farmers is subsidized at 50 percent by SONADER. The second motor pump is subsidized at 33 percent. Farmers can get loans from the SONADER at an annual nominal interest rate of 8.5, percent which has to be repaid over a three year period.

Table 5.6 (a) shows the agricultural equipment required to cultivate one irrigated hectare in a large scale perimeter in the upstream zone. However, agricultural equipment such as, tractors, ploughs, spreaders and threshers are not included in this table to avoid double accounting. These equipment costs are reflected in the operating costs for land preparation, harrowing and harvesting. The large-scale irrigated perimeter used in this study bought much of its agricultural equipments during its first operating year_ some of which not has been used due to the original misspecification of the needs. Thus, only those actually used are included in estimating operating costs. Comparing Tables 5.6(a) and 5.7 shows that great differences in agricultural equipment and motor pump costs exist between large and small scale perimeters. Financial and economic costs for a large scale perimeter are three times higher than those of a small scale perimeter, even when not all agricultural equipment actually purchased for the large scale perimeter are included.

5.2.3 Building Costs

There are four types of buildings: administrative buildings, personnel buildings, parking and storage facilities, and pumping stations. Small-scale perimeters use a mobile pumping set, installed on floating platforms, which is moved by the users in response to fluctuations in the Senegal River to keep the set within its working capacity.

The same building costs for both small and large scale perimeters are assumed because there are no data for the small scale perimeter. However, this overestimates small perimeters costs since they use less personnel than the large ones. Houses built on the perimeter are provided without charge to the staff. Depreciation and maintenance

TABLE 5.6 (a). PUMPING STATION AND OTHER AGRICULTURAL EQUIPMENTS PER HECTARE REQUIRED FOR THE LARGE SCALE PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

EQUIPMENT	FINANCIAL	ECONOMIC
ELECTRIC POWER STATION	53	60
PUMPING STATION	89	98
VEHICULES	4	5
TOTAL COSTS	145	163

SOURCE : APPENDIX III

We did not include agrcultural equipment such as tractors, ploughs, spreaders etc.to avoid double counting. These will be accounted in the operating costs such as machinery services for land preparation, harrowing and harvesting.

$ U.S.1 = U.M.46

TABLE 5.6 (b) BUILDING COSTS PER HECTARE REQUIRED FOR THE LARGE PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER, MAURITANIA, 1980 (THOUSANDS OF OUGUIAS)

	FINANCIAL	ECONOMIC
HOUSING CONSTRUCTION	71	80
OPERATING BUILDINGS	30	34
TOTAL COSTS	101	114

SOURCE: APPENDIX III

Operating buildings correspond to parking place, storage facilities, and the pumping station building.

TABLE 5.7. PUMPING EQUIPMENT AND BUILDING COSTS PER HECTARE FOR THE SMALL SCALE IRRIGATED PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

COST CATEGORY	FINANCIAL	ECONOMIC
MOTOR PUMP	44	52
OTHER PUMP EQUIPMENT(a)	2	3
BUILDING COSTS(b)	101	114
TOTAL COSTS	147	168

SOURCES : APPENDIX II

SONADER, ETUDE DE LA FILIERE PADDY/RIZ A LA

SONADER, DONNEES DE BASE, SEPTEMBRE 1984.

a) Includes floating ferry, spare parts, flexible pipe, aluminum tubes, joinings and accessories.

b) We do not have data concerning the building costs of the small perimeter. We assume that the small scale perimeter has the same building costs as those of the large scale perimeter. This may overestimate the building costs of the small perimeter.

$ U.S.1 = U.M.46

TABLE 5.8. ANNUAL FIXED COSTS OF BUILDINGS, PUMPING EQUIPMENT AND OTHER EQUIPMENT PER HECTARE FOR THE LARGE AND SMALL SCALE IRRIGATED PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

COST CATEGORY	LARGE PERIMETER		SMALL PERIMETER	
	FIN.	ECONOMIC	FIN	ECONOMIC
Depreciation	20	22	7	8
Maintenance	19	22	10	11
Interest on capital invested	1	22	0	13
Total costs for all crops	40	66	17	33
Total costs for rice component	32	53	14	26

SOURCE: Tables 5.2, 5.6 and 5.7

FIN = FINANCIAL $ U.S.1 = U.M.46

costs are supported by the perimeter. The estimated life of each building is twenty years and their maintenance cost is five percent. Building financial and economic costs per hectare are U.M. 100,500 and U.M. 114,000, respectively.

5.2.4 Summary of Investment Costs

Table 5.9 summarizes the financial and economic capital investment required to establish one hectare of irrigated land. The economic costs are, respectively, U.M.826,000 ($U.S.17,956) for the large scale perimeter and U.M.229,000 ($U.S.5,000) for a small-scale perimeter. Thus, required capital investment is almost three and half times higher in the large perimeter than in the small perimeter. Table 5.10, which compares, the annual fixed costs per hectare between small and large scale perimeters also indicates a similar difference in fixed costs between the two types of perimeter. However, in the large scale perimeter, SONADER does not charge all the fixed costs to farmers. Farmers pay only U.M. 10,400 per hectare per growing season. This amount, represents about 11 percent of the rice components' total economic fixed costs which corresponds to the farmers'financial costs. For the economic analysis, we count the full shadow priced total fixed costs, which amounts to U.M.93,000 (Table 5.10). The small perimeters, with substantial peasant participation, requires far less investment than large, more centrally controlled perimeters.

On Senegalese side of the Fleuve, Diallo (1980) found that the financial capital investment costs required to establish one hectare of irrigated land in 1978 are, respectively 260,000 CFAF (U.M.52,000) for small perimeters and 1,200,000 CFAF (U.M.240,000) for large perimeter. On the Mauritanian side of the Fleuve, these costs are, respectively, U.M. 737,000 for the large perimeter and U.M. 202,000 for the small perimeter. Thus, financial capital investment costs per hectare may be higher in Mauritania than in Senegal even when general inflation is taken into account. The costs

TABLE 5.9.SUMMARY OF THE FINANCIAL AND ECONOMIC COSTS OF CAPITAL INVESTMENT REQUIRED FOR ONE HECTARE OF IRRIGATED LAND IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

COST CATEGORY	LARGE PERIMETER		SMALL PERIMETER	
	FIN	ECON	FIN	ECON
PERIMETER ESTABLISMENT	491	549	56	62
AGRICULTURAL EQUIPMENT	145	163	46	55
BUILDING COSTS	101	114	101	114
TOTAL COSTS FOR ALL CROPS	737	826	203	231

SOURCE: TABLES 5.1 , 5.4 ,5.6 a) and 5.7

TABLE 5.10. ANNUAL FIXED COSTS PER HECTARE: A COMPARISON BETWEEN THE LARGE AND SMALL SCALE IRRIGATED PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

COST COMPONENT	LARGE PERIMETER(a)		SMALL PERIMETER	
	FIN	ECON	FIN	ECON
I) PERIMETER ESTABLISHMENT				
DEPRECIATION	15.9	18.7	2.8	3.1
MAINTENANCE	10.0	11.8	1.1	1.2
INTEREST	0.6	19.6	0.1	2.4
SUB TOTAL	26.5	50.1	3.9	6.7
II) EQUIPMENT AND BUILDINGS				
DEPRECIATION	19.9	22.2	7.3	8.4
MAINTENANCE	19.2	21.6	9.6	11.0
INTEREST	0.6	22.1	0.3	13.4
SUB TOTAL	39.7	65.9	17.2	32.8
TOTAL COSTS FOR ALL CROPS	66.2	116.0	21.1	39.5
TOTAL COSTS FOR RICE COMPONENT	53.0	93.0	17.1	31.8

SOURCE : TABLES 5.3. 5.5 and 5.8

$ U.S.1 = U.M.46

(a) Farmers pay only u.m.10,400 per hectare per growing season which represents about 11 percent of the rice component's total economic fixed costs.

differences may be related to better routes and local production of part of the materiels used in perimeters construction in Senegal.

5.3 Operating Costs

Operating costs concern only rice production and are divided into the following cost categories: 1) fertilizer 2) seeds 3)insecticides 4) fuel for water supply 5) machinery services 6) bags 7) manual equipment 8) and other costs.

5.3.1 Fertilizer

Irrigated rice is a relatively a new technology for Mauritanian farmers. The introduction and the adoption of this new technology require a favorable environment in terms of institutions and low input prices. To encourage farmers to adopt this new technology, the government has subsidized most of the inputs used for rice production. Fertilizer is subsidized through direct transfer from the government to farmers cultivating publicly irrigated rice perimeters.

In the financial analysis, subsidies raise no problems. Subsidies on fertilizer are transfer payment to farmers. The subsidy on fertilizer reduces its cost to the farmer and thereby increases his income. In the financial analysis, each entity is charged that part of the total cost which it actually pays. Fertilizer has been subsidized at a decreasing rate since 1980 when the government decided to create a credit line (under SONADER supervision) for subsidizing and financing agricultural inputs used in rice production. The rate of subsidy was 50 percent from 1980 to 1984, but reduced to 25 percent in 1985. Farmers are expected to pay the full cost in 1986. SONADER buys fertilizer from the market and supplies farmers at these prices. Market cost for all types of fertilizer was 21 ouguias per kg in 1980 so, we used 10.5 ouguias and 21 ouguias per kg for farmers' and SONADER's management, respectively. These prices are delivered fertilizer prices at the perimeter.

Soils used for irrigated rice are usually rich in potassium, but need phosphorus and nitrogen for plant consumption. SONADER has recommended 160 kg and 300 kg per hectare of phosphorus and urea, respectively, for all perimeters. However, this rate of phosphorus is incorporated into the soil by SONADER every three years. Therefore, only 43 kg per hectare of phosphorus is allocated to the rice component (160 / 3 / 1.25). Moreover, a survey done by SONADER enumerators found that farmers in both small and large scale perimeters actually use an average of 280 kg per hectare of urea. Consequently, the fertilizer financial costs for both types of perimeters are as follows :

For farmers:

Urea : 280 kg/ha * U.M.10.5 /kg = U.M. 2940/ha

Phosphorus : 43 kg/ha * 10.5 U.M./kg = U.M.451.5/ha

So, total fertilizer cost per hectare = U.M. 3,391.5/ha

For SONADER:

Urea :300 kg/ha. * U.M.21 /kg= U.M.6,300/ha

Phosphorus : 40 kg * 21 U.M./kg = U.M.849

Thus, the total fertilizer cost per hectare = U.M. 7,140/ha.

For economic analysis, market prices are adjusted to reflect the the real costs. The economic cost is equal to the financial cost plus the subsidies, and then shadow priced for foreign exchange component. All the agricultural inputs used for rice production are exempt of tax). Therefore, in this case, the economic value of resources used by farmers and SONADER are equal to U.M. 6720 and U.M. 8168 per hectare for farmers's and SONADER's management, respectively.

5.3.2 Seeds

Seed is not subsidized, but sold to farmers at full cost. SONADER has not started multipliying seed on these perimeters, so seed is bought from Senegal at U.M.30 per kg. This situation cannot continue forever because the forthcoming irrigation expansion, after the two dams on the Fleuve are completed, will require a tremendous amount of seed. Consequently, SONADER needs to use few hectares for seed multiplication. SONADER recommends a seed rate of 40 kg per hectare. Thus, the financial cost is as follows:

40 kg/ha. * 30 U.M./kg = U.M.1200/ha.

The economic value of resources used by SONADER and farmers for seeds is U.M.1254/ha. This is obtained by shadow pricing the financial cost with the use of Table 4.1. The same rate of seed is recommended for both large and small scale irrigated perimeters.

5.3.3 Insecticides

There are wide fluctuations in the use of insecticides from year-to-year and from one perimeter to the next. These products are not applied prophylactically, but in response to pest outbreaks. There was no pest disease outbreaks on these perimeters during 1980. However, a SONADER report (1984) indicated that one hectare requires U.M. 200 for pest disease outbreaks in average. Thus, U.M. 200 and U.M. 100 are allocated for insecticides as financial cost rspectively, for farmers and SONADER. Assuming that 80% of insecticides costs are imported, the economic values are U.M. 218 and U.M. 119 per hectare respectively, for SONADER and farmers.

5.3.4 Machinery Services

In large scale irrigated perimeters, SONADER uses machinery services for land preparation, seeding, fertilizing and threshing.In contrast, farmers in large perimeters use machinery services only for land preparation and use cart to transport their harvested paddy. This is illustrated in Table 5.11 which shows that SONADER machinery services are five times higher than those of the farmers' cultivation on the large perimeters. Land preparation requires deep plowing every three to four years and cross

TABLE 5.11. MACHINERY SERVICES COSTS PER HECTARE FOR FARMERS AND SONADER IN THE LARGE SCALE PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(OF OUGUIAS)

COST CATEGORY	SONADER		FARMERS	
	FIN	ECON	FIN	ECON
Land preparation for rice nursery bed	760	854	0	0
Deep plowing(a)	960	1085	867	1085
Mechanic fertilizing(b)	1660	1919	277	311
Harrowing	680	763	0	0
Transport	760	854	0	0
Threshing	360	418	0	0
Total	5180	5893	1144	1396

SOURCE : APPENDIXES V AND VI

(a)The cost of deep ploughing is divided by three since deep ploughing is done only once every three years. However, farmers pay a subsidized rate of 2,600 ouguias per hectare for harrowing and deep plowing their plots. Dividing this cost by 3, we get a plowing cost of U.M 867 per hectare for 1980.

(b) For SONADER, mechanical fertilizing includes fertilizing costs for phosphorus and urea. In contrast, for farmers, they include only phosphorus fertilizing because urea fertilizing is done manually.

harrowing in intervening years. Threshing is also done mechanically in the case of SONADER.

SONADER provides machinery services to farmers. SONADER owns all the agricultural equipment and provides contract services to farmers at subsidized prices. This explains why they pay only U.M.2,600 per hectare per 3 years (U.M. 867/ha/year) for deep plowing and harrowing. This cost is used as the financial cost, but it has to be adjusted by the amount of the subsidy, then to shadow priced for the foreign exchange component to reflect the economic value of resources used for these services. SONADER machinery services costs include : amortization costs, maintenance, repair costs and operating costs.

In the small scale perimeter, machinery services are not used. Family labor performs all the tasks. Family labor uses in both small and large scale irrigated perimeters will be discussed in a section E.

5.3.5 Fuel for Water Supply

For the small-scale irrigated perimeters, operating costs for irrigation includes gasoline and oil costs for using the pump. Appendix VII illustrates these financial costs. They represent U.M. 6,300 and U.M.600, respectively, for gasoline and oil per hectare of irrigated rice. Thus, one hectare of irrigated rice requires U.M. 6,900 for fuel costs. As one hectare of irrigated rice requires about 16,000 kiloliters (including losses) of water, the fuel cost is U.M..43 per kiloliter of supplied water. These financial costs are converted to the economic values of resources used by farmers using Table 4.2. Economic values of fuel are U.M.7,894 per hectare and U.M. 0.5 per kiloliter.

In large scale irrigated perimeter, fuel costs represent charges for producing power because electric pumps are used. A SONADER report (SONADER, 1980) shows that financial power costs are U.M.3,840 and U.M. 0.24 per hectare and per kiloliter, respectively. Using Table 4.2, the ecnomic values of resources are calculated as U.M.

TABLE 5.12. COSTS (a) OF FUEL FOR PUMPING WATER IN IRRIGATED PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

	LARGE PERIMETER		SMALL PERIMETER	
	FIN	ECON	FIN	ECON
Cost per kiloliter	.24	.27	.43	.50
Cost per hectare	3840.0	4393.0	6900.0	7894.0

SOURCES:

APPENDIX VII

SONADER : Evaluation campagne hivernage 1980 , p.17

(a) However, these figures cannot be directly compared because the large perimeter figures do not include pumping station operator salary.

4,393 and U.M. 27 for fuel costs per hectare and per kiloliter; respectively. However, these figures cannot be compared to those of the small scale irrigated perimeter because large scale irrigated perimeter figures do not include pumping station operator salary. The pumping station operator salary is already in the large scale perimeter personnel costs. Farmers pay only U.M.3,600 per hectare, which corresponds to U.M.22 per kiloliter for water supply fuel costs. This represents both the farmers' financial costs. Economic values of resources used by farmers and financial costs for both large and small scale irrigated perimeters are summarized in Table 5.12.

5.3.6 Bags Costs

After harvest, the paddy is loaded into bags. At this time farmers repay their short-term loan (inputs) that they received from SONADER at the beginning of the season. These loans can be reimbursed either in paddy or in cash. In general, farmers prefer to reimburse their loan in paddy. The paddy portion designated to the loan reimbursement is transported to SONADER's mill. The bagging cost to load the paddy is estimated to U.M. 1,250 per hectare. This cost is the same for both the large and the small scale perimeters. Using table 4.2, the economic value of resources used by SONADER per hectare is U.M.1,340.

5.3.7 Manual Equipment

In the large perimeter, manual equipment include: sickles, hoes and sticks which are mostly used by farmers. Farmers use hoes for leveling before they start irrigating their perimeters. Sickles are used for harvesting the paddy. Threshing is done both mechanically and manually by SONADER. In contrast, farmers use sticks to thresh their harvested paddy. Carts, which are usually rented, are used to transport farmers paddy to home or to the SONADER. Table 5.13 gives manual equipment costs per hectare required for large and small scale irrigated perimeters. At the large scale perimeter

TABLE 5.13. MANUAL EQUIPMENT COSTS PER HECTARE FOR LARGE AND SMALL PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

	LARGE SCALE IRRIGATED PERIMETER			SMALL PERIMETER	
	SONADER	FARMERS			
TYPES	FIN	FIN	ECON	FIN	ECON
Sickles(a	0.5	0.5	0.5	0.5	0.5
Hoes(a)	0.0	0.6	0.6	1.3	1.4
Sticks(a)	0.0	0.2	0.2	0.2	0.2
Cart(b)	0.0	0.8	0.9	0.8	0.8
Winnowing basket	0.0	0.0	0.0	0.1	0.1
Total	0.5	2.1	2.2	2.9	3.0

SOURCE :APPENDIXES V AND VI

(a) These manual equipment has an expected life of two years, so we count only half of their required cost per hectare for 1980.

(b) The cart is rented, and we assume that its market is competitive. Thus, the economic cost is equal to the market price (financial cost).

FIN = Financial costs   ECON = Economic costs

$ U.S.1 = U.M 46

level, farmers' financial costs and economic value of resources used by farmers are four times those of SONADER. At the small scale level, farmers use all the manual equipment used on the large-scale perimeter plus the winnowing basket to winnow the threshed paddy.

5.3.8 Other Costs

Additional costs include gasoline costs for cars and trucks, and writing paper. SONADER estimated the costs at about U.M.500 per hectare for the rice component on large scale perimeters. For small-scale perimeters, they amount to U.M.1,135 per hectare for the rice component. The difference between these two costs is explained by the high gasoline costs for the small perimeter. Small perimeters are spread throughout a region and the headquarter personnel has to travel among perimeters are located. These costs represent financial costs. Gasoline and writing paper are made locally but the raw materiel is imported. We assume that the foreign exchange component represents 40 percent of the total costs for producing these items. Thus, the economic value of resources by the perimeters are U.M. 536 and U.M.1276 per hectare for large-and small-scale irrigated perimeters, respectively. These costs are not charged to farmers.

5.4 General Administration Costs

The general administration costs of the SONADER amounted to 147.7 million ouguias in the 1980 budget (Appendix IX). These costs include all the operating costs of the central services (personnel, studies, materiel, rent, accounting, etc) in Nouakchott, the capital city. They exclude the investments, maintenance and operating costs of the perimeters. In 1980, SONADER was supervising 3,000 hectares under a full water control system. Dividing the total costs by the number of hectares cultivated, the average cost per hectare for SONADER administration expenses is: U.M. 47,200 Dividing this cost per the cropping intensity of 1.25, gives a cost per hectare of U.M. 37,760.

5.5 Family Labor

Farmers' labor in the Senegal River Valley consists of family labor. Some farmers with large farms and / or small families employ hired laborers during the peak demand periods (weeding and havesting, threshing and winnowing) for U.M.200 per day. As noted earlier, this wage rate is used in our sensitivity analysis. For the time being, a wage rate of U.M.100 per day (the opportunity of a worker) is assumed for the entire rainy season in both financial and economic analysis.

Labor inputs in this study are expressed in persondays, assuming an equal weight for labor for both males and females working in the field. A child's day of work is assumed equal to 0.5 persondays. Birdscaring is essentially done by children. Table 5.14 gives the details on labor input per hectare for large and small scale irrigated perimeters.

In large scale perimeters, land preparation is done mechanically and the other tasks are performed by family labor. However, this is at the farmers' level. Under SONADER management, more labor input is required because it uses only hired laborers whose productivity is less than that of family labor.

In small-scale irrigated perimeters, land preparation begins in early June with traditional tools (hand hoes). Seeding, weeding, harvesting and threshing are done manually. Rice is transplanted by hand in individual small plots. Paddy is sickle-harvested by all family members from October through December and left to dry in the field for two days before threshing. Threshing is done over a barrel by women, who also winnow the grain.

5.6 Perimeter Personnel Costs

Personnel in large-and small-scale irrigated perimeters carry out the following functions: 1) general administration, 2)extension services, 3)maintenance and repairs, and 4) marketing and input distributions.

TABLE 5.14 FAMILY LABOR INPUT FOR PADDY RICE CULTIVATION IN THE LARGE AND SMALL SCALE IRRIGATED PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1988.

(THOUSANDS OF OUGUIAS)

	LARGE PERIMETER FARMERS MANAGEMENT		SMALL PERIMETER(a)	
ACTIVITIES	MANDAYS	FIN	MANDAYS	FIN
Land preparation			30	3
Nursery bed	6	0.6	8	0.8
Fertilizing	3	0.3	3	0.3
Preirrigation	15	1.5	5	0.5
Transplanting	35	3.5	22	2.2
Weeding	30	3	30	3
Birdscaring(b)	0	0	30	3
Harvesting	28	2.8	30	3
Threshing	30	3	30	3
Winnowing	0	0	10	1
Tranportation	3	0.3	10	1
Total	150	15	208	20.8
Economic cost		15		20.8

Source : Appendixes IV and V

(a) For small scale irrigated perimeters the family labor input does not include perimeter establisment costs (land cleaning, canal construction etc.). These were computed under investment costs. It includes leveling and preparation of the soil for the new crop, in addition to crop production labor.

b) Birdcaring is done by children, we assume that a child' day is equal to .5 mandays.

$ U.S.1 = U.M.46

There are three types of personnel working in the perimeters: 1) permanent workers, 2) temporary workers, and 3) foreign technical assistants.

5.6.1 Permanent Workers

These workers include civil servants assigned by the Mauritanian government to SONADER or employees recruited by SONADER. The former receive their salaries from the government plus a monthly indemnity from SONADER. The latter are paid from SONADER's budget. The economic value of resources used by the perimeters for permanent workers and financial cost of permanent workers are the same since they are considered to be skilled labor. These costs include net salary, social security charges, taxes and transport costs. Table 5.15 shows that permanent personnel costs for large perimeters are almost two times those of personnel employed in small perimeters. In general, large perimeters hire more workers than small perimeters (even if they manage the same number of hectares). This is explained by the way each type of perimeter is managed. Small-scale perimeters are the farmers' property and are constructed at their request. Farmers associations are established at an early stage of perimeter design. SONADER's role is to provide technical assistance, especially during the first three or four years of the perimeter's operation. In contrast, large perimeters are designed by the government without any initial commitment of the famers who will use this perimeter. Thus, SONADER has to perform all tasks and farmers are only responsable for their plot.

5.6.2 Temporary Workers

In large-scale perimeters, unskilled laborers are recruited at the beginning of each season to maintain the perimeter. Drivers are hired to operate tractors and trucks for machinery services. In the small-scale perimeter, unskilled laborers are recruited to complement family labor to maintain the perimeter before the new growing season starts. These unskilled laborers and tractor drivers are paid by SONADER . In 1980,

TABLE 5.15. TOTAL PERSONNEL COSTS PER HECTARE USED ON THE LARGE AND SMALL SCALE PERIMETERS IN THE UPSTREAM ZONE OF THE FLEUVE, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

COST COMPONENT	LARGE PERIMETER		SMALL PERIMETER	
	FIN	ECON	FIN	ECON
LOCAL PERSONNEL				
Permanent personnel	10.0	10.0	4.7	4.7
TEMPORARY WORKERS(a)	3.4	3.4	0.1	0.1
Subtotal	13.4	13.4	4.8	4.8
PERSONNEL EXPATRIATES(b)	24.0	28.3	6.0	7.1
Total costs for all crops	37.4	41.7	10.8	11.9
Total cost for rice	29.9	33.3	8.6	9.5

SOURCES:

Cappeletti, Rapport d'activite du perimetre pilote du gorgol decembre 1980, p.17.

SONADER: Budget exploitation PPV, 1980. annexe 1/2

a) We do not know their number; we assume that they were hired at their opportunity cost.

b) These costs do not include housing costs. Technical assistants are housed by the project, and we already included building costs in the fixed costs. However, these expatriate personnel are generally paid in in foreign currencies, so we have to shadow price the financial costs to obtain the economic costs.

$ U.S.1 = U.M.46

large perimeter permanent workers, costs were 34 times those of a small scale perimeter. This is shown in Table 5.15, which summarizes the economic values of resources used by the perimeters and financial costs for temporary and permanent workers.

5.6.3 Foreign Technical Assistants

Foreign technicians are sent by donor agencies or recruited by SONADER to do specialized jobs for which there are no qualified Mauritanians available. Those working at the SONADER headquaters in Nouackchott are already included in the SONADER general administration costs. At the perimeter level, foreign technicians guide the control and supervision of the perimeter establishment and help local technicians to operate the perimeter. Table 5.15 gives economic value of resources used by perimeters and financial costs of foreign technicians. The perimeter establishment technical supervision costs were already included in the perimeter fixed costs. The annual cost of a technical assistant includes salaries, transportation, and indemnities which are paid by the donor agencies. However, we included only those technical assistants borne by loans. Including the portion of costs covered by grants would further increase the costs of the large perimeters relative to those of the small ones. In general, these costs are paid in foreign currencies, so they must be shadow priced to obtain the economic costs. It is assumed that all the costs, except the housing costs, are paid in foreign currencies.

5.6.4 Summary Personnel Costs

Table 5.15 summarizes personnel costs. It shows that in the large perimeter, personnel costs are three times those of the small perimeter. This great difference is explained by the fact that the large-scale perimeter uses more technical assistants than small-scale perimeter. Table 5.15 shows that foreign technician costs represent 68 percent of the total personnel costs. The large scale perimeter has more sophisticated technology than small scale perimeters, and this requires the uses of more specialized workers.

5.7 Operating Costs Summary

Table 5.16 summarizes the operating costs per hectare for large and small scale irrigated perimeters. The total financial cost per hectare varies between U.M. 13,000 and U.M. 50,000 for the large perimeter under SONADER management, a ratio of 4 to 1. SONADER cost per hectare in the large scale perimeter is four times as high as those of the farmers'. In financial terms, farmers' costs in the small scale irrigated perimeter are twice as high as those of those operating in the large perimeter. This difference is mostly due to the high pumping costs of the small perimeter, which include all the costs, whereas those of the large perimeter represent only the electric subsidized power costs for running pumps. The total economic values of resources used by SONADER and farmers per hectare are U.M. 55,000 and U.M. 31,000 respectively, for the large perimeter (SONADER management) and the small perimeter. Thus, the economic value of resources used by large perimeters is almost 2 times as high as those of the small one.

Table 5.16 shows great differences between large (SONADER' management) and small scale irrigated costs. These differences are mostly due to the uses of machinery services by SONADER for most of the perimeter operating services (land preparation, seeding, fertilizing and threshing).

5.8 Summary of the Farm Level Production Costs

Table 5.17 summarizes the financial and economic cost per hectare of producing paddy rice in the upstream zone of the Senegal River Valley in Mauritania. Table 5.18 gives the distribution of the financial cost between farmers and the government. The government share corresponds to the difference between the total financial rice production costs (without subsidies) and farmers costs. The economic value of resources

TABLE 5.16. OPERATING COSTS ON A PER HECTARE BASIS FOR THE LARGE AND SMALL- SCALE PERIMETERS IN THE UPSTREAM ZONE OF THE FLEUVE, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

COST CATEGORY	LARGE SCALE PERIMETER				SMALL PERIMETER	
	SONADER MANAGEMENT		FARMERS MANAGEMENT			
	FIN	ECON	FIN	ECON	FIN	ECON
Fertilizer	6.8	7.7	3.4	7.7	3.4	6.7
Seeds	1.2	1.3	1.2	1.5	1.2	1.3
Machinery services	5.2	5.9	1.1	1.4	0.0	0.0
Water supply fuel	3.8	4.4	3.6	4.4	6.9	8.0
Bags	1.3	1.3	1.3	1.3	1.3	1.3
Mannual equipment	0.5	0.5	2.1	2.2	2.9	3.0
Other costs	0.5	0.6	0.0	0.0	1.1	1.2
Personnel	29.9	33.3	0.0	0.0	8.6	9.5
Insecticides	0.2	0.2	0.1	0.2	0.1	0.1
Total for rice	49.3	55.2	12.8	18.8	25.4	31.1

SOURCES: TABLES 5.11, 5.12 AND 5.13

$ U.S.1 = U.M.46

used by SONADER and farmers per hectare of producing paddy rice varies from U.M. 164,000 to U.M. 122,500. Large scale perimeter costs (SONADER management) are almost one and half times as high as small scale perimeter costs. Farmers' production costs in the large scale perimeter are less than those of famers in the small scale perimeter. This is due to the higher transfer payments made to large scale perimeter farmers.

Table 5.17 also shows that the income transfer to the large perimeter farmers is almost five times as high as those of small perimeter farmers. So, there is a discrimination between the two groups of farmers. In the large scale perimeter, farmers' financial costs represent only 46 percent of the economic value of resources used for producing rice. In constrast, in the small scale perimeter, farmers' financial costs represent 85 percent of the economic value.

The portion of the financial costs per hectare by type of perimeter as divided between farmers and the government is given in table 5.19. This table clearly shows that cost per hectare is lower in small perimeter, but farmers bear a larger portion (40 percent) of the total cost. In contrast, in the large scale perimeter, farmers bear only 24 percent of the total producing cost of the paddy rice.

TABLE 5.17. COST OF PRODUCING PADDY RICE PER HECTARE IN THE LARGE AND SMALL SCALE PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

COST CATEGORY	LARGE SCALE IRRIGATED PERIMETER				SMALL PERIMETER	
	SONADER MANAGEMENT		FARMERS MANAGEMENT			
	FIN	ECON	FIN	ECON	FIN	ECON
FIXED COSTS	53.0	92.9	10.4	92.9	17.4	33.0
OPERATING COSTS	49.3	55.2	12.8	18.8	28.5	31.1
GENERAL ADMINISTRATION COSTS	37.8	37.8	37.8	37.8	37.8	37.8
FAMILY LABOR	0.0	0.0	15.0	15.0	20.8	20.8
TOTAL COSTS	140.1	185.9	76.0	164.5	104.5	122.6

SOURCE: TABLES 5.10, 5.14 AND 5.16

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$ U.S.1 = U.M.46

TABLE 5.18. DISTRIBUTION OF THE FINANCIAL COST OF PRODUCING PADDY RICE BETWEEN FARMERS AND THE GOVERNMENT IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS PER HECTARE)

COST CATEGORY	LARGE SCALE IRRIGATED PERIMETER				SMALL SCALE IRRIGATED PERIMETER			
	FINANCIAL COSTS			ECON COST	FINANCIAL COSTS			ECON COST
	FARMERS	GOVERN-MENT	TOTAL	TOTAL	FARMERS	GOVERNMEN	TOTAL	TOTAL
FIXED COSTS(a)	10.4	42.6	53.0	92.9	5.1	12.0	17.1	33.0
OPERATING COSTS								
Fertilizer(b)	3.4	3.4	6.7	7.7	3.4	3.4	6.7	6.7
Seeds	1.2	0.0	1.2	1.3	1.2	0.0	1.2	1.3
Machinery services	1.1	4.0	5.2	5.9	0.0	0.0	0.0	0.0
Water supply fuel	3.6	0.2	3.8	4.4	6.9	0.0	6.9	8.0
Bags	1.3	0.0	1.3	1.3	1.3	0.0	1.2	1.3
Manual equipment	2.1	0.0	2.1	2.3	2.9	0.0	2.9	3.0
Personnel	0.0	29.9	29.9	33.3	0.0	8.6	8.6	9.5
Other costs	0.0	0.5	0.5	0.6	0.0	1.1	1.1	1.2
Insecticides	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2
Sub total operating costs	12.8	38.1	50.9	57.0	15.7	13.2	28.8	31.2
ADMINISTRATION	0.0	37.8	37.8	37.8	0.0	37.8	37.8	37.8
FAMILY LABOR	15.0	0.0	15.0	15.0	20.8	0.0	20.8	20.8
TOTAL COSTS	38.2	118.5	156.7	202.7	41.6	63.0	104.5	122.7

SOURCE : Tables 5.16 and 5.17

(a) SONADER's share of the total fixed costs includes personnel, food for work and the susibsidy for farmers first motor pump in the case of the small perimeter.

(b) This corresponds to the real quantities of fertilizer used by farmers.

$ U.S. 1 = U.M.46

TABLE 5.19. PORTION OF THE FINANCIAL COST OF PRODUCING RICE BORNE BY FARMERS AND THE GOVERNMENT IN THE LARGE AND SMALL SCALE IRRIGATED PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

TYPE OF PERIMETER	COST/HECTARE	FARMER SHARE		GOVERNMENT SHARE	
		VALUE	%	VALUE	%
LARGE PERIMETER	156.7	38.2	24	118.5	76
SMALL PERIMETER	104.5	41.6	40	62.9	60

SOURCE: TABLE 5.18

$ U.S. 1 = U.M.46

CHAPTER VI

COMPARATIVE RETURNS OF LARGE- AND SMALL-SCALE IRRIGATED PERIMETERS

6.1 Average Yield Per Hectare

As noted in chapter V, average yield per hectare for a given perimeter is estimated by SONADER's extension agents. The process consists of estimating yield on randomly selected two square meter plots for each five hectares.

Yield varies among parcels and perimeters within a zone, and among the Fleuve's Zones. Yield is function of the level of fertilizer used, water and weed control, timeliness of paddy rice cultivation pratices, water management, variety used, etc. The first generation of small perimeters (up to 1972) obtained low yields of paddy (1.5 to 3.5 tons per hectare) because the paddy rice technology was not well handled by farmers at that time. This is part of the learning process. SONADER's recent surveys have shown that small perimeters' yields vary between 2.5 and 6 tons per hectare depending on a number of factors. These yields are now equivalent to yield for large scale irrigated perimeters.

An OMVS's survey (1980, p.C III12) showed that there is no significant difference between large and small perimeters' paddy yields, and that 4 tons per hectare can be considered as an average yield per growing season for both small- and large-scale irrigated perimeters. This was also confirmed by a WARDA study (1980) on irrigated rice in Mauritania. Therefore, this analysis uses a yield of four tons per hectare for both small and large scale irrigated perimeters.

6.1.1 Post-Havest Problems and Yields

After it is harvested, paddy rice has to be cleaned, dried, stored, milled and distributed to the market. Severe losses can occur when traditional methods of handling are used. According to Chandler (1979), studies conducted in several South and Southeast

Asian countries reveal that 13 to 14 percent of the crop is lost during harvest and post-harvest operations; during harvesting and threshing, losses range from 5 to 15 percent; and in cleaning and drying, 2 to 3 percent.

South and Southeast Asian countries have much more experience in irrigated rice than Mauritania. Thus, analysis assumes that crop losses amount to 20 percent in the upstream zone of the Senegal River Valley. Table 6.1 gives the adjusted yield per hectare and per type of scheme that will be used in calculating the return per hectare.

6.2 Post-farm Cost of Paddy Production

To obtain the cost of producing one kilogram of paddy the total cost in Table 5.18 is divided by the average yield per hectare net of losses (3,200 kg.), which is assumed to be the same for both small- and large-scale perimeters. Table 6.2 shows the cost of one kilogram of paddy rice for large- and small-scale perimeters. This indicates that the farmers' cost of producing paddy rice varies from U.M.12 to U.M.13 per kilogram. The paddy rice price fixed by the Mauritanian government and paid to farmers was U.M.10 per kilogram in 1980. This means that, at farmers' opportunity of U.M.100 per personday, the 1980 paddy price does not cover farmers' production costs. The difference would amount to 2 to U.M.3 per kilogram of paddy rice produced. In fact, without charging family labor, the returns to family labor are U.M. 54/day and U.M. 59/day for the small perimeter and the large perimeter, respectively, a paddy price of U.M. 10/kg. (Table 6.3).

There is a need to provide more incentives to these farmers involved in paddy rice production. Otherwise, they will abandon irrigated pertimeters during the flood recession growing season. These incentives could be increased through increasing yield by using a better technology package for rice production or through raising paddy price paid to farmers.

TABLE 6.1. YIELD PER HECTARE FOR THE SMALL AND LARGE SCALE IRRIGATED PERIMETERS IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

PERIMETER	AVERAGE YIELD	ADJUSTED YIELD 20 % (a)
Small perimeter	4,000	3,200
Large perimeter	4,000	3,200

Sources:

OMVS: Etude socio-economique, page C.III 12.

WARDA: Analyse economique de la culture irriguee du riz en Mauritanie, 10 Mars 1980, page 48.

Sy, Alioune: Amenagement hydroagricoles dans le Bassin du Fleuve Senegal 10 Fevrier 1981, p.13.

(a) Author's estimates.

TABLE 6.2. POST- FARM COST AND PUBLIC SUBSIDIES PER KILOGRAM OF PADDY RICE IN LARGE AND SMALL SCALE IRRIGATED PERIMETERS OF THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

PERIMETERS	FARMERS	GOVERNMENT	TOTAL		SUBSIDIES
			FINANCIAL A	ECONOMIC B	B - A
Large perimeter	11.9	37.0	49.0	63.3	14.3
Small perimeter	13.0	19.7	32.7	38.3	5.6

Source: Calculated from Tables 5.18 and 6.1.

$ U.S.1 = U.M.46

TABLE 6.3. FAMILY LABOR'S RETURN PER KILOGRAM OF PADDY PRODUCED IN THE UPSTREAM ZONE OF THE FLEUVE, MAURITANIA, 1980.

(OF OUGUIAS)

PERIMETER	FAMILY LABOR FINANCIAL COST PER HECTARE A	REAL YIELD PER HECTARE B	FAMILY LABOR FINANCIAL COST PER KG A/B = C	FARMERS COSTS PER KG D	OFFICIAL PRICES PER KG E	FAMILY LABOR RETURN PER DAY (C -(D-E))*100/A
Large perimeter(a)	20,800	3,200	6.5	13.0	10.0	54.0
Small perimeter(a)	15,000	3,200	4.7	11.9	10.0	59.0

Source: Calculations made from Tables 5.14, 6.1 and 6.2

$ U.S.1 = U.M.56

Table 6.2 also shows subsidies made by the public sector to farmers involved in the publicly irrigated perimeters. Large perimeters' farmers subsidies per kg of paddy rice are 2.5 times higher than those of the small perimeters' farmers, which mean that a larger income transfer is made to large perimeters' farmers.

6.3 Marketings Costs

Rice marketing costs are incurred in three stages: 1)paddy transport from the farm to the mill, 2)within the mill, and 3)from the mill to the consumer. However, rice paddy produced from large and small scale irrigated perimeters is marketed differently.

In the small perimeter, the paddy is used first for the family's consumption. Then the surplus (if there is any) is sold to neighboring villages. Since the small perimeter is close to the village and neighboring villagers are close to each other, this study assumes that there is no transport cost for the paddy rice. Thus, processing is the only marketing cost for small perimeter paddy rice. Before consumption, the paddy is hand pounded by women. The "milled"rice obtained is entirely broken, as hand pounding cannot produce whole rice.

A WARDA study (SONADER, 1980) indicates that hand pounding one ton of paddy rice requires 25 persondays and estimates a shadow wage rate per personday of U.M.100. Thus, hand pounding costs U.M.2,500 per ton (U.M.2.5 per kilogram) of paddy. This amount represents the total financial marketing costs since it is assumed that there is no transport cost. Since these women are paid at their shadow wage rate, the marketing economic costs are equal to U.M.2,500 per ton (U.M.2.5 per kilogram) of paddy rice marketed.

In the large perimeter in KAEDI, the paddy rice is processed by SONADER's mill, which was contructed with the perimeter. However, mill construction cost is not included in the perimeter's investment costs, since this is included in the paddy processing cost. The paddy is moved from the weighing center to the perimeter's mill.

Sacks are bought by SONADER and distributed to the farmers. Handling is done by unskilled workers hired for loading and unloading the truck. The paddy is cleaned and stored in a SONADER building before being processed.

A SONADER study (1984, p.31) estimates the paddy rice marketing costs at U.M.4,900 per ton in 1984. This cost includes the mill amortization costs, its operating costs, paddy rice transport from the perimeter to the central mill, bagging cost and rice transport from the mill to KAEDI region consumers. These marketing costs expressed in 1980's costs equal U.M.4,000 per ton (U.M.4 per kilogram) of paddy marketed.[3] Assuming that 80 percent of the SONADER milling costs are imported and using a foreign exchange premium of 1.18, the economic marketing costs equal U.M.4,600 per ton (U.M.4.6 per kilogram) of paddy marketed.

6.4 Total Cost of Producing and Importing Rice

6.4.1 Rice from the Upstream Zone of the Fleuve

The cost of one kilogram of rice produced in the upstream zone of the Fleuve and consumed locally is obtained by adding total marketing costs to the cost of producing one kilogram of paddy. These costs are summarized in Table 6.4. Its economic value of resources used for producing one kg. of rice varies from U.M. 40 to U.M. 68 per kilogram. Thus, the economic value of resources used by the large perimeter is 1.7 times higher than those of the small perimeters. Personnel expatriates' economic costs represent 33 and 14 percent of rice production economic costs in the large and small perimeters, respectively.

3. The 1984 cost was converted to 1980 prices using the GDP deflator (World Bank, 1986).

TABLE 6.4. TOTAL COST OF ONE KILOGRAM OF RICE PRODUCED IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA. 1980.

COST CATEGORY	LARGE SCALE IRRIGATED PERIMETER			SMALL SCALE IRRIGATED PERIMETER			
	FINANCIAL COSTS		ECONOMIC	FINANCIAL COSTS			ECONOMIC
	FARMERS SHARE	SONADER SHARE	COST	FARMERS SHARE	SONADER SHARE	TOTAL	COST
FIXED COSTS	3.3	13.3	29.0	1.6	3.8	5.4	10.3
OPERATING COSTS	4.0	11.9	17.7	4.9	4.1	8.9	9.7
ADMINISTRATION COSTS	0.0	11.8	11.8	0.0	11.8	11.8	11.8
FAMILY LABOR COSTS	4.7	0.0	4.7	6.5	0.0	6.5	6.5
MARKETING COSTS(a)	4.0	0.0	4.6	2.5	0.0	2.5	2.5
TOTAL COSTS	15.9	37.0	67.9	15.5	19.7	35.1	40.8
PERCENTAGE	30.0	70.0		44.0	56.0	100.0	

SOURCE: Calculations made from Table 5.18 using Table 6.1.

a) SONADER represents Mauritanian government or the public sector.

b) It is assumed that 80 percent of the SONADER milling costs are imported.Thus, marketing economic costs are u.m.4.6 for large scale perimeter.

$ U.S.1 = U.M. 46

6.4.2 Imported Rice

To show whether Mauritania can produce rice in the upstream zone of the Senegal River Valley more cheaply than importing it, the economic and financial costs of rice produced in the different irrigation schemes and consumed at production zones are compared with the average economic cost of one kilogram of imported milled rice delivered to the upstream zone of the Fleuve. The CIF price (see Table 6.5) is an average of seven consecutive years (1974-1980) following the drought of 1973-74. The average CIF price (U.M.13.8 per kilogram) is assumed to be representative of imported rice cost. Table 6.6 shows that the average financial and economic costs for one kilogram of imported milled rice and delivered to the upstream zone of the Fleuve are U.M.24.6 and U.M. 26.5, respectively. However, perimeters must compete against a market price of U.M. 20/kg.

The financial cost of one kilogram of rice produced in large and small scale irrigated perimeters and consumed at the production zones varies from U.M.35.2 to U.M.52.9 per kilogram versus U.M.20 for the prevailing market price.

This means that, from the perimeters viewpoint, domestically produced rice from irrigated perimeters cost 75 to 165 percent more than imported rice. The economic costs to Mauritania of producing one kilogram of paddy consumed at the production zones are U.M.40.8 and U.M.68 for the large and small scale perimeters, respectively, versus U.M.26.5 for imported rice.Thus, in economic terms, rice produced in the upstream zone of the Fleuve is from 54 percent to 156 percent more costly than imported rice.

The results detailed in Table 6.7 confirm that Mauritania is producing rice at a high cost.

TABLE 6.5. AVERAGE CIF PRICE OF ONE KILOGRAM OF IMPORTED MILLED RICE, MAURITANIA, 1974-1980.

YEAR	1974	1975	1976	1977	1978	1979	1980
Quantity imported (Metric tons)	32,000	8,000	23,000	34,000	50,975	20,526	50,650
Value ($ 1000)	9,000	3,200	7,500	10,500	12,500	5,759	15,500
Conversion factor(a)	U.M.43.3= $U.S.1	45.1= 1	43.6= 1	46= 1	46.1= 1	45.8= 1	46= 1
CIF price of one kilo(U.M.)	12.2	18.0	14.2	14.2	11.3	12.9	14.1
Average CIF price = 13.8							

Source : FAO Trade Yearbook, Vol 31 and 34, pp. 114, 115 and 133.

a) Internatioal Finance Statistics Yearbook 1982, IMF.

b) Average CIF orice = (12.2+ 18 +14.2 + 14.2 + 11.3 + 12.9)/7 = 13.8

TABLE 6.6. AVERAGE COST (OUGUIAS) FOR ONE KILOGRAM OF IMPORTED MILLED RICE DELIVERED TO THE UPSTREAM ZONE OF THE FLEUVE, MAURITANIA, 1980.

COST COMPONENT	Financial (c)	Economic (b)
Average CIF price	13.8	16.3
Buying cost(a)	0.5	0.5
Shipping and handling(a)	1.5	1.5
Taxes(a)	0.5	0.0
Margin(a)	0.3	0.3
General costs(a)	2.9	2.9
Total average cost in NOUAKCHOTT	19.6	21.5
Transport cost to the Fleuve Zone(a)	5.0	5.0
Total average cost in the Fleuve Zone	24.6	26.5

Source : RAMS, June 1981 and Table 5.6.

(a) These are 1980's costs. Due to the lack of data, the same costs are assumed for the other years.

$ U.S.1 = U.M.46

(b) CIF price * SER + Domestic costs (w/o taxes)

(c) The competing price for the perimeters is U.M 20 /kg, which is the prevailing market price.

TABLE 6.7. COMPARATIVE COSTS BETWEEN IMPORTED RICE AND RICE PRODUCED IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

TYPE OF SCHEME	AVERAGE ECONOMIC COST OF IMPORTED RICE	LOCALLY PRODUCED RICE			
		FINANCIAL COST PER KILO	% RATIO OF IMPORTED TO DOMESTIC COST (a)	ECONOMIC COST PER KILO	% RATIO OF IMPORTED TO DOMESTIC COST(b)
LARGE PERIMETER	26.5	52.9	264.5	67.9	256.2
SMALL PERIMETER	26.5	35.2	175.5	40.8	154.0

SOURCE : Tables 6.4 and 6.6

a) % RATIO = Financial cost for domestic rice divided by the prevailing market price of U.M 20/kg

b) Ratio = Economic cost divided by (CIF price * SER + Domestic costs(w/o taxes))

$ U.S.1 = U.M.46

CHAPTER VII

SENSITIVITY ANALYSIS

The objective of this sensitivity analysis is to look at the effects of yield, and cropping intensity variations on domestic rice production costs. Moreover, we will look at the effect of the revised wage rate assumptions on domestic rice production costs.

7.1 Unskilled Labor Wage Rate

The previous analysis assumes the same wage rate of U.M.100 for both market and shadow wages for laborers and family labor. A WARDA survey (1980) conducted in unskilled labor market in the upstream zone of the Fleuve found that market wage rates for unskilled labors were U.M.150 and U.M.200 for small and large perimeters, respectively. Large scale perimeters, such as the one studied in this analysis, are generally located near big cities. In such locations, there is a limited supply of laborers to work in perimeters. Therefore, laborer market is more competitive. This explains the relatively high wage rate paid to large perimeters' laborers. In contrast, small perimeters are established near villages where the supply of laborers is relatively high. Slack labor is readily available in the dry season during the perimeters' construction because villagers have fewer actvities during this period. This explains the relatively low wage rate for small perimeters' labor.

The same survey found wage discrimination between women and men. Women are paid U.M.100, one half of the male daily wage. Thus, in the sensitivity analysis a market wage rate of U.M.200 and U.M.150 per personday will be used for large and small-scale perimeters labor, respectively. For women's labor input in small perimeter construction, U.M.100 per personday will be used. However, it is assumed that family labor is considered as hired laborers and has an unchanged shadow wage rate of U.M.100 per personday.

Table 7.1 shows that the cost of producing one kilogram of rice, after adjusting the unskilled market wage rate. Its economic cost varies from 44 to U.M. 72.6 per kilogram. The large scale perimeter's production costs are one and half as high as the small small scale perimeter.

Table 7.2 compares the economic costs of imported rice to the upstream zone of the Fleuve and rice produced domestically (consumed at production zones). It also compares the prevailing market price in the production zones and the perimeters' financial cost of producing rice. From the perimeter's viewpoint, domestic rice production in irrigated perimeters cost 96(small) to 188(large) percent more than imported rice. In economic terms, rice produced in the upstream zone of the Fleuve is from 166 to 174 percent more than imported rice.

Unskilled laborer wage variation increases rice production costs by 10 and 11 percent for the large and small scale perimeters, respectively. The cost increase is higher for the small scale perimeter because family labor costs represent 26 percent of total rice production costs for this system.

7.2 Cropping Intensity

The cropping intensity in the upstream zone of the Fleuve is low averaging 1.25 crops per year. This is mainly due to water shortage in the season hot dry (March to June) associated with the low water level of the Senegal River during that period. Thus, perimeters seldom grow a second rice crop during this period. It will be possible to reach a cropping intensity of two after the the Senegal River flow is regularized with the installation of the two new dams. Thus, in this analysis the cropping intensity is assumed to be up to 2.0 to evaluate the effects of higher cropping intensity on rice production costs.

Table 7.3 shows that increasing the cropping intensity reduce rice production costs. In the large scale perimeter, domestic rice production is still not competitive with imported rice, even at a cropping intensity of 2.0. In contrast, in the small perimeter

TABLE 7.1. TOTAL COST (IN OUGUIAS) OF ONE KILOGRAM OF RICE PRODUCED IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY UNDER REVISED WAGE RATE ASSUMPTIONS, MAURITANIA, 1980.

COST CATEGORY	LARGE SCALE IRRIGATED PERIMETER				SMALL SCALE IRRIGATED PERIMETER			
	FINANCIAL COSTS			ECONOMIC	FINANCIAL COSTS			ECONOMIC
	FARMERS SHARE	GOVERN-MENT SHARE	TOTAL	COST	FARMERS SHARE	GOVERN-MENT SHARE	TOTAL	COST
FIXED COSTS	3.3	13.3	16.6	29.0	2.4	3.8	6.2	10.3
OPERATING COSTS	4.0	11.9	15.9	17.8	4.9	4.1	9.0	9.7
ADMINISTRATION COSTS	0.0	11.8	11.8	11.8	0.0	11.8	11.8	11.8
FAMILY LABOR COSTS	9.4	0.0	9.4	9.4	9.7	0.0	9.7	9.7
MARKETING COSTS(a)	4.0	0.0	4.0	4.6	2.5	0.0	2.5	2.5
TOTAL COSTS	20.6	37.0	57.7	72.6	19.5	19.7	39.2	44.0
PERCENTAGE(b)	28.0	72.0		100.0	44.0	56.0		100.0
PERCENTAGE(C)	35.0	65.0	100.0		50.0	50.0	100.0	

SOURCE: Calculations made from Table 6.4

(a) It is assumed that 80 percent of the SONADER milling costs are imported. Thus, marketing economic costs are U.M.4.6/kg for large scale perimeter.

$ U.S.1 = U.M.46

(b) Percentage in economic terms.

(c) Percentage in financial terms

TABLE 7.2. COMPARATIVE COSTS (OUGUIAS) BETWEEN IMPORTED RICE AND RICE PRODUCED IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY UNDER REVISED WAGE RATE ASSUMPTIONS, MAURITANIA, 1980.

TYPE OF SCHEME	AVERAGE ECONOMIC COST OF IMPORTED RICE	LOCALLY PRODUCED RICE			
		FINANCIAL COST PER KILO	% RATIO OF IMPORTED TO DOMESTIC COST (a)	ECONOMIC COST PER KILO	% RATIO OF IMPORTED TO DOMESTIC COST(b)
LARGE PERIMETER	26.5	57.7	288.0	72.6	274.0
SMALL PERIMETER	26.5	39.2	196.0	44.0	166.0

SOURCE : Tables 6.8 and 6.6

a) % Ratio = Domestic financial cost divided by the prevailing market price (U.M 20/kg)

b) Ratio =Domestic economic cost divided by (CIF price * SER + Domestic costs(w/o taxes))

Cost of imported rice = 100

$ U.S.1 = U.M.46

TABLE 7.3. TOTAL ECONOMIC COST (OUGUIAS) OF PRODUCING ONE KILOGRAMME AT VAIOUS CROPPING INTENSITIES IN THE LARGE AND SMALL PERIMETERS. UPSTREAM ZONE OF THE FLEUVE, MAURITANIA. 1980.

	CROPPING		INTENSITY
SCHEME TYPE	1.5	1.75	2.0
LARGE PERIMETER	57.0	48.6	42.5
SMALL PERIMETER	34.0	29.0	25.5

SOURCE : Calculations made from Table 6.4.

$ U.S.1 = U.M.46

domestic rice production is competitive with imported rice at a cropping intensity of 2.0.

Table 7.4 presents farmers' rice production costs with several cropping intensities. It shows that farmers have to achieve at least a cropping intensity of 1.5 on both small and large schemes to break even at paddy price (U.M.10) prevaling in 1980, assuming a return to family labor of U.M. 100/personday.

7.3 Yield

Yield is a major variable affecting the competitiveness of local versus imported rice. Table 5.18 gives the total financial costs of producing paddy rice per hectare at farm level. Adding to these cost rice marketing costs gives the total financial cost of domestic milled rice. The cost per kilogram of domestic rice production is calculated by dividing total financial costs per hectare by the adjusted yields (yields net of losses) per hectare. Table 6.6 gives an average cost of U.M.24.6 for one kilogram of imported milled rice.

Thus, a minimum adjusted yield of four tons and six tons per hectare must be achieved in the small and large scale perimeters, respectively, for domestic rice to compete with imported rice. With twenty percent on the field plot loss, a minimum yield on field of 4.8 tons and 7.2 tons per hectare on the small and large scale perimeters, respectively, are required for domestic rice production to be competitive with imported rice. Consequently, yields have to increase by an average of twenty and eighty percent in the small and large perimeters, respectively. Furthemore, farmers need to obtain yield of 4 tons and 3.8 tons per hectare in the small and large perimeters, respectively, to breakeven at the paddy price (U.M.10/kg) in 1980.

7.4 Yield and Cropping Intensity

Table 7.5 shows total economic cost of producing one kilogram of rice at various cropping intensities and yields in large and small scale perimeters. Increasing both

TABLE 7.4. FARMERS COSTS (IN OUGUIAS) OF PRODUCING ONE KILOGRAM OF RICE AT VARIOUS CROPPING INTENSITIES IN THE LARGE AND SMALL SCALE PERIMETERS, FLEUVE, MAURITANIA, 1980.

	CROPPING INTENSITY		
SCHEME TYPE	1.5	1.75	2.0
LARGE PERIMETER	9.9	8.5	7.4
SMALL PERIMETR	10.8	9.3	8.1

SOURCE : Calculations made from Table 6.2

$ U.S.1 = U.M.46

TABLE 7.5. TOTAL ECONOMIC COST (IN OUGUIAS) OF PRODUCING ONE KILOGRAM OF RICE AT VARIOUS CROPPING INTENSITIES AND REAL YIELDS IN THE LARGE AND SMALL SCALE PERIMETERS, UPSTREAM ZONE OF THE FLEUVE, MAURITANIA, 1980.

YIELD (TONS/HA)	CROPPING INTENSITY PER YEAR							
	1.25		1.5		1.75		2	
	S	L	S	L	S	L	S	L
4	35.2	58.0	29.3	48.4	25.1	41.5	22.0	36.3
5	27.0	44.7	23.5	38.7	20.1	33.2	17.6	29.0
6	23.5	38.7	19.5	32.3	16.8	27.6	14.7	24.2

SOURCE : Calculations made from Table 7.1

$ U.S.1 = U.M.46

L = Large scale perimeter

S = Small scale perimeter

cropping intensity and yield at the same time reduces rice production costs. In the large perimeter, domestic rice production is competitive with imported rice at a cropping intensity of 1.25 and a net yield (on-farm yield) of 6 tons (7.2 tons). In contrast, in the small perimeter domestic rice production is competitive with imported rice (U.M. 26.5/kg) at cropping intensity of 1.75 and a net yield (on-farm yield) of 4.8 tons.

Table 7.6 presents farmers' costs of producing one kilogram of rice at various intensities and net yields in the large- and small-scale perimeters. It shows that in the small-scale perimeter farmers have to achieve at least a cropping intensity of 1.5 and a net yield (on-farm yield) of 4 (4.8) tons to break even at the paddy price (U.M.10 per kilogram) prevailing in 1980. In contrast, in the large scale perimeter, they have to achieve at least a cropping intensity of 1.25 and a net yield (on-farm yield) of 4 tons (4.8) tons to breakeven at the paddy price (U.M.10 per kilogram) prevaling in 1980.

TABLE 7.6. FARMERS COSTS (IN OUGUIAS) OF PRODUCING ONE KILOGRAM OF RICE AT VARIOUS CROPPING INTENSITIES AND NET YIELDS IN THE LARGE AND SMALL SCALE PERIMETERS, UPSTREAM ZONE OF THE FLEUVE, MAURITANIA, 1980.

YIELD (TONS)	CROPPING INTENSITY PER YEAR							
	1.25		1.5		1.75		2	
	S	L	S	L	S	L	S	L
4	10.4	9.5	8.7	7.9	7.4	6.8	6.5	6.0
5	8.1	7.4	6.8	6.2	5.8	5.3	5.1	4.6
6	6.8	6.3	5.7	5.2	4.9	4.5	4.3	3.9

SOURCE : Calculations made from Table 6.3

$ U.S.1 = U.M. 46

L = Large scale perimeter

S = Small scale perimeter

CHAPTER VIII

CONSTRAINTS ON IRRIGATED FARMING

The previous analysis has shown that rice production in Mauritania involves very high costs. If domestic rice production is to be competitigve with imports, it is essential that costs of production be reduced. Previous chapters of this study, as well as a number of other technical studies have examined factors that contribute to the high cost of rice production in the country, and some of the most important factors include the following: land-leveling in small perimeters, under-cultivation of some areas, water scheduling, etc.

8.1 Under-Cultivation of Some Areas

Some irrigated farming areas are under-developed. Water shortage during the hot season is only one of several reasons which explain this situation. First, land smoothing techniques used have often resulted in inadequate leveling and in removal of top soil, making part of the land sterile. Consequently, in dry-season corn cultivation, plots where top soil has been removed have had yields ranging from 1.2 to 2.5 tons per hectare. In contrast, unaffected areas have yielded from 5 to 7 tons per hectare (OMVS study, 1977). The quality of land leveling has a strong effect on paddy rice yield. A study by Sy and Dembele (1981) showed that up to a four inch difference in within-parcel water level variation does not affect yields. From four to six inches, yield is on average reduced by .9 tons per hectare; and differences greater than six inches reduce yield by 1.3 tons per hectare.

Second, for irrigated crops other than rice (sorghum, maize and cowpeas), there are problems due the poorly developed marketing system. These problems have contributed to the low expansion of surface areas under cultivation in the off season, when off season rice production is hampered by the cold. Moreover, yield levels are still irregular and insufficient for cereal grains other than rice.

Third, predator damage strongly influenced the amount of land cultivated in the off season (dry season) and the year-to-year variations in yields. Each year, birds reduce yield considerably, especially for off season-crops.

Finally, on the small perimeters, the areas cultivated (as well as yields) are affected by competition for labor between traditional and irrigated crops. In years of favorable flooding, peasants often either abandon or reduce the amount of off season farming to devote themselves to Walo (flood recession land) agriculture. This shift has catastrophic consequences on irrigated rice yield. In fact, peasants who have been assigned parcels in village-level perimeters typically grow four crops on land located in three different areas. One crop is grown on Dieri, a second irrigated crop is grown during the rainy season, a third crop is grown on flood recession land and finally, a second irrigated crop is grown during the off season. Therefore, there is a need to enlarge the areas assigned to villagers in the village-level perimeters to encourage the people to give priority to allocating family labor to irrigated farming.

8.2 Problem of Protection of Small Perimeters Against Flooding

Small perimeters are located on elevated land where the risk of flooding is one or two flood years out of ten (OMVS, 1977). This prediction is based on the actual hydrological conditions of the Senegal River. After the dams are completed, the risk of perimeter submersion (large perimeters are diked) will be higher as the majority of these perimeters are not protected against flooding. Submersion would destroy the hydraulic infrastructure constructed by the farmers and discourage their future participation, which would be subsequently difficult to combat. Consequently, there is a need to protect all the small perimeters against flooding by constructing dikes. As this would require contructing a dike along the whole Senegal River, it would require a tremendous capital investment and may not be financially viable.

8.3 Water Scheduling

Farmer adherence to the rotational water schedule is a problem in the perimeters when the social organization for water management is weak (misunderstanding among perimeter cooperative members) and motor pump performance is poor. An OMVS survey (1977) indicated that failure to respect the parcels' watering schedule was one of the major problems in both small-and-large scale perimeters. The survey showed that twenty-two percent of the parcels surveyed in the 1977 rainy season experienced water shortages and seventeen percent had excess water. Thus, the disrespect of watering schedules leads to inefficient uses of water. Moreover, pump breakdowns affected fifteen percent of the parcels surveyed.

8.4 Rice Growing Season Calendar

The rice crop calendar depends upon rainfall and hydrological conditions of the Senegal River. Planting at the beginning of rice growing season is more critical in the Delta (from Rosso to Boghue) where salt water from the sea intrudes into the Senegal River during the dry season. This makes it difficult to double crop irrigated rice. Low rainfall and river flows delay the flood arrival and therefore postpone the main rice growing season. Experiences have shown that August 15 is the deadline to transplant paddy rice in the Senegal River Basin. After this date, part of the rice plant's vegetative cycle falls in the cold season, which substantially reduces paddy yield.

In the other Fleuve zones, a second crop (maize or cowpeas) can be grown during the cool dry season (November to February). But the lower water level of the Fleuve during the hot dry season (March to June) makes it almost impossible to grow a second rice crop in perimeters.

8.5 Saline Soils

In the Delta, the major constraint to irrigated farming is the presence of salt. It may take years or decades of permanent drainage to "desalt" the land. "Desalinization" of the land requires the construction of underground permeable pipelines to absorb water containing the salt. The cost of this operation is very high. Large quantities of water pumped from the Senegal River are needed to flush drain the soil. More water, in turn, means more fuel and oil. SY and Dembele (1981) pointed out that average paddy rice yields in the Delta are lower than those of the other Fleuve zones. Yields range from 2-3 tons per hectare in the Delta compared to 2.5-60 tons per hectare for the Middle Valley.

Increasing yields in the Delta under existing conditions can be achieved only by using saline tolerant high yielding varieties which are not yet available. At the current time, investing in "desalinization" systems is too expensive given the expected results. With the regularization of the Fleuve flows, "desalinization" may be a financially viable alternative solution.

8.6 Training Problem

SONADER is planning to intensify 5,000 hectares per year after the Fleuve flow is regularized. Training the human resources and supervisory personnel to achieve this goal may be the major constraint. Currently, SONADER has few national technicians specialized in land development, perimeter management, irrigation etc. The RAMS study (1980) indicated that SONADER had only 18 national technicians (11 at the master's level and 7 with associate degree) in relevant fields in 1980. An OMVS study (1977) showed that development and cultivation of 5,000 hectares requires 15 technicians at the master's level and 88 at the associate degree's level to manage the first three years of land intensification.

Currently, foreign technical assistants are responsible for most of the planning, implementation and perimeters management. Even though their services are costly (up to 20 percent of rice production costs), their presence is necessary to implement the land development program in a reasonable length of time and to train national technicians working with them. Their number would be reduced as more national technicians are trained to replace them.

In the meantime, the Mauritanian government should emphasize training in different agricultural fields by sending students to foreign schools or creating more domestic agricultural school to train students locally. It is difficult to believe that a country which gives the "priority of the priorities" to rural development supports only one agricultural school in the whole country. Furthemore, this school has a very limited capacity and a low level of training.

8.7 Institutional Constraints

It is desirable to plan for the gradual transfer of the management and support functions initially assumed by SONADER to the collective production organizations. This would reduce SONADER management and logistical support responsabilities, making it possible for the parastatal to focus on development expansion and productivity improvement. This will be increasingly necessary as the command area and the farmer population involved increases.

But before turning management and support functions to the collective production organizations, they must be trained to assume these tasks. Even though this has started, SONADER extension agents perform poorly and some are even losing their credibility among farmers. Thus, SONADER must retrain these extension agents so that their expertise corresponds to farmers' needs.

8.8 Financing Contraints on Development

The Mauritanian government plans to develop 93,000 hectares for irrigation by year 2000 (5,000 hectares). This thesis estimates that in 1980, the average cost of capital investment required per developed hectare amounts to U.N.737,000 (U.S. $16,000) and U.N. 203,000 (U.S. $4,000) for large and small scale perimeters, repectively. Assuming that one third of the yearly land development program is devoted to small perimeters and two-thirds to large perimeters, a total financing of 2.5 billion ouguias (U.S $4.3 millions) would be needed yearly to implement this land development program. To this figure must be added the operating costs.

Up to now, no serious problems have been met in obtaining foreign financial resources. Yet, the key question is whether donors will continue to finance the tremendous amount of money required to implement this land development program. Without external assistance, Mauritania has limited resources to finance this ambitious program.

8.9 Long Term Indebtedness and its Consequences

High development costs will eventually raise the as yet not encountered problem of repaying the debts incurred for these irrigation projects. An OMVS study (1977) indicated that, given the hypothesis of a 30 year interest free loan, repayment of each large perimeter hectare would amount to the equivalent of nearly 2.5 tons of rice per year for Mauritania. Repayment of these annual amounts (in addition to operating costs which raise total costs to from 3 to 4 tons per hectare), will present difficult constraints on the government effort to improve the standard of living of the people. It is hoped these problems will be resolved by the provision of new technological packages and their assimilation by the peasants.

CHAPTER IX

CONCLUSIONS, STUDY LIMITATIONS AND NEEDED RESEARCH

9.1 Conclusions

Our analysis indicates that, in economic terms, rice produced in irrigated perimeters and consumed at the production zones costs 66-174 percent (small and large perimeters, respectively) more than imported rice in the upstream zone of the Fleuve. From perimeters viewpoint, locally produced rice costs 96-188 percent (small and large perimeters, respectively) more than imported rice. In financial terms, for the large perimeter, 65 percent of the costs are borne by the government, while only 35 percent are supported by farmers. In contrast, in the small perimeter 50 percent of total costs are borne by farmers and 50 percent by the government. In economic terms, for the large perimeter, 72 percent of the costs are borne by the government, while only 28 percent are supported by farmers. In contrast, in the small perimeter 44 percent of the total costs are borne by farmers and 56 percent by the government.

The comparison between domestic rice production and imported rice costs shows that Mauritania is producing rice at high cost. Thus, from a purely economic efficiency standpoint Mauritania should import rice rather than produce it. However, we should consider the political and strategic cost to Mauritania of being so dependent on food imports and international food aid. What would happen if world price rose or if exporting countries were no longer in position to export?

Although small scale perimeters are more cost effective than the large ones, neither the large perimeter's nor the small perimeter's production costs are competitive with imported rice delivered to the upstream zone of the Fleuve. To some extent, the high domestic cost of rice production represents the costs of achieving food security by being partly independent from external supply sources. Yet, these costs could be substantially reduced by implementing the following measures:

9.1.1 Construction of Medium Size Perimeters

Efforts should be directed to develop a prototype perimeter that will combine the positive aspects involved in the large perimeter with more effective incentives offered by the small perimeters. The new perimeters should be large enough to offer at least .75 hectares to each farm family, so that plots can generate acceptable return to family labor inputs. This would encourage farmers to concentrate only on irrigated farming, thereby improving management. The total command area of the medium sized perimeters may be quite large, and include many different villages. Yet each village hydraulic unit should include 50-100 ha and be irrigated by a separate pumping station.

Enlarging existing small perimeters to medium perimeter size would require "hollalde" soils be brought into production. Therefore, it would be necessary for SONADER to provide heavy machinery services for tasks that cannot be done by farmers, such as constructing the peripheral dike and principal canal, in addition to land plowing.

9.1.2 Improved Perimeter and Pump Maintenance

The collective production organization leader should require all members to maintain the commun irrigation system (main canal and small dikes). A member absent during perimeter maintenance workdays should be required to pay a fine. Farmers also maintain their individual plot.

National private companies should be established to provide pump repair and spare part services. The Mauritanian government should support local firms by providing credit facilities and possibly subsidies during the first years to help defray start-up costs. These companies should establish branches at the irrigated perimeter levels so that they can immediately intervene when breakdowns occur. Pump repair costs should be subsidized for farmers during the first two years of perimeters operations, and then gradually eliminated.

9.1.3 Improvment of Water Management

Farmers must adhere to the rotational water shedule. This disrespect of water scheduling led to inefficient water use, yield losses and higher than necessary pumping costs.

9.1.4 Supervisory Personnel and Farmers Training

First, supervisory personnel should be trained to implement government land development plans scheduled so national supervisors can replace foreign technical advisors. This would substantially reduce domestic rice production costs. Second, SONADER extension agents should be retrained , so that their expertise corresponds to farmers' needs. The training should be oriented to pratical tasks, including water management and cooperative organization management. Third, some of the farmers most receptive to learning about modern production techniques should also be be provided this training and used as extension agents. Finally, leaders of collective production organizations must be trained to assume gradually the management and support functions initially asumed by SONADER. This would reduce SONADER management and logistical support responsibilities, making it possible for the parastatal to focus on development expansion and productivity improvment.

9.1.5 Reducing Production Cost

After the completion of the dams on the Fleuve, it will be possible to grow at least two crops on the perimeters. The dams costs will be sum costs. Therefore, increasing the cropping intensity reduces high fixed costs per kilogram of production in perimeters, thereby making medium size perimeters more financially and economically viable. Yet, if crops other than rice are to be produced (sorghum, maize and cowpeas), the marketing systems must also be strengthened. Also, when more water is available it will be possible to plow "Hollalde" soils when completly satured. This will make land plowing easier and reduce the cost. In addition, the National Research Center should supplement on-station screening of disease resistant high yielding varieties with on-farm trials. This effort should help to identify new yielding potential varieties that can be made available to farmers. Finally, SONADER production costs on the large perimeter are too high. Land in these perimeters should be turned over to farmers- with SONADER retaining enough land to test new varieties for future use by farmers.

9.1.6 Reducing Perimeter Constuction Costs

Short term contracting of foreign firms has resulted in high costs as these firms have minimal incentive to establish local facilities. Multiple year contracting in which a large volume of construction -along with the requirement that the foreign constractor establish on-site facilities- would reduce costs in the long run. Also, the government should promote the extensive participation of national companies (subcontractors) to assist in perimeter construction.

Grouping calls for bids and anouncing them far in advance permit more firms to tender bids, thereby increasing the competion and reducing costs. To facilitate this recommendation, it would be necessary for the different financing sources to agree to forego conditions which limit participation to companies of a specific national origin. This would permit companies which are established in the field to have a chance to have regular work, and as a consequence, improve the competitiveness of their prices.

Farmers participation in carrying out perimeters should be required. This would reduce construction costs as land clearing, stump removal, earth leveling , digging small dikes, such works can be performed very well by the farmers.

9.1.7 Resolution of Sociological Problems

Agreement from owners of land on which perimeters are to be constructed should be obtained before the government implements construction. This would avoid problems about compensation which have plagued previous projects.

9.1.8 Pricing Policies

Adequate paddy prices, covering at least production costs (including family labor costs), should be paid by the goverment to farmers involved in irrigated perimeters. In addition, paddy rice floor prices should be anounced to farmers before each growing season.

9.1.9 Improved Design and Perimeter Construction

There is a need to improve leveling, especially for small perimeters. The quality of land leveling has a strong effect on paddy yield. Significant differences (more than six inches) in within parcel water level variation leads to a more complex irrigation and an inefficient water use. Canals should be large and sloped enough in order to flow water correctly.

9.2 Study Limitations and Needed Research

The study has several limitations. First, this study covers only one year and uses secondary data. Second, although it gives a study basis for food security costs in Mauritania, there is a need to conduct it over many years in order to understand better the variation of rice production costs over time in the different types of irrigated schemes. Third, we worked on average hectare and on small perimeters due to the lack of data. Finally, the use of straight line depreciation understimates the large scale perimeter costs.

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APPENDICES

APPENDIX I

SMALL SCALE PERIMETER ESTABLISHMENT (LABOR USES AND REPARTITION BETWEEN SEXES) IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY MAURITANIA, 1980.

(IN OUGUIAS)

Operation	Person-day		Cost/Ha
	Men	Women	
Land clearing	8	1	850
Burning	2		200
Principal canal	12	1	1250
Filling up	8		800
Secondary canal	40	2	4200
Small dikes	30	2	3150
Plot leveling	30	2	3150
Total costs	130	6	13600

Source :WARDA , Analyse economique de la culture irriguée en Mauritanie, 10 Mars 1980.

The same wage rate is assumed for both women and men which is equal to 100 ouguias per person m.d.. Women bring water and food for men at work on the perimeter.

$ U.S.1 = U.M.46

APPENDIX II

COST COMPUTATION FOR ESTABLISHING A SMALL SCALE PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

Costs Category	Per Ha costs
Expatriates	20.0
Local personnel	5.0
Cars	9.0
Food for work	8.6
Motorpump	44.4
Other equipment(a)	2.2
Total costs	89.2

Source: Requete et programme d' execution financière I.D.A. rapport d' evaluation BIRD du 12 Mars 1979

a) Includes : Floating ferry, spare parts , flexible pipe, aluminium tubes , joinings and accessories.

$ U.S.1 = U.M.46

APPENDIX III

INVESTMENT COSTS PER HECTARE FOR ESTABLISING A LARGE SCALE IRRIGATION PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

COSTS CATEGORY	COST
Dikes	159
Roads	32
Sluice gate	74
Pumping station	89
Electric exchange	53
Canal for irrigation	51
Drainage canal	50
Leveling	68
House building	71
Operating building	30
Trucs and cars	4
Control costs of the perimeter establishment	16
Engineering consultant services	41
Total establishing costs	737

Source: SONADER, Investissements du casier pilote du Gorgol novembre 1979.

$ U.S.1 = U.M.46

APPENDIX IV

SMALL SCALE PERIMETER : LABOR PERSONDAYS, FACTORS OF PRODUCTION AND EQUIPMENT COSTS PER HECTARE USED IN THE UPSTREAM ZONE OF THE FLEUVE. MAURITANIA, 1980.

(NON SUBSIDIZED COSTS IN OUGUIA)

TASK TYPE	LABOR	FACT. OF PROD. OR EQUIPMENT		
	p.d.	nature	quantity	cost
Nursery rice bed	8	seeds	40kg	1200
Land preparation	30	hoe	3u	2000
Fertilization	1	phosp.	160kg	3360
Preirrigation	5	Z	Z	Z
Transplanting	22	Z	Z	Z
Fertilizing	2	urea	280kg	5880
Weeding	30	hoe	6u	600
Harvesting	30	sickles	6u	900
Threshing	30	sticks		
Winnowing	10	basket	2u	200
Tranporting	10	container		Z
Birdscaring	30	Z	Z	Z

SOURCE : WARDA. Analyse économique de la culture irriguée du riz en Mauritanie, 10 Mars 1980, p.44.

p.d. = personday

FACT. OF PROD. : factors of production

phosp. : phosphorus Z : zero value or non used

$ U.S.1 = U.M.46

APPENDIX V

LARGE SCALE PERIMETER : LABOR PERSONDAYS, MACHINERY SERVICES AND FACTOR OF PRODUCTION OR EQUIPMENT COSTS IN THE UPSTREAM ZONE OF THE FLEUVE AT FARMERS' LEVEL, MAURITANIA. 1980.

(NON SUBSIDIZED COSTS IN OUGUIAS)

TASK TYPE	LABOR	MACHINERY SERVICES			F.P. OR EQUIP. USED		
	p.d./ha	nature	d/h	cost/ha	nature	quantity	cost/ha
Nursery rice bed	6	7	Z	Z	seeds	40 kg	1200
Plowing(a)		Tr.100hp	3h	2610	Z	Z	Z
		Plow	3h	270	Z	Z	Z
Fertilizing	!	7	Z	Z	pho.	160 kg	3360
Preirrigation	15	7	Z	Z	hoe	1 unit	400
Transplanting	35	7	Z	Z	Z	Z	Z
Fertilizing	2	7	Z	Z	urea	280 kg	5880
Weeding	30	7	Z	Z	hoe	4 units	800
Harvesting	28	7	Z	Z	sickles	6	900
Tranporting	3	cart	2	800	bag	50 units	1250
Irrigation costs	Z	7	Z	Z	Z	Z	1200

SOURCES:

a) WARDA, Analyse economique de la culture irriguee du riz en Mauritanie, 10 Mars 1980, p.34.

b) Appendix VIII.

Tr : tractor pho : phosphorus Z :zero value or non used

d/h = day or hour F.P.: factors of production

EQUIP.: equipment ha : hectare p.d. = personday

a) Farmers pay only u.m. 2,600

$ U.S.! = U.M.46

APPENDIX VI

LARGE SCALE PERIMETER : LABOR PERSONDAYS. MACHINERY SERVICES AND FACTORS OR EQUIPMENT USED COSTS IN THE UPSTREAM ZONE OF THE FLEUVE AT SONADER'S MANAGEMENT LEVEL, MAURITANIA, 1980. (COST IN OUGUIAS)

(NON SUBSIDIZED COSTS)

TYPE OF TASK	LABOR	MACHINERY	SERVICES		F.P. OR EQUIP. USED		
	p.d	nature	hour	cost	nature	quantity	cost
Nursery bed	4	Tr.65hp	1	570	seeds	40 kg	1200
		Wagon	1	190	Z	Z	Z
Plowing	7	Tr.100hp	3	2610	Z	Z	Z
		Wagon	3	270	Z	Z	Z
Fertilizing	7	Tr.65hp	2	1140	pho.	160 kg	3360
		Spreader	2	520	urea	300 kg	6300
Harrowing	7	Tr.65hp	1	570	Z	Z	Z
		Harrow	1	110	Z	Z	Z
Transplanting plants	73	Z	Z	Z	Z	Z	Z
Weeding	23	Z	Z	Z	Z	Z	Z
Harvesting	90	Z	Z	Z	sickles	6 units	900
Transporting	7	Tr.65hp	1	570	Z	Z	Z
		Wagon	1	190	Z	Z	Z
Threshing	7	Thresher	4	360	Z	Z	Z
Bagging	7	Z	z	Z	bags	50 units	1250

SOURCE : WARDA .Analyse economique de la culture irriguee du riz en Mauritanie . 1980 . p.33.

Tr. = tractor   pho : phosphorus   EQUIP.: equipment

p.d = personday   F.P.: factors of production

$ U.S.1 = U.M.46   Z : zero value or non used

APPENDIX VII

IRRIGATED FINANCIAL COSTS PER HECTARE FOR THE SMALL SCALE IRRIGATED PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY, MAURITANIA, 1980.

(THOUSANDS OF OUGUIAS)

FIXED COSTS	
Pump amortization	3.6
Interest on invested capital	1.8
Sub total	5.4
VARIABLE COSTS	
Fuel : 300 liters * 21 ouguias	= 6.3
Pump operator salary	1.0
Oil : 6 liters * 100 ouguias	= .6
Maintenance and sparts part	1.0
Sub total	8.9
TOTAL WATER SUPPLY COSTS(a)	12.457

SOURCE : WARDA. Analyse economique de la culture irriguee' en Mauritanie. 10 Mars 1979. p.103.

a) This is the total water supply costs per hectare. One hectare of rice requires 16 000 kiloliters of water (including all losses), so the cost of water supply per kiloliter is .78 ouguias.

1 ouguias = 46 dollars

APPENDIX VIII

FINANCIAL COST PER HOUR OF MACHINERY SERVICES FOR THE LARGE SCALE IRRIGATED PERIMETER IN THE UPSTREAM ZONE OF THE SENEGAL RIVER VALLEY. MAURITANIA. 1980.

(IN OUGUIAS)

Type of equipment	Acquisition costs		
	Imported	Local	Total
Tractor 65 hp	375.0	195.0	570.0
Tractor 100 hp	625.0	245.0	870.0
Farm wagon	150.0	40.0	190.0
Plough	70.0	20.0	90.0
Sprayer	100.0	30.0	130.0
Harrow	85.0	25.0	110.0
Fertilizer spreade	200.0	60.0	260.0
Thresher	80.0	10.0	90.0

Source: WARDA. Analyse economique de la culture irriguee du riz en Mauritanie, 10 Mars 1979. p. 99

$ U.S.1 = U.M.46

APPENDIX IX

SONADER GENERAL ADMISTRATION COSTS, MAURITANIA, 1980.

(MILLIONS OF OUGUIAS)

COST CATEGORY	AMOUNT
Local personnel	41.5
Supplies and Materiels	20.3
Taxes	.3
Transport and personnel per diem	2.3
Expatriates(a)	41.1
Other costs	14.1
Total general admistration costs	147.7

SOURCE : SONADER Budget 1980, Annexe 1/1

a) These costs are paid in foreign currencies. Thus they have to be shadow priced. Total costs (except for housing) are multiplied by a shadow exchange of 1.18 to get their real costs. However, we include only those costs borne by loans.

$ U.S.1 = U.M.46