

**ISLAMIC REPUBLIC OF MAURITANIA**  
**THE FEASIBILITY STUDY OF THE IRRIGATION AND AGRICULTURAL**  
**DEVELOPMENT PROJECT IN UPPER DELTA OF THE SENEGAL RIVER**

**MAIN REPORT**

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## Abbreviations

### Organization, etc.

AFNOR	Association Française de Normalisation
AGETA	Association Générale de Groupement d'Exploitation et Eleveurs pour l'Etude des Techniques Améliorées Agricoles et Amindes
AUD	Association des Usargers du Dioup
AUG	Association des Usargers du Gouère
AVB	Agent de Vulgarisation de Base
BAD	Banque Africain pour le Développement
BFR	Bureau Foncier de ROSSO
BID	Banque Islamique de Développement
BNM	Banque Nationale de Maulitanie
CFD	Caisse Française de Développement
CGEM	Confédération Generale des Employeurs de Mauritanie
CILSS	Caisse Nationale de Sécurité Sociate
CNERV	Centre National d'Etude et de Recherche Vétérinaire
CNRADA	Centre National de Recherche Agronomique pour le Développement Agricole
CPF	Centre de Promotion Feminine
DAF	Direction d'Administration et Finance
DDRA	Direction Développement des Ressources Agro-pastorales
DEAR	Direction de l'Environnement et de l'Ménagement Rural
DET	Direction d'Etudes et Travaux
DHS	Distinction Homogeniété Stabilité
DRFV	Direction de la Recherche - Formation - Vulgarisation
ENFVA	Ecole Nationale de Formation et de Vulgarisation Agricole
FAC	Fonds d'Aide et de Coopération France
FAEM	Fédération de l'Agriculture et de l'Eleavage de Mauritanie
FAO	Food Agriculture Organisation
FED	Fond Européen pour le Développement
GDP	Gross Domestic Product
GERSAR	Groupement d'Etudes et de Recherches des Societés d'Amenagement Rural
GMP	Groupe Motorpompe
GOM	Gouvernement de la Mauritanie
GPA	Groupements Précoopératif Agricoles
IGN	Institut Géographique National Français
IMF	International Monetary Fund
ISRA	Institut Sénégalais de Recherche Agronomique
ISS	Institut Scientifique Superieur
JICA	Agence Japonaise de Coopération Internaionale
LEG	Laboratoire d'Etudes Geographiques
LNTP	Laboratire National des Travax Publics
MAEC	Ministère des Affaires Etrangères et la Coopération
MDRE	Ministère du Développement Rural et de l'Environnement
MP	Ministère du Plan
OMVS	Organisation pour la Mise en Valeur de Fleuve Sénégal
ONS	L'Office National de la Statistique
PDS	Programme de Développement pour Sedentarisatic
PSA	Projet de Service Agricole
RIM	République Islamique de Mauritanie

SAED	Société d'Aménagement et d'Exploitation des Terres du Delta du Fleuve S始使at et de la Faleme
SFV	Service Formation et Vulgarisation
SONADER	Société Nationale de Développement Rural
SONELEC	Société Nationale d'Eaux et d'Electricité
SONIMEX	Société Nationale d'Importation et d'Exportation
UM	Ouguiya
UNCACEM	Union Nationale des Coopératives Agricoles de Crédit et D'épargne de Mauritanie
UNDP	United Nations Development Program
USAID	US Agency for International Development
UUE	Unité des Usagers de l'Eau
VAT	Valeur Agronomique et Technologique
WARDA	West African Rice Development Association
WB (BM)	Banque Mondiale
WID	Women in Development

### Units of Measurement

<u>Length</u>	<u>Time</u>	<u>Area</u>
mm = Millimetre	s = Second	cm <sup>2</sup> = Square centimetre
cm = Centimetre	min = Minute	m <sup>2</sup> = Square meter
m = Meter	h = Hour	ha = Hectare
km = Kilometre	d = Day	km <sup>2</sup> = Square kilometre

<u>Electrical Measures</u>	<u>Volume</u>	<u>Other Measures</u>
W = Watt	cm <sup>3</sup> = Cubic centimetre	% = Percent
kW = Kilowatt	lit = Liter	° = Degree
MW = Megawatt	m <sup>3</sup> = Cubic meter	' = Minute
kWh = Kilowatt hour	MCM = Million cubic meter	

<u>Weight</u>	<u>Derived Measures</u>	<u>Currency and Others</u>
mg = Milligram	m <sup>3</sup> /sec = Cubic meter per second	UM = Mauritanian Currency
g = Gram	lit/sec = Litre per second	US\$ = US Dollar
kg = Kilogram	lit/s/ha = Litre per second per hectare	¥ = Japanese Yen
ton = Metric ton	nd = Man day	US\$1.0 = UM150.2 = ¥124.2
	M/M = Man Month	(As of Mid February 1997)



# CHAPTER 1 INTRODUCTION

## 1.1 Authority

The Agreement between the Ministry of Rural Development and Environment (MDRE) and the Japan International Cooperation Agency (JICA) on the Scope of Work, and the Agreement between the National Rural Development Agency (SONADER) and JICA on the Minutes of Meeting on Scope of Work, both of which have been signed on March 21, 1997, constitute the covenants between Mauritania and Japan for the implementation of the Feasibility Study for the Irrigation and Agricultural Development Project in Upper Delta of the Senegal River in the Islamic Republic of Mauritania (hereinafter referred to as "the Study").

The present Final Report has been prepared in accordance with the Agreements on Scope of Work mentioned above.

## 1.2 Background of the Project

The commissioning of the Diama and Manantali dams and the completion of the right bank embankment in 1992 have made it possible to irrigate an area of 8,000 ha in the Upper Delta.

The people living in the Delta are aware that the increase of agricultural production will improve their living standards. In addition, the proximity of the Delta area to the important centers of Nouakchott and Rosso, as well as its adjacency to Senegal makes it an attraction pole for private investors. In this context, it can be said that the Upper Delta plays an important role in the national food production program and, at the same time, constitutes a pilot area for agricultural development in the Senegal river valley.

However, the lack of appropriate irrigation and drainage facilities seriously hinders irrigated agriculture development in the area. Moreover, the construction of embankment without taking into account the drainage issue has caused some environmental problems, such as increase in soil salinity, deterioration of water quality which is harmful to the health of local people and to the vegetation, and spreading of diseases due to water stagnancy.

In consequence, there is an urgent need to rapidly implement irrigation and drainage and agricultural development programs taking due and adequate consideration of such an environmental condition, and aiming at increasing agricultural production and improving productivity of the area.

Under such circumstances, the Government of Mauritania requested the Government of Japan in September 1994 to provide technical assistance for formulation of the Irrigation and Agricultural Development Project in the Dioup area located to the west of Rosso. In response to this request, the Government of Japan, through JICA, dispatched a preliminary study mission to the site in March 1996, and the Scope of Work for the Study was signed between JICA and MDRE on March 21 of the same year.

### **1.3 Objectives of the Study**

The objectives of the Study are as follows:

- (a) Execution of a feasibility study of the Irrigation and Agricultural Development Project in the Dioup area in the alluvial plain located on the right bank of the Senegal river, some 150 km south of Nouakchott; the Project will be aimed at improving the living conditions of rural population, increasing food production, and preserving the environment.
- (b) Transfer of technology to the Mauritanian counterparts through the execution of the Study.

### **1.4 Study Area**

The Study Area has been delineated to cover about 8,000 ha of land in the Dioup area (the Project beneficiary area including floodable depressions) in the Senegal River Delta, to the west of Rosso and in the south-west part of Mauritania. Part of the Study, however, covers an area of about 10,000 ha in N'Diader located just downstream of the Dioup area.

### **1.5 Work Schedule**

The Study Team together with the Advisory Team and SONADER held a meeting on the Inception Report on August 5, 1996 and agreed with the contents of the said report.

The Study was carried out in two phases over two consecutive years. The scope of study works for each year was as follows:

- (1) First year (1996)
  - a) Preparatory work in Japan
  - b) Phase I field work (rainy season)
  - c) Phase I home work in Japan, preparation of the Interim Report
  - d) Phase II field work (dry season)
- (2) Second year (1997)
  - a) Phase II home work in Japan, preparation of the Draft Final Report
  - b) Explanation of the Draft Final Report in Mauritania
  - c) Preparation of Final Report

The work flow chart, schedule of study activities, and plan and schedule of execution of study works are shown in Figures 1.5.1, 1.5.2 and 1.5.3, respectively.

### **1.6 List of Counterpart Personnel**

The Government of Mauritania assigned eight staffs from SONADER as counterpart personnel for the Project. A list of counterpart personnel is given in Table 1.6.1.

## CHAPTER 2 SOCIO-ECONOMIC BACKGROUND

### 2.1 National Socio-economy

The Islamic Republic of Mauritania, located in the south-west of Sahara Desert, gained independence in 1960. The country has an area of 1,032,000 km<sup>2</sup> and a population of about 2.3 million.

The country's economy is based on three main sectors: fishery which is practiced along the Atlantic Coast (about 670 km), agriculture mainly in the valley on the right bank of the Senegal river (about 800 km), and iron ore mining in the north.

Originally, nomadism and extensive stock farming were mainly the traditional living way of the people until the drought of the 1970s occurred. These droughts caused severe damage to the nomadic society and extensive stock farming and lead to a gradual sedentary settlement of the population in urban areas. Therefore, a new national economic policy was deemed more and more necessary to deal with the modern life of the country. Due to this new socio-economic situation and hard climatic conditions in the area, extensive stock farming was no more considered as one of the national development bases and, at the same time, fishery had no promising prospects.

The table below shows basic socio-economic figures of the country in 1994 :

Basic Socio-economic Data of Mauritania		
Item	Unit	1994
POPULATION	Nbre	2,211,473
Growth Rate	%	2.94
SOCIO-ECONOMY		
GDP at Current Prices	million UM	128,144
GDP at Constant Prices (1985 Price Level)	million UM	69,491
GDP at Current Prices per capita	UM	58,247

Source: La Mauritanie en Chiffres (Mauritania Figures), ONS, 1995

### 2.2 National Development Programs

After gaining independence in 1960, the Government of Mauritania formulated and implemented until the end of the 1970s a number of national development plans focused on social stabilization. It should be noted, however, that the Government of Mauritania was able to work out substantial national development programs only towards the end of the said period. Finally, the 4th Five-Year National Development Plan of 1981 - 1985 was the first national economic development plan that embraced all the socio-economic sectors.

Since 1986, Mauritania has adopted the Structural Adjustment Program recommended by the World Bank and IMF in order to improve the nation's socio-economic conditions.

After the sluggish period until 1992, the economic situation in terms of GDP has progressively improved at an estimated average growth rate of 4.5% in the years

1993 - 1996, thanks to the implementation of the recent Structural Rectification and Adjustment Program which defines the economic development policy.

The composition of GDP by sector in 1992 - 1994 is indicated in the following table:

		1992	1993	1994
GDP (Market Prices)	million UM	96,591	113,919	125,446
GDP (1985)		63,509	65,726	69,452
Growth Rate	%	2.5	3.4	5.6
Agriculture, Stock				
Farming, Fishery*	million UM	12,862	14,511	15,016
(1985 Price Level)				
(Ratio)	%	20.25	22.08	21.62
Construction, Mining, Public Works				
(Ratio)	%	19.84	21.75	21.21
Transport, Communication, administration, service				
(ratio)	%	59.89	56.17	57.17

\*: Small-scale fishery practiced by farmers

The development programs adopted in recent years cover a shorter period (three years) so that they can be adjusted on the basis of the evaluation of results obtained in the preceding year.

In order to attain the economic development targets, a Public Investment Program (PIP) and an Investment Budget Plan (BCI) for each year have been implemented. The following table shows the annual investment budget by sector in 1995 - 1997:

	(Unit: million UM)		
Items	1995	1996	1997
Rural Development	5,022	5,400	5,323
Industrial Development	3,296	2,735	1,527
Land Development	4,919	4,160	6,647
Human Resources	1,710	2,113	3,041
Institutional Development	1,985	1,990	1,034
<b>Total</b>	<b>16,632</b>	<b>16,397</b>	<b>17,572</b>

Source: PIP 1994 - 1996; BCI 1997

## 2.3 Agriculture in Mauritania

### 2.3.1 Agro-ecological Areas

Mauritania can be divided into the following four agro-ecological areas:

#### (1) Arid Area of Sahara

This area occupies about 60% of the country's total area and presents some locations suitable for development of permanent oases. Date production was an important activity in the area, however, palm plantations have suffered seriously from drought due to rural exodus.

#### (2) Semi-arid Area of Sahel

This area is the core of rural economy of Mauritania, involving about 400,000 people. The area can be divided into three sub-areas: East, Central and West Sub-areas. The East Sub-area includes Hod el Gharbi and Hod ech Chargui, the Central Sub-area consists of Tagant and Assaba, and the West Sub-area is composed of Brakna and Trarza.

### (3) Senegal River Valley

This area has the largest agricultural potential. Approximately 400,000 people are living on the river's right bank, on Mauritanian side. The dominant agricultural activities are traditional flood recession farming, pasturage, and fishery.

### (4) Coastal Area

This area is a 50 km wide and 670 km long stretch of land covering 2% - 3% of the country's total area. A population of about 500,000 is inhabiting this area which includes Nouakchott and Nouadhibou cities.

## 2.3.2 Agricultural Resources

The area of arable lands in Mauritania is 481,000 ha and that of irrigable lands is 135,000 ha, of which 125,000 ha are located in the Senegal river basin. The area in which rain-fed farming is possible is very small, representing only 0.2% of the country's total area. Agricultural production is concentrated along the south area and especially on the right bank of the Senegal river, where rainfall is relatively large. About 17% of cultivable lands in the area receive more than 150 mm of rain per annum and they may be considered as potential pasture lands. However, agriculture and stock farming are precarious due to serious climatic instability. The distribution of arable lands is shown in Figure 2.3.1.

The most serious problem that faced Mauritania was the succession of drought spells occurring between 1968 and 1973 and between 1983 and 1985. It was estimated that the isohyet of 150 mm has moved about 100 km and reached the south of Nouakchott. The production potential of lands has so decreased that the population density in rural areas has dropped dramatically. The cattle population (mainly bovines and ovines) also has been considerably reduced. Under such circumstances, irrigation development has been started aiming at intensification of agriculture in order to ensure continued production. As such, irrigated areas have increased from 2,000 ha in 1980 to 24,000 ha in the 1980s.

## 2.3.3 Food Production

The main agricultural products of Mauritania are sorghum, millet, niébé, maize, and rice. In a year with normal rainfall, the production can satisfy 1/3 to 2/3 of the cereal demand which is estimated at 150 kg per capita, but the harvest fluctuates largely from one year to another. The self-sufficiency rate was only 20% during the drought period of 1983 - 1985.

In addition, the production of date and gum arabic, which had been an income source not so long ago, has diminished considerably as a result of drought.

The population growth rate is about 2.9% while agricultural production remains stagnant or decreases, such as the case of irrigated rice cultivation.

## 2.3.4 Stock Farming

Domestic stock farming is an important activity of the rural sector, accounting for 80% of GDP of agriculture (20% of total GDP), but it is not integrated entirely into the national economy. As mentioned previously, the impact of drought on pasturage and stock farming was very strong: The bovine population of 2,430,000 in 1969 significantly shrank to 1,115,000 (46%) in 1973. The figure rose to 1,900,000 in 1979 but, as a consequence of successive droughts, fell down gradually and reached 1,200,000 in 1992. Droughts reduced fodder resources in the north so largely that pasturage was practiced all year round in grassy lands where stock farming had been conducted only in the dry season. This situation affected in particular the Senegal river valley where cattle had been used to pasture only in the dry season of 4 months per year. Pasture lands in many places were overused, especially around water points and farming areas, leading to the deterioration of the environment and productivity.

### 2.3.5 Framework of the National Development Plan

The Government adopted, between 1989 and 1993, an agricultural development plan called "Agricultural Sector Adjustment Program" (PASA) with the cooperation of international financing agencies. Under PASA, some achievements were made in the socio-economic and institutional aspects, such as agricultural credit, agrarian reform, marketing, price fixing, reorganization of MDRE, restructuring of SONADER, and implementation of agricultural research and extension services. However, the impact of these measures on production increase and improvement of living conditions of farmers was weak.

Following PASA, the Government introduced an irrigated agriculture development program in May 1993. This program, named "Program of Integrated Development of Irrigated Agriculture in Mauritania" (PDIAIM), constituted a concept for planning to be applied to all irrigated agriculture development projects in the Senegal river valley. The objectives of PDIAIM are:

- to embark on irrigated agriculture development within the framework of a comprehensive and integrated approach which is contrary to:
  - partial and independent development that has been prevailing up to the present;
  - actions too much limited to rice production only;
- to proceed with irrigated agriculture development based on a coherent plan for the medium and long term;
- to raise profitability of farms, through namely the rehabilitation and expansion of irrigated land parcels, introduction of double cropping, diversification of production, and development of coherent support services; and
- to continue on-going land reforms, liberalization and responsabilization of the rural world.

The implementation period of PDIAIM is determined to be ten years from 1996 and consists of two phases. The first five years will be devoted to the rehabilitation of irrigated agriculture projects and feasibility studies for new irrigation development projects. The second phase is for the extension of irrigation development. The planned net development area is 62,200 ha, consisting of the existing irrigated area of 35,700 ha and the new extension area of 26,500 ha. The newly developed area of 13,000 ha is classified in the private agricultural sector, while small and large cooperatives will hold 8,700 ha and 4,800 ha of land, respectively.

The total amount required for PDIAIM realization is estimated at 33.6 billion UM, comprising 28 billion UM from public fund and 5.6 billion UM from private fund.

The public fund consists of 2.8 billion UM to be allotted from the national budget and 25.2 billion UM from foreign financing.

### 2.3.6 Present International Cooperation Situation

Many international development aid agencies and donor countries are providing technical and financial cooperation to Mauritania. The most important among those agencies and countries are the World Bank and France.

The World Bank has been engaged in the agricultural sector since 1971 and has concentrated its funding in the sub-sectors of irrigation, stock farming development, and relief for drought effects. At present, two agricultural projects are under operation: The Project for Investment and Adjustment of the Agricultural Sector (PIASA) and the Project for Agricultural Services (PSA). PIASA consists of two components: Rapid disbursement program and investment program. The first component was completed and the second component is being implemented for the Fom Gleita Integrated Rural Development Project covering a total area of 1,950 ha in the Gorgol area. PSA's objective is to promote agricultural services in the whole country, focusing mainly on and strengthening the organizational relations between agricultural extension services, research, and training.

The French Government is providing assistance to Mauritania in the agricultural sector through the French Development Fund (CFD). CFD is being engaged in many projects, namely the private agricultural extension services through Rosso-based AGETA, financial and technical support for agricultural credit services, provision of long-term credits for rehabilitation and extension of irrigation works, financial cooperation for irrigation projects implemented by PDIAIM in collaboration with other donors and the Government, assistance in the reorganization of SONADER, technical and financial assistance for the project of rehabilitation of agricultural infrastructure of the Boghé Pilot Farm (CPB), agricultural and irrigation development in Gouère area, etc. CFD will continue to provide assistance in these projects and is planing the agricultural development in the eastern area of Rosso and the phase II development of the Gouère area.

### 2.3.7 Land Tenure System

In 1983 the Government has enacted a law recognizing the right of land ownership by individuals even though it is understood that all lands in principle belong to the State. In addition, a law amendment issued in 1990 has further promoted decentralization of land allocations. The right of land ownership is obtained through the following procedure:

- a) Obtaining of authorization for farming for five years
- b) Obtaining of provisional right of cultivation for five years
- c) Obtaining of definitive right of ownership

After the period of development of five years, if the land is still not fully used the authorization will be canceled. To apply for the provisional right of cultivation thereafter, the applicant must fulfill the terms and conditions set forth for obtaining of the farming authorization. Besides, within the period of provisional right of cultivation of five years, it is obligatory to follow the submitted farming plan (types of crops, farming plan). The definitive right of ownership is obtainable ten years after obtaining the farming authorization. Then the right will be registered in the cadastral register concerned.

## 2.4 Senegal River Bank Development Plan

### 2.4.1 Background and Objectives

The Senegal river has a large catchment area of about 290,000 km<sup>2</sup> as shown in Figure 2.4.1 and an annual discharge of 24 billion m<sup>3</sup>. The river is however characterized by irregular hydrologic conditions and may dry up during a half of the year.

In 1972, Mali, Mauritania and Senegal have established the Organization for Development of the Senegal River (OMVS) to unite their efforts in coordination of the development of the river basin.

OMVS has built two dams (Manantali upstream of the basin and Diama downstream) with an aim to irrigate 375,000 ha of land, generate 800 GWh of electric power per year, and allow navigation along the river from Saint Louis on the estuary to Ambidédi (Mali is a landlocked country).

### 2.4.2 Infrastructure Development Program

OMVS started the construction of the Diama dam in 1981 and that of the Manantali dam immediately thereafter, in 1982. The embankment extending on the right bank from the Diama dam up to Rosso was constructed during the period of 1988 to 1994.

The three countries proceed separately with irrigation of the total area of 375,000 ha, with 9,000 ha belonging to Mali, 240,000 ha to Senegal, and 126,000 ha to Mauritania. Since financing is available for the construction of a 200 MW hydroelectric power station and transmission lines, the first phase development works are scheduled to be commenced in 2000.

OMVS plans to raise the water level in the Diama dam by 1 m from the present elevation of 1.5 m, to reach EL. 2.5 m in order to increase the storage capacity for the purpose of extending the gravity irrigation system for the arable lands along the river and ensuring rational utilization of water in coordination with the Manantali dam. This project, which consists of the construction of embankments of 100 km long on both river banks upstream of Rosso, is in the stage of mobilization of fund for project study.

### 2.4.3 Delta Development Management and Water Tax Collection

#### (1) Delta Development Management

Management of the Senegal river development falls under the responsibility of OMVS. The agency in charge of management of OMVS's structures on the river has its headquarters in Rosso. Operation and maintenance of the Diama and Manantali dams as well as the hydraulic structures constructed on the embankment are fully undertaken by this agency. As shown in Figure 2.4.1, the Senegal river is divided into four hydraulic sectors from the upstream hydrological control structure in Bakel. OMVS's management agency stationed in Rosso collects daily data concerning water level and discharge of the two dams and of ten hydrological control structures and issues instructions for operation of the Manantali and Diama dams.



Operation and maintenance of gated structures built on the right bank are performed by OMVS according to the request of the agencies responsible for irrigation in the countries concerned, that is SONADER in the case of Mauritania.

## (2) Water Tax Collection

Water charge to be paid to OMVS is collected from farmers through imposition of a tax on the price of diesel fuel used for irrigation pumps. Farmers are entitled to purchase diesel fuel at a duty-free price of 24.57 UM/liter for irrigation purposes, while the standard market price is 55 UM/liter.

The unit rates of charges paid to OMVS by the Government are fixed at 500 CFAF/ha for the rainy season, 200 CFAF/ha for the cold dry season and 1,400 CFAF/ha for the hot dry season. The total amount of water charge paid to OMVS in the last three years was 12,900,000 CFAF per year on an average.

### 2.4.4 Irrigation Development Program for the Basin in Mauritania

The total arable area on the Senegal river bank on Mauritanian side is estimated to be about 185,300 ha, including pasture areas. This consists of an irrigable area of about 135,410 ha, a flood recession area (Walo) of 39,440 ha, and a pasture area of 10,410 ha as indicated in Table 2.4.1. Irrigated agriculture has been introduced in the Senegal river basin at the beginning of the 1960s. It has boomed with the establishment of SONADER in 1975 and has been promoted also by the commissioning of the Dama and Manantali dams at the end of the 1980s and, furthermore, by the enactment of the land ownership law in 1983 and 1990. This law which authorizes private ownership of agricultural development land, has promoted investment on a larger scale leading to expansion of farm mechanization.

The composition of the irrigable area of 135,410 ha is detailed in Table 2.4.1 and its layout is illustrated in Figure 2.4.2. The irrigated areas since 1975 are summarized in Table 2.4.2. Those areas are classified into three categories: The areas developed by SONADER, the M'Pouré farm under management of MDRE, and the areas developed by the private sector.

Irrigation development is concentrated in Trarza where areas developed by the private sector are predominant. This area is favorable thanks to its proximity to Nouakchott and the position of Rosso in exchanges with Senegal, as well as improved hydraulic conditions following the construction of the right embankment and installation of gates in the Delta. The very poor condition of roads between Boghé and Rosso represents the most serious constraint to development of the eastern part of this area.

In accordance with PDIAIM, SONADER has prepared a five-year investment program for irrigation development in the Senegal river basin in the 1996 - 2000 period, as indicated in Table 2.4.3. This program envisages the construction in 1999 of the irrigated agriculture development project as a first priority project in the Dioup area which forms the present Study Area.

## CHAPTER 3 PRESENT CONDITIONS OF THE STUDY AREA

### 3.1 Location and Administrative Jurisdiction

The Study Area is located in the center of the Upper Delta, downstream of the Senegal river and about 200 km south of Nouakchott, capital city of Mauritania. The area is a 10 km wide stretch of land extending between 20 and 40 km to the west of Rosso and is bounded by sand dunes to the north and the right embankment of the Senegal river to the south. Administratively the Study Area is under the jurisdiction of Keur Macène province, Trarza region.

### 3.2. Meteorology, Hydrology, Water Quality, and Topography

#### 3.2.1 Meteorology

##### (1) General

There are two meteorological observation stations in the Study Area: The Rosso weather station and the Keur Macène rain-gauge station. Table 3.2.1 shows meteorological data recorded by the Rosso station, including duration and quantity of rain, temperature, humidity, sunshine duration, wind and evaporation, as well as rainfall in Keur Macène. The area has a Sahelian climate characterized by a large fluctuation of temperatures between daytime and night time and low rainfall. Annual rainfall observed in the last 30 years in Rosso ranges from 37 mm to 338 mm, averaging 213 mm. Approximately 90% of rainfall is concentrated in the three months of July, August and September. Downpours generally last for three hours.

Mean monthly temperature and humidity are 28°C (varying between 23°C and 31°C) and 48% (varying between 33% and 69%), respectively. Maximum and minimum temperature and humidity are as follows: 40.3°C in May and 15.6°C in January, and 89.6% in August and 13.5% in March. Mean monthly sunshine duration is 8.6 hours, with short periods where the duration becomes 7.3 hours in December and 9.7 hours in April. Wind is relatively strong all year round with a wind velocity averaging 4.6 m/s from 5.6 m/s in May to 3.6 m/s in August. Mean annual evaporation measured by Piche method is 3,129 mm, corresponding to 8.57 mm/day.

##### (2) Rainfall Analysis

Figure 3.2.1 shows annual precipitation recorded at the Rosso weather station from 1954 to 1994, i.e. 31 years, and the average difference of five years. Based on the values given in the figure, it is presumed that droughts started occurring in the latter half of the 1960s, followed by a slight decrease of annual rainfall.

A rainfall analysis was conducted using the daily rainfall data collected by the Rosso weather station for 31 years from 1964 to 1994 as follows:

- a) Probable annual rainfall in drought years
- b) Probable maximum rainfall in three consecutive days
- c) Maximum daily rainfall

The results of calculation of probability by Gumbel formula are as follows:

(Unit: mm)

Probability	Rainfall in Drought Year	Rainfall in 3 Consecutive Days	Maximum Daily Rainfall
5 years	138	78	60
10 years	96	95	71

### (3) Evaporation from Water Surface in the Gungala Depression

Mean daily evaporation of each month in the Gungala depression is estimated as shown in Figure 3.2.3 and summarized below:

(Unit: mm/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
5.5	6.8	7.5	7.6	7.2	6.1	5.6	5.4	4.7	4.1	3.8	4.8

## 3.2.2 Hydrology

### (1) General

The reference hydrological observation points in the Study Area are those located at the Manantali dam, Bakel and Diama dam. Monthly discharges measured at these points and mean water level upstream of the Diama dam are shown in Table 3.2.3 and summarized in the table below:

Year	Mean Annual Discharge and Water Level			Water Level at Diama (cm, IGN)
	Discharge (m <sup>3</sup> /s)			
	Manantali	Bakel	Diama	
1987	120	203	175	-
1988	114	457	434	-
1989	104	410	292	38
1990	103	220	165	79
1991	142	404	301	84
1992	228	391	238	142
1993	201	373	316	159
1994	418	849	671	154
1995	257	696	620	163
1996				186

Source: OMVS

The water levels recorded upstream of the Diama dam since 1989 are shown in Figure 3.2.4. It can be seen from this figure that from the completion of the right embankment of the Senegal river in 1992 until the second half of 1995, the water level was maintained in general at EL. 1.5 m which is the design water level of the Project. Thereafter, the water level has raised gradually and reached EL. 2.0 m in the second half of 1996. This fact results from the increase of water storage upstream of the Diama dam for ensuring irrigation water supply against the substantial decrease of discharge of the Senegal river.

### (2) Discharge Control Plan

The functions of the Manantali dam are decided by OMVS differently for the pre-commissioning and post-commissioning period of the hydropower station as follows:

Pre-commissioning period:

- Supplying water to Dakar, Nouakchott and cities and villages located along the Senegal river;
- Maintaining a minimum discharge downstream of the dam ( $10 \text{ m}^3/\text{s}$ );
- Maintaining artificial flood in flood recession areas; and
- Supplying irrigation water.

Post-commissioning period:

- Generating 86 MW of electric power per year (the minimum maintenance discharge is already included in the discharge for power generation);
- Supplying irrigation water; and
- Maintaining artificial flood for a temporary period of time.

In 1987, on the basis of the above-mentioned functions of the Manantali dam, OMVS selected Bakel as a hydrological control point and defined the rules for dam operation before and after the commissioning of the hydropower station (see Figure 3.2.5).

It is assumed that the guaranteed minimum discharge after the commissioning the power station will be  $250 \text{ m}^3/\text{s}$ . This discharge is enough for irrigation of an area of 100,000 ha including drinking water supply.

Taking into consideration the following factors, however, it is necessary to review the water balance of the entire Senegal river basin:

- No detailed water balance study was conducted so far after the commissioning of the Manantali and Diama dams;
- There is a tendency of gradual decrease of total annual discharge of the Senegal river; and
- The total irrigation development area in Mauritania and Senegal amounts to more than 70,000 ha at present.

### 3.2.3 Groundwater

The Study Team has constructed an observation well in Keur Macène and two in Dara Salem for measuring the water table level, as shown in Figure 3.2.2. Data obtained from these three wells are given in Figure 3.2.6 together with the water level in the Gungala depression. These data indicate a close correlation between the groundwater level and the surface water level in the Gungala depression. As the groundwater level is lower than the surface water level in the depression, it can be concluded that waters in the Gungala depression constitute a water source for the aquifer in the northern outlying part of the Study Area.

Fifteen observation wells equipped with piezometers have been installed by OMVS in the Study Area, seven of which (shown in Figure 3.2.2) are being maintained in good condition. Figure 3.2.7 gives data obtained from the five wells located inside the Senegal river embankment, as well as data on water level of the river. These data indicate that the groundwater level inside the embankment is practically not affected by fluctuations of water level of the Senegal river after completion of the embankment.

From the groundwater observation results and previous measurement data, it can be presumed that the groundwater level within the Study Area varies between EL. +1.2 m and -0.5 m. Considering the fact that the water level in the Gungala depression is planned to be kept under EL. +1.0 m under the Project, the groundwater level will remain around EL. +0.5 m. However, since irrigated agriculture development may

change the groundwater level, it is necessary to continue to observe this level and at the same time to monitor salt alleviation at the soil surface.

### 3.2.4 Water Quality

#### (1) Irrigation Water

Since irrigation water will be taken from the Senegal river, measurements of pH value, electric conductivity and salinity of the river water were conducted upstream of Ibrahima. The general values obtained are as follows: pH = 7.4 - 7.6, EC = 0.06 - 0.44 mS/cm, salinity = 38 - 282 ppm. Judging from these figures, it is considered that the river water is quite acceptable for irrigated rice cultivation.

#### (2) Water for Consumption

The results of three series of quality survey of consumption water taken from wells in three villages are described below:

##### a) Bacteriological Analysis Results

It was found that the total number of germs in the water of all the three wells is large to countless, but this number decreases considerably in the water taken during the second series of sampling from the well in Awlig. The presence of bacteria of intestinal origin, of E. Coli type, is an indication of water pollution caused by faeces and presents a risk of disease for the population who consumes this water. The same germs were observed in N'Kheila and Beni Nadji wells during all the three survey series and in Awlig well in the last series. It is therefore evident that there is faecal contamination of water due to the way of life of the population and the presence of animals.

##### b) Chemical Analysis Results

A high content of nitrates resulting probably from both the presence of many bacteria and the decomposition of organic wastes may make the use of this water for human needs hazardous. A gradual decrease of nitrate content was observed in all the three wells but the salt content remained above the standard level.

### 3.2.5 Topography

#### (1) General Topographic Condition

The Study Area is composed of flat lands, natural canals and floodable depressions. The flat lands are located generally at elevations between 0.75 m and 2.0 m and partly at an elevation over 2.0 m. The maximum land elevation is 2.5 m except for the embankment crest on the right bank of the Senegal river, which is around EL. 4.0 m.

The depressions have a vat shape with small depth. Their elevation is generally below 0.75 m. The deepest bottom is at EL. -0.9 m.

#### (2) Gungala Depression

The topographic conditions in the Gungala depression are defined from the results of topographic survey carried out during the Phase II field work, and also based on the topographic data obtained from the Study on Construction of Hydraulic Infrastructure in Upper Delta of Mauritania conducted by SONADER with assistance of French Consultant GERSAR. These information and data are necessary for the water balance study for drainage planning. The water area and storage volume of the depression at each elevation of 0.25 m under EL. 1.25 m are estimated as follows:

Topographic Conditions in the Gungala Depression		
Elevation	Water Area	Storage Volume
(m)	(ha)	(million m <sup>3</sup> )
1.25	4,260	18.00
1.00	2,370	9.71
0.75	1,540	4.82
0.50	590	2.16
0.25	310	1.03
0.00	110	0.50
-0.90	0	0.00

The relation between elevation, water area and storage volume mentioned above is illustrated in Figure 3.2.8.

### 3.3 Soils and Land Suitability

#### 3.3.1 Soils

##### (1) Review of Existing Documents

The following two reports were available for the study of soil conditions in the Study Area:

- a) Land Suitability Map of areas in the valley of the Senegal Delta, Hydro-agricultural Study of Senegal River, OMVS, FAO, SEDAGRI, 1973; and
- b) Soil Map of West Area, Technical Itinerary for Production of Crops and Delivery of Paddy in Trarza Region, MDRE, 1993.

##### (2) Soil Study Conducted under this Feasibility Study

A soil profile study was conducted at 80 points in the Study Area to grasp the soil characteristics.

Samples taken from 16 profiles representing the respective soil classes were transported to a laboratory for analyses of physical and chemical characteristics related to agricultural production. The laboratory analyses performed on these samples included such items as grain size distribution, electric conductivity, pH value, contents of organic matter, nitrogen, phosphorus, exchangeable bases such as Ca, Mg, Na and K, and cation exchange capacity (CEC).

##### (3) Soil Classification

The soils in the Study Area were classified according to FAO System. Three soil types, namely Eutric Gleysol, Eutric Fluvisol and Chromic Vertisol were identified based on the results of a semi-detailed soil study.

Each soil group was subdivided into soil units according to their salinity degree. A soil map was prepared on the basis of the study results and also referring to a 1:10,000 topographic map and aerial photographs covering the Study Area (see Table 3.3.1 and Figure 3.3.1).

The areas of lands classified by soil type can be summarized as follows:

(Unit: ha)

	Eutric Gleysol	Eutric Fluvisol	Chromic Vertisol	Others	
No salt content	370	820	530		
Slightly salt	3,680	1,150	1,180		
Moderately salt	2,290	220	570	River/Water Area :	910
Very salt	530	740	480	Villages/Others:	260
Sub-total	6,870	2,930	2,760		1,170

#### (4) Main Soil Characteristics Relating to Agricultural Production

The soils in the Study Area are physically characterized by poor natural internal drainage due to the presence of clay. This does not constitute a major constraint to rice growing but artificial drainage is required for easy land preparation, weed control, and harvesting in paddy fields.

Soil salinity is a main chemical factor limiting agricultural production in the Study Area at different degrees.

Other soil features such as soil layer thickness, pH value, and CEC would not present extreme limitations to the planned land use in the area.

#### 3.3.2 Study of Salt Illuviation Mechanism

##### (1) Origin of Soil Salinity

It has been recognized in general that before the construction of embankments and the tide control gate, salinity in the area was caused by sea water intrusion at high tides. The results of soil study conducted within the framework of the present Feasibility Study demonstrate that soil salinity has substantially changed since the soil study carried out by FAO-SEDAGRI in 1973.

The FAO-SEDAGRI report mentions that salinity has a tendency to decrease in the upper soil layer compared to the lower layer. The results of soil study this time revealed a contrary tendency: Higher salinity was observed in the upper soil layer in several surveyed points. In most areas where an increase in salinity was noticed, the salinity degree in the upper layer was higher than that in the lower layer. This evidences the occurrence of salt illuviation towards the soil surface.

After the construction of the embankment and tide control gate, the water level in the Senegal river has raised. This rise in water level has increased hydraulic pressure and aggravated river water leakage into the lands adjacent to the embankment. The process of salt illuviation towards the soil surface can be explained as a result of salt transport from a lower soil layer to an upper layer by waters leaked under the embankment.

It is therefore necessary to install an effective drainage system to prevent salt illuviation towards the soil surface, in order to reduce land losses due to salinization.

Moreover, it was observed that in most places where salinity has diminished, irrigated rice cultivation had been introduced. Accordingly, the reduction in salinity is likely due to the leaching effect of irrigation.

##### (2) Monitoring of Soil Salinity

It is possible that certain physical and chemical properties of soils will change as a consequence of the implementation of the proposed agricultural development plan. It is therefore recommended to conduct a systematic monitoring program in order to evaluate the tendency of eventual changes in soil characteristics which might directly affect productivity. The monitoring results will be useful for determining the causes and correlation of changes in soil features, as well as for working out measures for improvement of land productivity in the future.

More concretely, it is recommended to collect data on electric conductivity, pH, groundwater level, execution of proposed leaching operation, and maintenance of the drainage system. For places where the monitoring results show an increase in soil salinity, it is preferable to proceed with a soil analysis to evaluate exchangeable bases and the nitrogen absorption rate. Monitoring work will be done twice a year, at the beginning and the end of the cropping season. The soils to be monitored are those in areas proposed for irrigation of paddy fields and pastures, including the major representative soil types prevailing in the Study Area. The proposed locations for monitoring are indicated in Figure 3.3.1.

### 3.3.3 Land Suitability Classification

Suitability of lands in the Study Area was assessed according to the "FAO System for Land Evaluation". The results are summarized below. The land use types taken into account in the assessment are rice cultivation and pasturage (see Tables 3.3.2 and 3.3.3).

Land Suitability Class	Land Use	
	Rice Cultivation	Fodder Production
Highly suitable (S1)	810	1,720
Moderately suitable (S2)	330	5,500
Marginally suitable (S3)	1,100	2,150
Provisionally unsuitable (N1)	4,140	340
Unsuitable (N2)	7,080	3,750
Others	270	270
Total	13,730	13,730

(Unit: ha)

Class N1 covers a large area but most of this area can eventually become suitable (S2 or S3 class) if an effective irrigation and drainage system is installed and proper soil management is introduced.

Lands classified as unsuitable in N2 class are those presenting extremely severe constraints such as considerably high salinity and/or very difficult drainage which prevent rice cultivation and pasturage. To develop these lands, special measures necessitating a long period of time and a high cost are required to be implemented. For this reason, the lands in this class are considered disadvantageous from the economic viewpoint.

The land suitability map is shown in Figure 3.3.2.

## 3.4 Agriculture

### 3.4.1 Land Use

#### (I) General



Study of present land use was made on the basis of the topographic map of the Study Area on a scale of 1:10,000, aerial photographs, field reconnaissance and confirmation, as well as results of the land use survey carried out in the 1996 rainy season and the 1997 dry season. The study results are given in Figure 3.4.1 and summarized in the table below:

Land Categories	Gross Area (ha)	Ratio (%)
Wild meadow	2,620	19.0
Meadow with bush	380	2.8
Paddy field	860	6.3
Marshland	4,590	33.3
Seasonal marshland	1,690	12.3
Shrubby forest	110	0.8
Dry field	50	0.4
Water area	910	6.6
Forest	50	0.4
Bare land	1,790	13.0
Dune	100	0.7
Village	10	0.1
Borrow area	570	4.2
<b>Total</b>	<b>13,730</b>	<b>100.0</b>

## (2) Condition of Paddy Fields

The locations and areas of lands envisaged to be developed up to now were examined by using the topographic map and cadastral documents. The results are presented in Figure 3.4.2.

The total developed area is 4,650 ha, of which 700 ha belong to cooperatives and 1,610 ha to private farmers, and the remaining 2,340 ha have not been registered. The paddy cultivated area in the 1996/1997 rainy season is estimated to be 860 ha (770 ha net), consisting of 90 ha cultivated by cooperatives, 120 ha by private farmers, and 650 ha by unidentified farmers (non registered). A large area of cultivable land has not been used due mainly to the lack of irrigation and drainage infrastructure, soil salinity, flooding, and insufficient farming fund.

## (3) Condition of Fruit and Vegetable Fields

Fruit and vegetables are cultivated mainly in the areas along the north embankment of the natural canal. As these areas are located near the villages, they are fenced for prevention of damage by cattle. These cultivated areas belong either to farm cooperatives, women farm cooperatives or private farmers. Most of the areas have a mean size (less than 0.1 ha on an average).

### 3.4.2 Agricultural Products

#### (1) Main Agricultural Products in the Study Area

The most important production in the area is that of paddy cultivated by both private farmers and cooperatives. Other products are onion, sweet potato, tomato, egg-plant, okra, niébé, pumpkin, melon, water melon, as well as maize and sorghum cultivated in small areas.

#### (2) Farming Practices

## Paddy

In the Study Area paddy is planted mostly by broadcast sowing in submerged paddy fields. The land is plowed and harrowed by tractor. Small-holding farmers prepare the land manually. Animal draft is not used at all for land preparation. In general, seeds are immersed for one day and kept for pre-germination for another day then sown in submerged condition. The sowing period is between July and August. Two or three days after sowing water is drained out and the land is irrigated according to its hydraulic condition. According to the results of survey of farmers, the average dosage of fertilizer is 100 kg of urea and 50 kg of TSP per hectare. Urea is used by most farmers while TSP is used only by 60% of farmers. The condition of rice cultivation according to the results of survey of farmers is indicated in Table 3.4.1.

Weeding is usually done by hand but some individual producers use herbicides. Harvesting is carried out between November and December by means of combine harvester in the case of large farms, and by hand in the case of small-holding farms. Damage caused by weeds (in particular for millet, sade and awekhaye) is so severe that harvesting is even abandoned in some paddy fields.

The rice varieties adopted are limited to JAYA, TN 1, IR 28 and IKP. JAYA and TN 1 are applied by 80% of farmers. Damage to paddy is generally caused by birds. Clouds of leafhoppers appear from time to time. Damage caused by rodents and insects is also observed but it is minimal. According to an old villager, there has never been any damage caused by locusts in Keur Macène. Herbicides are used in some individual farms but pesticides are not used at all. This is due to the less damage by insects and plant diseases, as well as due to economic problems. Some fields suffer from serious damage caused by the increase of salinity.

Double rice cropping has never been practiced in the Study Area. The land is not cultivated in the dry season due to havoc caused by birds, lack of irrigation water, absence of adequate species (early species), etc.

## Yield and Rice Production

The results of survey of 66 paddy farms reveal that paddy yield substantially differs from one farm to another. It ranges from 5.0 to 0.4 tons/ha and averages 1.1 ton/ha. The extremely low yield is due to damage caused by weeds and salinity. Assuming an average yield of 1.1 ton/ha, it is estimated that the total rice production in 1996 in the Study Area was 870 tons from the cultivated area of 770 ha of paddy fields.

## Vegetables

Main vegetables cultivated inside and outside the Study Area are tomato and onion. Okra, egg-plant, water melon, radish, beet, cabbage, carrot, lettuce, etc. are also cultivated in extremely limited areas. Small fruit and vegetable fields are plowed by hand and large fields by tractor. TSP (10:10:20) and urea are applied at a rate of 100 kg/ha, respectively. Pesticides are sprayed about 4 times. Aphid is the main harmful insect. Serious damage is inflicted to cabbage by cabbage-moths (*Plutella xylostella* spp.).

Animals cause more damage to fruit and vegetable crops. Market price instability and insufficiency of quality seeds and transport facilities present other difficulties. Most fields are subject to damage by salinity.

### (3) Present Condition of Inland Fisheries

According to the results of survey of farmers, inland fisheries in flood and flood-recession periods of the Senegal river was prosperous before the construction of the

Diana dam and embankments. However, halieutic production was suddenly reduced because these structures have virtually broken fishing linkage with the Senegal river. The farmer survey results indicate that no so many people depend now on fisheries for their living: About 28% of the working population is engaged in halieutic activities in one or another form, but 9.3% of which depend mainly on agriculture and practice fisheries as a secondary activity, while only 3.5% are doing inversely.

### 3.4.3 Agricultural Development Constraints

Major factors hindering sustainable agricultural development with high productivity are insufficient agricultural support services and lack of various facilities. The main constraints are summarized below:

#### (1) Insufficient Irrigation and Drainage Facilities and High Salinity

Because farmers have no financial means to construct facilities required for rice cultivation, they cannot solve the problems of submergence of paddy fields and adequate supply of irrigation water. The Government is making efforts in developing efficient irrigation and drainage facilities required for agricultural development to ensure national food security, which constitutes the base of farmers' life. In relation with the insufficiency of irrigation and drainage infrastructure, high salinity occurs at several places as a result of continuous immersion of soil and damages rice cultivation.

#### (2) Lack of Support Services and Efficient Techniques

Rice cultivation, fruit and vegetable cultivation, stock farming, etc. practiced in the Study Area present high potential for productivity improvement, but no appropriate agricultural techniques have been developed. Due to the absence of a base for technical tests, the extension of techniques for increasing vegetal and animal productions cannot be realized to an adequate extent. The lack of competent manpower resource, facilities, equipment, budget for development and execution of tests and extension services, as well as an adequate credit system, is the main cause of the problems.

#### (3) Inadequate Marketing of Agricultural Inputs and Products

The lack of not only fertilizers and pesticides but also quality seeds and plants is a serious constraint. Many farmers have no financial means for the purchase of agricultural inputs and products and suffer from inefficient transport facilities. In addition, due to insufficient development of a marketing system, farmers have access only to limited market information, which hinders their participation in the market.

## 3.5 Pasture Management

### 3.5.1 Stock Farming Condition in the Study Area

#### (1) Animal Population

The total number livestock such as bovines and ovines in the 10 villages in the Study Area is 10,170 heads (4,240 TLU). The maximum number of animals kept per household is 7 - 8 heads, and the minimum is 0.2 head.

Stock farming is practiced more than cultivation in Awlig and Legnan villages while in Dara Wolof and N'Jilar cultivation is the main activity. In Keur Macène village which has a long history, both stock farming and cultivation are practiced.

## (2) Stock Farming Types

The stock farming method observed in and around the Study Area is as follows:

### a) Seasonal Herdsmen

These herdsmen have their fixed villages but shift with their tents and family to search for pastures among sand dunes in the north of the Study Area. During the shifting season the village becomes almost empty. The second reason for shifting is to avoid mosquitoes in August and September. They return to the village in October and use the fields after harvest or flood-recession areas where grass starts to grow, for pasturage.

### b) Sedentary Breeding

The animals graze in perennial pastures and those appearing after flood recession, as well as in paddy fields near the villages after the harvest.

### c) Transhumance

The traditional herdsmen living over 300 km from the Study Area come in the area during the dry season to search for pasture and water.

## (3) Composition of Bovine Cattle

### a) Species

The majority of oxen and cows in the Study Area are of two species: Maura and Peulh as described below:

Description	Maure Species	Peulh Species
Appearance	Small horn, brown color	Long horn
Utility	Milk	Meat
Weight at birth	15 kg	25 kg
Weight at weaning	40 kg	55 kg
Adult cow (3 - 4 years)	300 kg	350 kg

### b) Composition of Cattle and Annual Production

In general, a herd of cattle consists of 50 to 60 heads. The composition of a herd of 100 bovines is as follows: 40 oxen (20 adult bulls, 4 - 5 young bulls, and 15 - 16 castrated oxen), 40 adult cows, 20 calves, and 13 milch cows.

Annual reproduction to maintain the herd at 100 heads, assuming a 0% loss, is six aged cows and two bulls and four castrated beefs. Average milk production is two liters per day. Assuming a lactation period of 200 days/year, the milk production is estimated at 5,200 liters.

## 3.5.2 Present Condition of Pastures and Issues

### (1) Classification Pastures by Location

According to their location, the pasture lands in the Study Area are used for different purposes at different periods, as described below:

a) Pastures on Dunes

Pastures of this type are located in the north of the Study Area. They are utilizable until the end of October, from the beginning of the rainy season, when grass sprouts and grows. The area is vast but weed growth is limited.

b) Pastures at the Foot of Sand Dunes

These areas are called "Founded" and stretch at the foot of sand dunes. They had been inundated during severe floods. If the area is located near the village, it is cultivated with fruit and vegetables. If it is very far from the village or is located on the border of paddy fields, it constitutes a good natural pasture with water availability and can be utilized throughout the year.

c) Lowland Areas (Faux Holladé, Holladé)

At present these areas are practically submerged in their entirety. Graminaceae had formed the greater part of the grass in the areas before flooding but they were replaced by useless aquatic weeds such as Awekhaye and Sade.

(2) Fodder Resources and Production

a) Weed Species

Natural meadows are utilized mainly for grazing. The vegetation of these meadows is a mixture of herb species, in particular graminaceae. In marshlands, Awekhaye and Sade prevail over other species. In dry lands, Tizuguit is predominant.

b) Fodder Production

The production is weak in general owing to the fact that wild grasses which start sprouting with the arrival of the rainy season and stop growing at the end of the same season, have only a short vegetation period, and that a large portion of natural pasture lands is occupied by bare land. Fodder production in the rainy season in the Study Area is estimated to be 610 tons in dry weight.

c) Condition of Pastures in the Dry Season

The pastures in the dry season are covered with the remainder of grasses grown in the rainy season and are located in sand dunes, paddy fields after harvest in the Study Area, and in outlying areas of submerged depressions. The animals move to paddy fields and depressions as residual grasses in the sand dunes disappear progressively.

The percentage of seasonal transhumance is estimated as shown below:

Period	Sand Dunes	Around Villages *	Depressions*
August - October	92%	6%	2%
Nov. - March	5%	90%	5%
April - July	0%	15%	85%

\*: The animals go to depressions in the day and return to areas around the village in the night

Most of the cattle go grazing in sand dunes in the rainy season, but a part remain in the fields around villages even in the said season. During the period from

November to March, the majority of cattle stay near the villages and in April - July most go to the pasture lands at the river-side and far away from the villages.

d) Fodder Self-sufficiency

Fodder demand for the cattle in the 10 villages involved in the Project amounts to about 630 tons per month. Most cattle graze in meadows located in sand dunes because pasture lands inside the site are practically limited in the dry season. The animals return from the sand dunes when the rainy season's grass withers and consume it in less than a month. They then feed on the grass that grows in the dry season at the river-side and on paddy straws. However, feeding of milch cows on concentrates starts to become popular.

(3) Constraints and Issues

The following constraints and issues were observed or might occur with the continuation of stock farming in the Study Area:

a) Issues Resulting from the Enactment of Land Ownership Law

As the rights of farming and land ownership are established following the implementation of this law, the use of land by nomads who have no juridical right will become difficult.

b) Damage Caused by Animals to Farmlands

The pasture area would be radically reduced due to the introduction of double rice cropping which will become possible in the whole Project area after the construction of agricultural infrastructure. As a result of shrinkage of pasture area, damage caused by animals will increase and, accordingly, many disputes would arise between farmers and stock breeders.

c) Deterioration of the Environment

In principle, the cattle in and around the Study Area move about in search of water and pastures. Stock breeders however tend to stay near permanent agglomerations to be in proximity of water and pastures. This phenomenon results from the rainfall decrease and drought spells. Overgrazing near villages due to progression of sedentarization has caused environmental problems.

d) Expectations and Opinions of Farmers and Stock Breeders

During the public meeting, farmers expressed a strong desire for development of pastures. Thereafter, the Study Team collected their opinions concerning the level of development, type of fodder to be introduced, irrigation and fertilization management, development and management of pastures by cooperatives, etc. According to these opinions, it was clear that farmers requested the introduction of quality grasses and they feared in particular the depletion of fodder resources in the dry season. With regard to operation and management, farmers are conscious enough of the necessity of irrigation and fertilization management, and they wanted to participate actively in the organization of this activity under the Government's management.

### 3.6 Social and Agro-economic Conditions

#### 3.6.1 Social Conditions in Rural Areas

### (1) Villages and Population

The Study Area is located to the west of Rosso. In this area, except for some small areas (where people are living in tents), there are 15 villages, of which 13 are settled on the edge of the sand dunes in the north plateaus to avoid flooding and mosquitoes. Keur Macène village where the governor's office is located, is in the center of the area. This village is active with the presence of open air markets and merchants.

The number of households in the 15 villages is 1,740. The average family size is 6.4 people. The total population of the area is about 11,180, 70% of which are Maures (Beydanes and Haratines) cohabiting with Wolofs and Soninkés. Islam is the only religion of the population in the area (each village has at least a mosque).

### (2) Rural Infrastructure

Keur Macène is accessible from two roads: One is on the right embankment connecting Rosso directly to Keur Macène (about 3 km) and the other branches off from the asphalted Nouakchott - Rosso national road and connects Keur Macène to the northern villages (Awlig, Dara Salam, El Mitgueidem, Dara Wolof, Bouteidouma, Dar El Barka, N'Kheila, N'Deigna). The impracticability of these sandy-earth roads in the rainy season represents a serious social constraint for the area, interrupting communication between the villages sometimes up to a few months in a year, especially in the sections near Keur Macène.

Besides, except for Keur Macène village which is supplied with treated tapped water, other villages have only saline and contaminated well or pond water available for consumption. The water treatment plants constructed with French cooperation in 1993 supply drinking water to 156 houses in the village.

### (3) Public Health

There are only one dispensary in Keur Macène village and one public hospital in Rosso. According to the results of survey of farmer households, the most frequent diseases are malaria, bronchitis, and microbial diarrhea. At present, there are no waste and wastewater treatment facilities in the villages, and the houses have neither appropriate toilet nor bathroom.

### (4) Education

Keur Macène village has a primary school and a high school with classrooms but other villages have only two-classroom primary schools with deteriorated buildings. Both French and Coran are taught in primary schools.

### (5) Economic Activities

Economic activities of villagers consist mainly of agriculture (cultivation and stock farming at the same time), followed by stock farming, fisheries, trade, working as employees, and handicraft production. The number of animals (bovines and ovines) raised by each household is two - five heads on an average even in farms engaged only in stock farming, which means that in principle stock farming is practiced on a small scale. In general there are no camels in the Study Area. In the villages of Wolofs and Haratines cultivation is more practiced than stock farming. Fisheries also is an important activity on the Senegal river and in submerged areas in the Project site, but the lack of financial means prevents procurement of adequate fishing tackle like net, etc.

### (6) Condition of Agricultural Production

Agricultural activities in the site are limited by the poor conditions in the area. During the survey in rural areas, all farmers (100%) cited insufficient development of farmlands as a constraint to agricultural development. Insufficient inputs and flooding problems were also cited.

#### (7) Problems in Rural Areas

The most serious problem is the lack of road infrastructure followed by the lack of public welfare facilities, especially those for drinking water supply, dispensaries, etc. With regard to agricultural production, it was noted that the farm infrastructure such as irrigation and drainage systems is not developed enough. As to the living conditions, although 48% of farmers consider natural conditions are severe, 85% wish to continue living in the area.

### 3.6.2 Agro-economic Conditions

An agro-economic survey was conducted on 103 households in 12 villages in the Study Area. The survey results are described in the following sub-sections (see Figure 3.6.1).

#### (1) Family Composition

The total number of people of the surveyed 103 households is 874 with a male/female ratio of 51:49. The average family size is 8.5 persons (4.3 men and 4.2 women, of whom 4.4, i.e. 52%, are in the working age (both men and women aged 16 to 54). Working women account for 52%, i.e. more than half of the total working population. The higher ratio of working women in spite of a larger ratio of men in household population is obviously due to the migration of men towards agglomerations for work.

With regard to activities by profession, 72% of the total number of inhabitants (874) of the 103 households constitutes the working population and 73% of this is engaged in agriculture (cultivation). In the cultivation sub-sector, the number of female workers is larger than that of male workers, but in the stock farming sub-sector, the male/female ratio is practically the same. Women are not engaged in fisheries. About 10% of the working population is practicing trade and other activities.

#### (2) Farming system

The results of farming system survey of agricultural farmers (cultivation of agricultural products), agro-pastoral farmers, agro-fishery farmers, and other agricultural farmers (vegetables and fruit tree plantations) are described below. Only three farmers practice exclusively agriculture or stock farming and none farmer is engaged exclusively in fisheries. The most popular farming system is mixed practice of cultivation, stock farming and fisheries (25%).

The cultivation areas of agricultural products in the Study Area consists of irrigated paddy fields and rain-fed crop fields, belong either to private farmers or to collectives such as villages, farm cooperatives, etc. With regard to farm size, 31 farmers, i.e. 30% of the total number of farmers, possess large size farms of more than 10 ha, and 35 farmers or 34% of the total number have small size farms of less than 2 ha. In Dioup village located in the irrigated area, the size of private farms is 1 ha and that of collectives is 1 - 3 ha, i.e. 3.6 ha on average. The total cultivated area of both private farms and collectives is 11.9 ha on average.

In the Study Area, paddy, maize, dry vegetables, and sorghum are cultivated in the rain-fed areas in the rainy season. In the dry season, paddy is cultivated in irrigated paddy fields and dry vegetables in small parcels of land. Green vegetables and dry



vegetables are also cultivated in areas near villages or housing areas as products for marketing. The paddy cultivation area occupies 26 ha, corresponding to 2% of the total area. The annual cultivated area in 1995 was in the order of 80% (69% in the rainy season and 11% in the dry season).

The low ratio of cereal cultivation area is due to, among others, the lack of farm budget for rental of tractors, payment for operation and maintenance of irrigation pumps, and purchase of agricultural inputs (seeds, fertilizer, pesticide, and others), poor harvest due to damage by birds, cattle, weeds, etc., as well as unfavorable soil conditions (infertility, salinity).

The table below shows the results of study of measures to be taken and improvements to be made in priority in order to solve the problems relating to agricultural development of today. It may be considered that countermeasures for damage by birds and cattle are most urgent, followed by the rehabilitation and construction of roads and development of farmlands.

a) Countermeasures for damage by birds and cattle	:	22.9%
b) Rehabilitation and construction of roads	:	20.6%
c) Development of farmlands	:	18.8%
d) Improvement of irrigation facilities	:	16.8%
e) Soil salinity and fertility	:	11.2%
f) Measures for flood control and drainage	:	9.7%
Total		: 100.0%

### (3) Farmers' Economy

Sixty per cent of income of farmers in the Study Area is generated by the sale of agricultural products (rice, green vegetables, and dry vegetables) and livestock (bovines and ovines). The results of survey of the 103 households in the area showed that 72% of them get their income from agricultural activities (including agricultural production, stock farming, and fisheries), 18% from trade, and 10% from handicraft production. For the households whose income issues mainly from agriculture, the sale of farm products represents 34% of total income, for those practicing mainly stock farming 25%, and for those depending mainly on fisheries 13%. Nevertheless, the farm income of the households that farm on a small scale of 1 to 2 ha with single cropping per year, is not sufficient for their living and they have to resort to other income sources such as migrant work of male adults (in Nouakchott, Rosso), sale of cattle and milk, vegetables, handicraft goods (local mats), etc. produced by women groups.

The 103 households surveyed were inquired about monthly food consumption (basic food, supplemental food, spices, etc.), monthly food expenses, annual household expenses, annual farming expenses, etc. According to an estimate for a household size of 8.49 people on an average, total annual food expenses amount to 440,800 UM (71.5%) and total annual household expenses to 616,400 UM. Annual farming expenses for an area of 9.5 ha are 134,470 UM (14,150 UM/ha) on an average.

#### 3.6.3 Farmers' Organizations

##### (1) Background

Recognizing the need to organize farmers, strengthen the supporting system, and establish a management structure, the Government promulgated the first law on

cooperatives (No. 67.171) on July 18, 1967. Subsequently, with a view to organizing agricultural development in rural areas, the Government promoted the creation of Agricultural Pre-cooperative Groups (GPA) in the whole country at the beginning of the latter half of the 1980s. In Keur Macène area where the Project site is located, there are already about 30 GPAs, 90% of which are engaged in agriculture, stock farming, and fruit and vegetable cultivation.

## (2) Present Condition of Organization of Farmers

In order to regulate cooperatives' activities, the Government promulgated on January 21, 1993 a law amendment (No. 93.15) concerning cooperatives and recommended GPAs to take the procedures of cooperatives registering. Based on the legal status of cooperatives, village groups can proceed with the regularization of their lands (traditional farmland or newly developed farmland) with the land agency.

Farmers' cooperatives submit a request for registering mentioning the fields of activities such as rice cultivation, stock farming, fruit and vegetable cultivation, handicraft production, environment, etc. According to the law on cooperatives, any group of more than seven people having the same objective can submit a plan describing the capital amount (equal to or more than 1,400 UM), office address, scope of activities, etc. for obtaining the legal status of cooperative. The Government plans to establish at least a cooperative in each village. Farmers can participate in several cooperatives in different fields of activities.

## (3) Privileges of Farm Cooperatives

Farm cooperatives engaged in agriculture (rice cultivation, stock farming, fruit and vegetable cultivation, and other forms of mixed agricultural production) can apply for the right to use cultivation land. In response to the application, the Government will examine the agricultural activities carried out by the cooperative's members, plan of use of cultivation land, and capability of members in executing agricultural activities, etc. before granting the cooperative the right to use cultivation land (five years). The right to use cultivation land will allow the cooperative to apply for agricultural credit for agricultural activities.

At present, there are about 50 cooperatives in Keur Macène area. Half of these cooperatives are cooperatives of male farmers (see Table 3.6.2). All of the male cooperatives in the area are having debts averaging 1,000,000 UM per cooperative due to poor harvests. These cooperatives are therefore unable to continue their activities in the last few years. On the contrary, despite a lack of financial means, the women's cooperatives are considered more active than the male cooperatives, especially in handicraft production.

## (4) Organization of Cooperatives and Unions

Farm cooperatives and unions established in accordance with the law on cooperatives have a General Assembly and a Management Office. In principle, the General Assembly is held twice per year and, in special or emergency cases, supplemental general assemblies are convened. The General Assembly is attended by representatives of the Government and each of the participants has a vote. The General Assembly, which constitutes the highest body of the cooperative, elects the Board of Directors, decide annual action programs, and other important subjects.

## (5) Problems

Problems facing farm cooperatives at present are the following:

- a) There exist many cooperatives according to different fields of activities and sexes in a village;
- b) Since it is possible to obtain the legal status of cooperative only after examination of the application, there are bad cooperatives;
- c) Certain cooperatives are organized solely for the purpose of obtaining lands or financing;
- d) The supporting system for activities of farmers' cooperatives is not sufficient; and
- e) Farmers have not enough knowledge of the importance and functions of cooperatives. Besides, many cooperatives are still incapable of exerting and managing their activities without support of other organizations.

(6) Other Organizations Concerned

In addition to the above-mentioned farm cooperatives that are promoted by SONADER, other agricultural organizations performing in the Senegal river valley include AGETA and FAEM. AGETA is an association established with foreign assistance while FAEM is an organization of farmers-stock breeders. AGETA, among others, is conducting extensive activities in the Study Area, therefore it is necessary to maintain coordination with this association on matters related to the Project implementation progress. Activities of each organization are summarized below:

AGETA

AGETA is a special association established in 1990 following the grouping of about 20 farmers and stock breeders with French assistance. Under the jurisdiction MDRE, AGETA plays the role of promoting initiatives of the private sector in agricultural development through extension of farming techniques and training of farmers.

This association receives financing and technical assistance from various agencies (ADRAO, PSI-CORAF, CNRADA) and foreign countries, mainly France. Its annual budget amounts to 23 million UM, 87% of which is financed under the French cooperation program and the remainder is contributed by members at a rate of 10,000 UM per member per year.

At present AGETA has a membership of 306 (winter cropping season of 1995/1996), 90% of which is from the private sector. The membership has expanded since the association's foundation in 1992, due in particular to the increase of group members. Administrative management of the association is undertaken by 12 persons and its activities are conducted by a team of 12 engineers including 9 general engineers and 2 specialized engineers (vegetable and fruit tree plantation).

Following are the main activities of AGETA:

- a) Extension of modern techniques for rice cultivation and fruit and vegetable cultivation;
- b) Training on technology of farm equipment; and
- c) Supply of improved paddy and vegetable seeds (in collaboration with CNRADA).

In the Study Area, AGETA has 66 members: 40 in Awlig and 26 in Keur Macène. In the winter cropping season of 1996/1997, a total area of 1,348 ha was cultivated by 27 farms in the Keur Macène and Awlig areas.

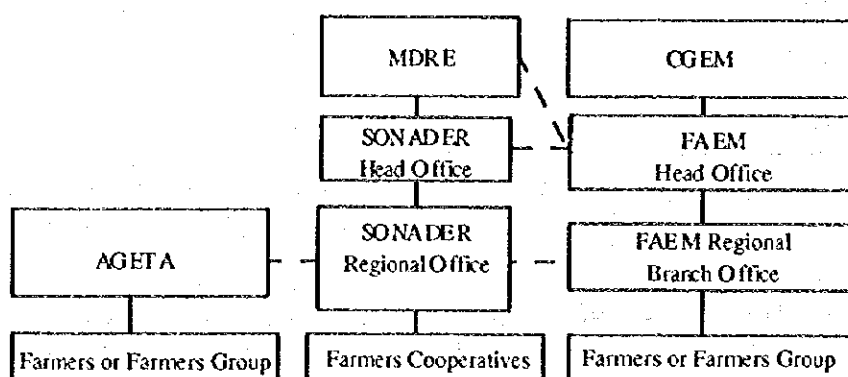
## FAEM

The associations of farmers and stock breeders under FAEM must submit a request to the Government for registering before starting their activities, in order to obtain a public juridical status. Operation costs of these federations are financed from contributions by members. In its activities, this organization emphasizes in particular the support of commercial activities of its members. The objectives of FAEM are as follows:

- a) Support of economic activities and production, and protection of the rights of farmers and stock breeders of Mauritania;
- b) Supporting services such as guarantee, intervention and guidance to attain maximum harvests under projects implemented on the initiatives of particular or collective members;
- c) Effective participation in socio-economic development and reconstruction of Mauritania;
- d) Collaboration with CGEM as a professional federation; and
- e) Joint activities with other cooperatives.

### Mutual Relation between Organizations

The figure below shows the mutual relation between the above-mentioned farmers' organizations:



The regional offices of SONADER, AGETA and CGEM (regional branches) are in cooperative relation solely within the framework of business.

### 3.7 Marketing and Processing of Agricultural Products

#### 3.7.1 Food Balance

Since wheat and rice constitute staple foods of the majority of population, their availability at reasonable prices on the market is an important socio-economic objective of the agricultural policies of Mauritania. Even though rice self-sufficiency is one of the principal targets set forth in the national development plan formulated by the Government, rice production remain insufficient. During the last three years, an average rice deficit of 78,700 tons was observed.

The deficit amount and the food security stock must be made up by imports. In spite of the food policy adopted by the Government in recent years, the quantity of imported rice continues to increase due to the existing imbalance of supply and demand (see Figures 3.7.1 and 3.7.2). The increase in rice import hinders the marketing of local produce to a large extent. Wholesalers (importers) purchase imported rice during the period of insufficiency of domestic rice.

Because local rice is more expensive than imported rice due to high costs of production and processing, importers tend to increase the quantity of imported rice which is cheaper and sells well on the market.

#### 3.7.2 Marketing of Agricultural Products and Inputs

Upon instruction by the Government in 1995, SONIMEX (National Import-Export Company) and private farmers' groups and importers have established an association called "POOL" which has the function to purchase all local paddy produce before importing rice from foreign countries. Owing to this, local farmers have no difficulty in selling their produce. For instance, in the 1995/1996 cropping season, some POOL members such as SONIMEX (30%), MAOA (30%), AON (30%), and EMINOU (10%) purchased local rice.

In consequence, most of rice produced in the Study Area is sold directly to the association at farm gate then transported to rice mills or to small units in Rosso city. After milling, rice is sold to merchants or wholesalers in Nouakchott, other Wilayas, or Rosso city. Vegetables such as tomato, onion and others are sold in Rosso and Nouakchott markets. AGETA and private establishments are marketing agricultural inputs (seeds, fertilizers, and pesticides). There are four large merchants in Rosso city who purchase fertilizers from Nouakchott.

Rice production in Rosso reached 16,880 tons in the 1995/1996 harvest season, while the treatment capacity was 36,000 tons. The cost of treatment by large units is 2 UM/kg during the harvest times. Storage facilities for agricultural inputs and products in Rosso are provided by the private sector.

#### 3.7.3 Prices of Agricultural Products and Inputs and Production Cost

##### (1) Prices of Agricultural Products and Inputs

Official paddy prices fixed by the Government increase every year: 32.0 UM/kg in 1994/1995, 36.0 UM/kg in 1995/1996, and 45.0 UM/kg in 1996/1997. All the members of POOL purchase paddy according to its official price and its quality.

Average selling prices of main agricultural products in Nouakchott and Rosso markets from January 1995 to December 1996 are summarized in the table below.

Paddy price has slightly increased while prices of vegetables have fluctuated during the harvest season.

Products	(unit UM/Kg)	
	Nouakchott	Rosso
Imported whole rice	150 - 360	190 - 400
Imported broken rice	90 - 95	84 - 110
Local whole rice	80 - 90	75 - 80
Local broken rice	75 - 80	70 - 80
Paddy		35 - 45
Wheat	50 - 60	50 - 60
Beans	80 - 100	40 - 80
Tomato	20 - 120	40 - 60
Onion	60 - 120	80 - 120
Fodder		3-5(6.5 on average)
<u>Seeds</u>		
Paddy		50-75
Tomato		1,500-4,000 per 100 g
Turnip/Radish		350-500 per 100g
Onion		1,300-1,800 per 100g
<u>Fertilizers</u>		
Urea (46%)		46 - 50
TPS (10-20-20,10-20-10)		50
<u>Pesticides</u>		
Insecticides		1.800-4.000 per litre
Herbicides		1.300-4.000 per litre

The farm-gate price of paddy is calculated on the basis on the market price. Expenses for marketing (farm gate - market) are deducted. Finally, the farm-gate price is in the order of 60% - 70% of the average market price.

## (2) Present Receipts and Expenses for Paddy

The present paddy balance is estimated on the basis of the above-mentioned prices, costs for personnel and agricultural inputs, and present yield that is assumed at 1.1 tons/ha (see Table 3.7.3). Low production yields do not allow farmers to get sufficient income and savings for their subsistence. With regard to rice cultivation, it is difficult to continue growing rice unless the yield reaches more than 2.5 tons/ha and farmers have other financial resources than agriculture.

## 3.8 Agricultural Support Organization

### 3.8.1 Agricultural Support System

#### (1) Agricultural Extension System

SONADER had been playing the principal role in agricultural extension in Mauritania since a long time, but DRFV has started participating in the services with the establishment of AGEFA in 1990 and the reorganization of MDRE.

#### (2) SONADER's Agricultural Extension System

The main functions assigned to SONADER under the agricultural policy had been focused on the following six objectives:

- Establishment of an agricultural credit system
- Marketing and supply of agricultural inputs
- Promotion of agricultural development

- Extension/training
- Organization of farm cooperatives
- Increase of farm income of farmers

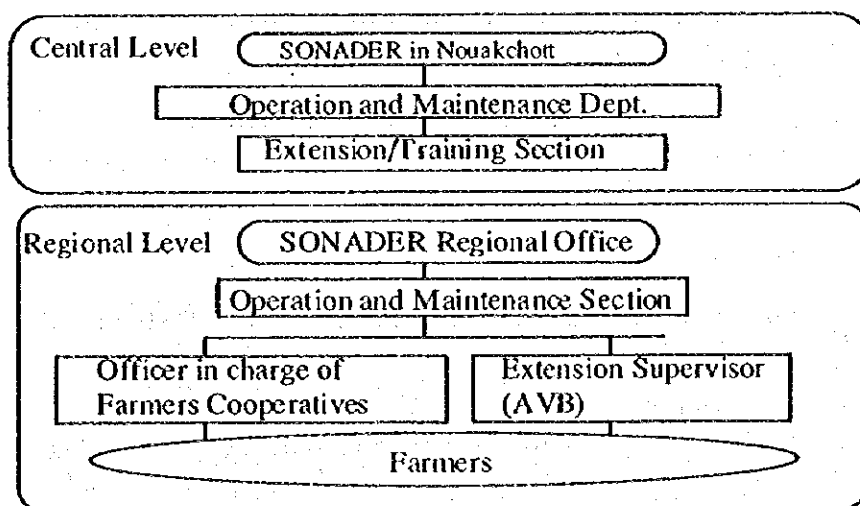
At present SONADER is relieved from responsibilities for agricultural credit, marketing and supply of agricultural inputs, and maintenance of GMP (pumping equipment). The fundamental task of SONADER now is to help improve productivity of farmlands of cooperatives which already possess irrigation and drainage facilities, as well as to promote activities of cooperatives.

Agricultural extension services are carried out through SONADER Head Office (Operation and Maintenance Department) and Regional Offices (Rosso, Boghé, Kaédi, Gouraye, Foug Gleita). The staff composition of these office is as follows:

- SONADER Head Office	: Engineers, etc.:	5
- SONADER Regional Offices (5 locations)	: Engineers, etc.:	31
	Extension workers:	47
<u>Total</u>	:	<u>83</u>

Agricultural extension personnel in SONADER Regional Offices is composed of Specialists on Farmer Organization and Extension Supervisors, under management of the Operation and Maintenance Section. The Basic Extension Officers (AVB) organize their extension activities through farmers' organizations.

The organization chart of the extension/training system of SONADER is illustrated below:



The Regional Office in Rosso commands five areas: Keur Macène, Rosso, Koundi, Tekane, and Lexeiba, which form part of the Study Area. Eight AVBs undertake extension services under supervision of two chiefs. One AVB stationed in Keur Macène provides primary guidance on promotion of establishment of cooperatives and agricultural extension by visiting the villages one after another with a motorbike.

SONADER's agricultural extension services are having several problems such as inadequate staff assignment, insufficient equipment supply and promotion of farmers' activities. Following are main problems of extension services:

- Maladjustment of extension activities

Farmers are needing development of farmlands including irrigation and drainage facilities and supply of farm equipment instead of technical guidance, but AVBs' activities are mainly focused on the latter.

- Farmers' distrust of SONADER

The cessation of provision of agricultural credit and farm equipment by SONADER in 1993 has placed farmers in a difficult situation. Since then, farmers have become distrustful of SONADER's undertakings. On the other hand, SONADER is critical of farmers for the fact that they do not follow its technical instructions and they adopt imperfect operation and maintenance (O&) programs.

- Insufficiency of farming techniques suitable to the site

The present technical level is not enough to cope with problems facing local agricultural production such as inadequate drainage, land submersion, salinity, desertification, and damage caused by crickets, birds, weeds, and plant diseases.

### 3.8.2 Agronomic Research

#### (1) Agronomic Research Organizations

MDRE is responsible for agronomic research through the following research agencies:

- a) Research, Extension and Training Department (DRFV)
- b) National Agronomic Research and Development Center (CNRADA)
- c) National Stock Farming and Veterinary Research Center (CNERV)
- d) National Rural Development Company (SONADER)

The above organizations suffer in general from defective research equipment and lack of researchers and research fund, therefore they are not yet capable of forming a sufficient supporting system for agricultural development at present.

#### (2) Research, Training and Extension Department (DRFV)

The reorganization of MDRE led to the establishment of DRFV in accordance with Law No. 22 - 93 enacted in March 1993. The Department's duty is to formulate measures for extension of techniques concerning agriculture, pasturage and environment, as well for guidance and management of these techniques. DRFV is a central agency that manages agronomic research activities conducted in Mauritania by various research organizations which operate separately without exchanging information between them. In the Study Area, a representative of MDRE is assigned to each province to work in collaboration with DRFV.

#### (3) National Research, Training and Extension Center (CNRADA)

CNRADA is in charge mainly of research on crops. The Center has its headquarters in Kaédi and 3 laboratories in Sélibaby, Kankossa, and Barkeal. It has a staff of 20 including 15 engineers or agricultural technicians.

CNRADA conducts research on seeds with assistance of international organizations (USAID, UNDP, FAO, FED, FAC, CILSS, SAFGRAD, GERDAT, OMVS, University of Arizona, etc.).



In recent years, this organization has concentrated its activities in the development of seeds through improvement of species and sorting of seeds. Studies on Distinction, Homogeneity and Stability (DHS) and Agronomic and Technological Value (VAT) have been conducted by CNRADA on a number of crop varieties.

Studies on rice cultivation and fruit and vegetable cultivation also have been carried out but studies on pasture development and farming practices have not yet been initiated.

(4) National Stock Farming and Veterinary Research Center (CNERV)

CNERV, which has been established in Nouakchott in 1973, has as objectives pathological research on cattle and improvement of fodder production in irrigated pasture lands. Its staff of about 20 includes five veterinarians and ten technicians. Its present activities cover mainly pathological and microbiological studies on animals. A CNERV worker is based in Keur Macène to monitor epidemiology of animals in the region.

(5) National Rural Development Company (SONADER)

Originally, SONADER is not an agronomic research organization. It undertakes studies of issues relating to agricultural and rural development activities. The Company has conducted several studies in the field of agricultural extension and training. At present it is engaged mainly in studies on implementation of irrigation and agricultural development and in provision of guidance (extension and training) to cooperatives.

(6) Agronomic Research Tasks

Until now there was virtually no reciprocal cooperation in research between SONADER, CNRADA, and CNERV. It seems that these research organizations give priority to scientific research instead of coping with basic needs of farmers.

Considering the fact that agronomic research is one of the important factors of agricultural assistance, it is indispensable to strengthen research activities taking into account in particular the socio-economic condition of Mauritania. Studies on techniques of intensive stock farming, stock farming management, integrated management of agriculture and stock farming, basic techniques of pasture development and management as well as of crops cultivation, and other basic techniques such as method of operation of farm equipment are likely the most important studies required.

### 3.8.3 Agricultural Credit

(1) UNCACEM

The agricultural credit system in Mauritania has experienced periods of unsteadiness due to serious management problems. At the beginning, the agricultural credit operation had been entrusted to the National Development Fund (FND) and then to SMB. From the beginning of the 1980s until 1988, SONADER was in charge of this business. In 1988, the Union of Development Banks was established and took over the system until 1991. From 1992, with the agreement of main donors (France, Germany, and the World Bank), The Mauritanian Government established an autonomous agricultural credit institution called the National Union of Cooperatives of Agricultural Credit and Savings of Mauritania (UNCACEM). This agricultural credit system, which is financially and juridically autonomous, is aimed at the promotion of production and commercial activities of farms.

Furthermore, to establish a financial system to deal with urgent needs of farmers, CACET, a local office of UNCACEM in Rosso, provides short- and medium-term credits at an interest rate of 12% covering 70% of production cost in maximum.

a) Short-term Credit

In general, this kind of credit is provided only for winter cropping season. The credit is conditioned by a repayment period of 7 months (from the end of May to January 5) and an interest rate of 12% and is provided essentially to cover the costs of land preparation and farm inputs (such as fertilizer, diesel oil, and seeds). The credit may be granted in kind or in cash according to the farmer's choice.

b) Medium-term Credit

This credit is provided for the procurement of farm equipment (such as power pump units, combine harvester, and tractor). The credit amount covers 70% of the cost of farm equipment and is repayable within a period of 4 - 7 years at an interest rate of 12%.

To recover the loan amounts, CACET adopts a system of domiciliation of its clients' income from production. Under this system, the institution in charge of purchase of local produce (POOL) makes payments, through the channel of CACET, to its client producers who are also debtors to the credit bank, after deducting the loan amount. Table 2.7.2 gives details on the amounts and contents of loans extended in recent years.

At present UNCACEM is facing the following difficulties:

- A high ratio of non performing loans possibly leading to complete strangulation of the institution;
- Lack of strictness in management due to lack of experience of administrators;
- Absence of a long-term credit system;
- Absence of expeditious judicial mechanism for legal actions against bad debtors; and
- Insufficiency of proper resources due to limited collection of savings.

(2) ACOPAM

The "associative and cooperative support to basic development initiatives" project of ACOPAM strengthens the capacity of populations, both male and female, to initiate and consolidate sustainable development processes for farming areas in Foun Gleita. ACOPAM's action is centered on training and organization of rural producers. It covers multiple sectors involving, for instance, development of land, irrigated areas, establishment of cereal banks and cotton markets or establishment of a savings/credit system at the village level. ACOPAM contribute to fighting extreme poverty, desertification and deterioration of natural resources, as well as to strengthening self-sufficiency and food security.

The credit type provided by ACOPAM on a trial basis should allow farmer groups to stock part of the produce of their members after harvest (cereal bank) so as to resell it at better prices during the bridging period. The beneficiary group uses the credit to pay for cereals supplied by its members on the basis of a price fixed by the general assembly and the price ceiling set forth in the credit contract. The group member can then provide for his needs before paying a balance amount (refund) determined by the general assembly after calculation of the result of operation. The price difference

between the harvest period and the bridging period constitutes a potential gross margin of the activity.

### 3.9 Irrigation and Drainage

#### 3.9.1 Existing Upper Delta Irrigation and Agricultural Development Plan

##### (1) General Upper Delta Development Plan

In 1991 SONADER has formulated the General Upper Delta Development Plan through French consultant GERSAR which prepared the Report on Study on Construction of Hydraulic Infrastructure in Upper Delta of Mauritania (also called "GERSAR Report"). This plan covers the three areas of Gouère, Dioup, and N'Diader, located downstream of Rosso in the Upper Delta. The general irrigation and agricultural development plan proposed within the development framework recommended in the GERSAR Report aims at creating favorable conditions for irrigated agriculture and pasture in flood recession areas in the three basins of Upper Delta through improvement of irrigation and drainage systems, and improvement of depressions where excess water evaporates. The development potential of the three areas is as shown in the table below:

Summary of Existing Irrigated Agriculture Development Plan  
of Three Areas of Upper Delta

(Unit: ha)			
Region	Irrigated Agriculture	Pasture in Flood Recession Areas	Storage Lakes
Gouère	3,300	920	1,160
Dioup	2,630	2,490	2,350
N'Diader	2,030	4,700	3,590
Total	7,960	9,110	7,100

Source: Study on Construction of Hydraulic Infrastructure in Upper Delta of Mauritania (SONADER, 1991)

The general development plan of the 3 areas is briefly described in Figure 3.9.1.

##### (2) Existing Development Plan of Dioup Area

The development of the Dioup area is aimed at two targets: Development of pastures in flood recession areas for increasing livestock production, and irrigated agriculture. Pastures shall be developed in low depressions over a total area of 2,500 ha of land located between EL. 1.25 m and EL. 0.75 m, consisting of 2,350 ha in the Gungala depression and 150 ha in the Yoraye depression. A potential rice cultivation area of 2,630 ha is identified. This area consists of lands located at elevation over 1.25 m. Rice cultivation parcels are irrigated by power pumps either directly from the Senegal river or via the Ibrahima, Dioup and Diallo canals which are interconnected.

Excess water is collected in the depressions and in the Dioup and Diallo canals and then drained towards Chott Boul. This operation is carried out through many successive cycles of inundation and drainage in each year in relation to pastures in flood recession areas. Water in these pastures is controlled artificially: Impounding water in the depression up to EL. 1.25 m for ten days and releasing water to lower water level from EL. 1.25 to EL. 0.75 for ten days. Therefore, canals with large capacity are required for the pastures in flood recession areas.

#### 3.9.2 Similar Projects in Adjacent Areas

Diouf is one of the 4 areas of the Upper Delta of the Senegal river. The other three areas are M'Pourié, Gouère, and N'Diader. The M'Pourié area was developed for rice cultivation since 1966 with assistance from China. In the Gouère basin, an irrigation and drainage development program is under implementation with financing by the French Government.

(1) M'Pourié National Farm

The M'Pourié plain has a land development potential of 4,000 ha, of which 1,450 ha have been developed and used for rice cultivation by the M'Pourié farm. The remaining 2,500 ha would be developed as paddy fields by private investors under technical guidance of the farm. The M'Pourié farm is a semi-public organization under the jurisdiction of MDRE, grouping 35 cooperatives. It is irrigated with water from the Senegal river by a pumping station with 5 pump units powered by a diesel generator. Drainage is done by pumping and by evaporation. The irrigation and drainage systems in the plain are separate from each other.

The pumping station and principal and secondary irrigation and drainage networks were rehabilitated between 1993 and 1996 with financing by FIDA. However, the tertiary and peripheral networks were not included. Single cropping is practiced at present in the area but it is possible to introduce double cropping in view of the soil fertility and water availability. There remain however some constraints due to the deteriorated condition of the tertiary network, lack of hydraulic management and financing for the farm.

(2) Gouère Irrigated Agriculture Development Project

This project is being implemented by SONADER with assistance by the French Government, based on the Study on Construction of Hydraulic Infrastructure in Upper Delta of Mauritania (SONADER, 1991). The gross area utilized in Gouère is estimated to be 8,150 ha.

The Gouère project has an institutional component, that is the establishment of a farmers' association called Association of Gouère Users (AUG). It is planned that all responsibilities for management of the project will be transferred to AUG. AUG was established in 1996 and application for registering with the Government was made in September 1996, in accordance with law on associations. This has not yet been approved.

An area of 1,300 ha located in the west end of the Gouère project area is covered by the Study Area, in accordance with a mutual agreement between SONADER and the Study Team. This area was included in the topographic maps prepared from aerial photographs during the Phase-I work. The area will be irrigated by the Ibrahima canal; in fact a part of the area is being irrigated directly by the Ibrahima canal and Awlig canal which is connected to the former canal.

(3) Present Conditions in N'Diader Area

Since 1992, private farmers have started investing in farm development for rice cultivation on a large scale in areas along the N'Diader canal. On the basis of pictures taken by "SPOT" satellite and available in MDRE, it was estimated that the total area developed so far amounts 3,600 ha, consisting of 1,600 ha on the right bank of the N'Diader canal and the remainder on its left bank. The pictures show that approximately 780 ha are actually cultivated, including 380 ha on the right bank.

### 3.9.3 Existing Irrigation and Drainage Facilities

(1) General

The networks of canals and waterways covering the potential irrigation areas and pastures in the three basins of Gouère, Dioup, and N'Diader are schematically shown in Figure 3.9.1, based on the 1991 development plan. As seen in the figure, the three basins are connected by a complex network of canals and waterways. The Study Area is bounded by the right embankment of the Senegal river to the south, the west side of Gouère basin to the east, the Dioup and Diallo waterways to the north, and the Aftout canal to the west. With regard to drainage, the network has no discharge outlets.

(2) Irrigation

Irrigation Water Intake

In the Study Area there are four intake structures on the right embankment: The Ibrahima, Dalagona, Dioup, and Aftout intakes, from upstream to downstream. All these structures have been constructed by OMVS.

OMVS operates the gates of water intakes at the request of SONADER. The design discharges of these structures are as follows:

(Unit: m <sup>3</sup> /s)			
Ibrahima	Dalagona	Dioup	Aftout
10	20	5	60

Principal Waterways

The Dioup area is surrounded by a series of four main waterways: Ibrahima, Dioup, Diallo, and Aftout, from east to west. The Ibrahima canal starts from the Ibrahima gated intake and joins the Dioup waterway at KM 9. The Dioup waterway with a length of about 20 m is connected to the 11 km long Diallo waterway. The N'Diader canal starts from the Aftout intake and runs to the north. The Diallo and N'Diader canals are connected at a point 35 km. from the Aftout intake. The Ibrahima and N'Diader canals consist of excavated canals over the lengths of 3 km and 600 m respectively, and of natural waterways and depressions in the remaining sections.

(3) Drainage

There is none drainage system in the Study Area. Irrigation waters disappear by evapotranspiration and seepage in the fields. Excess waters are stored in depressions. There are two depressions in the Study Area: Gungala and Yoraye. There are no discharge outlets for waters accumulated in these depressions, and this fact results in the increase in salinity due to high evaporation and evapotranspiration rates.

In addition, the area on the west edge of the Study Area is severely flooded due to the presence of the road between the embankment and Keur Macène village on the one hand, and blockage of culverts on the other hand, making rice cultivation impossible except in some blocks. This flooding problem results from the need to raise the water level of the N'Diader canal in order to irrigate farmlands downstream of the canal. Accordingly, widening of culverts would not be of any help to solve the problem. To mitigate floods, it is essential to construct a gated control structure at the end of the Diallo canal before its connection with the N'Diader canal, as well as to construct embankments along the N'Diader canal.

### 3.9.4 Present Condition of Irrigated Rice Cultivation

The gross area of paddy fields developed in the Study Area is estimated at 4,650 ha. The effectively cultivated and irrigated area of paddy fields in 1996 was 859 ha gross covering 30 blocks. The net area was 773 ha, accounting for only 18.5% of the developed area (see Figure 3.4.2). Cultivated fields are concentrated in some areas, especially in Awlig, Ibrahima, Keur Macène, and the western part of Beni Nadji. Aerial photographs taken in December 1992 show some cultivated fields of about 580 ha in gross area, mainly along the Awlig and Dioup canals as well as in N'Degue and in the west of Keur Macène. The cultivated area of paddy fields slightly varied between 1992 and 1996, but in general it was the same.

The Study Team conducted a survey of irrigated paddy fields. The survey results are given in Table 3.9.1 and the diagrams of existing irrigation systems are illustrated in Figure 3.9.2.

### 3.9.5 Present Condition of Operation and Maintenance of Irrigation and Drainage Systems

The system of maintenance and management of irrigation and drainage facilities is divided into two levels: One involves the main canals and is undertaken by SONADER in collaboration with OMVS, and the other concerns the peripheral canals and is the responsibility of farmers. The role of SONADER is to control the intake gates installed on the embankment of the Senegal river within the Study Area, namely the Ibrahima, Dioup and Aftout gates, through OMVS, as well as to maintain the 3 km long Ibrahima irrigation canal and 0.6 km long Aftout canal. There is no fixed schedule for operation of these intake gates. SONADER requests OMVS to operate them according to the request of farmers.

At the level of farmlands, which belong either to cooperatives or to private individuals, the owners undertake O&M of irrigation and drainage facilities in their own lands. In general, all the canals and their related irrigation and drainage system are not well built and maintained.

### 3.9.6 Pasture Development in the Northern Part of the Study Area

There are more than ten depressions in the sand dunes located along the northern edge of the Study Area. At the public meeting held during the Phase-II field work, attendants expressed some opinions indicating the necessity of construction of hydraulic facilities to supply water to these depressions in order to increase the pasture potential of this area. The Study Team thus conducted a reconnaissance and identified the following nine depressions in sand dunes in the vicinity of the Study Area:

No.	Depression	Village	Approx. Area (ha)	Approx. Length (km)	Proposed Intake	Distance from Water Source
1	Tin Mara	Beni Nadji	500	10	Canal de Diallo	2,2
2	El Temgounit	Beni Nadji	300	6	Canal de Diallo	0,5
3	Tifaj	Keur-M	150	2	Canal de Diallo	0,0
4	Bounayatt	Keur-M	100	5	Canal de Diallo	0,2
5	Kralekyab	N'kheifa	800	20	Dep Gungala	0,0
6	Mitgueidem	Dara	150	3	Canal de Dioup	1,5
7	Alguena	Dara Salam	150	3	Canal d'Awlig	0,2
8	Alguena 4	Awlig	100	2,5	Canal d'Awlig	0,2
9	Gowd Tembess	Awlig	100	3,5	Canal d'Awlig	0,5

The above-mentioned nine depressions are classified into three categories as follows:

- (1) The Tifaj and Bounayatt depressions form part of the Study Area and will be provided with necessary facilities.
- (2) The 4 depressions of Elb Temgounit, Kralekyab, Alguena, and Alguena 4 are located very near the Study Area. For two reasons: i) prevention of seepage of floodwater from the depressions into the Study Area, and ii) storage of rainwater in the depressions in the rainy season for utilization for traditional pasturage, it is proposed to install gated conduits under the roads to be constructed. A canal will be provided for connecting these conduits to the water source.
- (3) The 3 depressions of Tin Mara, Mitgueidem, and Gowd Tembess are located very far from the water source or separated therefrom by low sand dunes. No economic relation between these depressions and the Study Area was considered, therefore, they were excluded from the present Study.

### 3.10 Rural Infrastructure

#### 3.10.1 Road Network

The road network in the Study Area is composed of the following:

- A road connecting the Ibrahima gate to the Aftout gate, running along the right embankment of the Senegal river (approx. 22 km);
- A road between Keur Macène and the right embankment (approx. 3 km); and
- A road from Keur Macène to Bounaye (approx. 6 km).

In the rainy season, traffic on these roads becomes difficult, except for the paved road on the right embankment.

Besides, there is a path connecting Keur Macène to Dara Salam (approx. 28 km in the Study Area) which has been formed by frequent passage of vehicles. Traffic of this path is very difficult in the rainy season.

There are two access roads to the Study Area from Rosso: One is the path constructed along the right embankment, and the other is the National Road N1 connecting Nouakchott to Rosso. There are many intersections of paths with the NR N1 in the section from 10 to 50 km from Rosso to Nouakchott. All these paths are connected to some villages in the north of the Study Area, such as Dara Salam, El Migueidem, Dara, and Bouteidouma.

#### 3.10.2 Water Supply

Almost all villages in the Study Area use well water or river water directly for drinking and domestic use. There are only two water supply stations in the Study Area. They are located in Keur Macène and Awlig. The Keur Macène station is more modern and consists of a treatment plant, a regulating reservoir, and a distribution system. Water is pumped up from the Diallo depression, stored and filtered at the station. The distribution system consists of a pipeline conveying water to each tap in Keur Macène village. At present there are 155 taps installed in Keur Macène.

The water pumping system is operated by wind power. Three wind-mills are connected to the water supply equipment: One is used for pumping up water from the

Diallo waterway and the other two are for generating electric power required for operation of GMP and conveying water to the regulating reservoir. The treatment capacity is 20 m<sup>3</sup> per day. According to the officer in charge of O&M, this water supply system was designed and constructed thanks to the establishment of relationship as sister-cities between Keur Macène and Vert-Saint-Denis of France in 1993. The cost of one m<sup>3</sup> of water is 150 UM. A layout of the water supply system is illustrated in Figure 3.10.1.

The Awlig water supply system consists of a well, a wind-mill, two regulating reservoirs, a tap, and a pond for cattle. Water is pumped up from the well and discharged into the reservoir. The pump has a suction lift of 7 m and is activated by kinetic energy of the wind-mill. The pumping capacity is estimated to be about 6 m<sup>3</sup> per day. A detergent agent called JAVEL is added from time to time to the water in the reservoir.

### 3.11 Project Management System

#### 3.11.1 Present Condition of Project Management

##### (1) Project Implementation

The irrigation project in the valley of the Senegal river has been implemented under the responsibility and management of SONADER.

The Department of Studies and Works of SONADER head office undertakes the supervision of construction works by assigning its personnel to the site. The Regional Offices are not directly involved in the supervision work but assume the task of coordination.

##### (2) Operation and Maintenance

According to the principle of management of irrigation and agricultural development projects in the valley of the Senegal river, the facilities have to be transferred to the project beneficiaries after completion of construction works.

SONADER adopts the following 2 methods of operation of the projects upon their completion, based on the project size:

##### a) Small or Medium-size Projects

For small-size projects (20 - 50 ha) or medium-size projects (50 - 200 ha), the project management is handed over to the farmers immediately after the completion of development of farmlands and construction of irrigation and drainage facilities. After the distribution of lands, the agricultural contractors, farmers or cooperatives undertake the O&M of cultivated areas and irrigation and drainage facilities.

##### b) Large-size Projects

Like the case of the Boghé, Kaédi, and Foun Gleita projects, the system of operation of a large-size project after its completion is as described below.

In principle, O&M of less important facilities (under tertiary canals) are undertaken by farmers and O&M of more important facilities (above secondary canals) by SONADER. Even after completion of works, the project manager of SONADER assumes the responsibility for execution of the farming program in



the areas developed under the project. To this effect, he carries out the organization of farmers and extension programs with SONADER's annual budget.

On the other hand, after distribution of developed lands, farmers organize the beneficiary group (cooperative or union) to take charge of O&M of the project after completion of works (less important facilities and other project components), in principle on the basis of a concession contract with the Government. SONADER assumes the role of advisor to assist the group in its O&M activities. SONADER continues providing assistance to the group until it becomes fully competent in cooperative management. With regard to O&M activities, the two parties conclude a contract to implement an O&M system within a determined period of time.

Large-size farmlands such as those under the Boghé and Kaédi projects are operated by the Regional Office of SONADER and local farmers' organizations. In principle, SONADER is not directly responsible for maintenance of facilities after completion of works, but only organize farmers and assist in project operation and management on the basis of government guidance. However, in most cases farmers had not been sufficiently surveyed to confirm their intention of participating in the project in the design stage. In consequence, it seems that the project O&M system was not adequately suitable. Moreover, no substantial training of farmers on maintenance had been conducted.

Learning from the above lesson, in the implementation of the Gouère project, the Gouère Users' Association had been established in advance so that farmers will be capable of undertaking themselves the O&M of facilities after their completion. All responsibilities for operation and management of the Project will be handed over to AUG. This association was established in October 1995 and has submitted an application for registering in accordance with law on associations, but no response has been received as of this date.

Since AUG falls under the jurisdiction of the Rosso Office of SONADER, it is managed by the Office Manager who also holds the post of Gouère Project Manager. The juridical status of AUG is defined in the statutes of AUG consisting of six parts; General Framework (Part 1), Association Membership (Part 2), Contributions - Tariffing (Part 3), The Association's Organs (Part 4), Financial Clauses (Part 5), Other Clauses (Part 6).

### 3.11.2 Role of SONADER

SONADER has been established in 1975 as a state company under MDRE. The company's duties include:

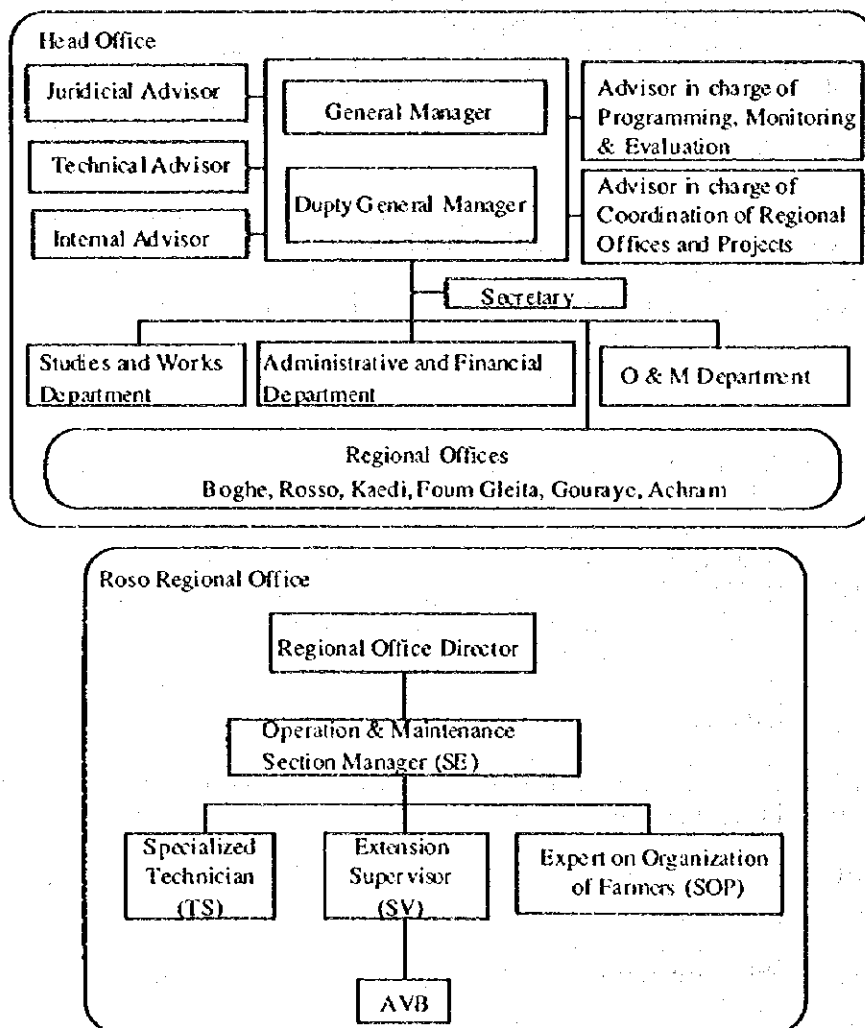
- study, implementation, and maintenance of works relating to irrigation and drainage projects;
- carrying out all operations entrusted by the Government; and
- development of farmlands for extension services, training, and organization of farmers.

At the beginning, within the framework of the above duties, SONADER had undertaken multiple functions (agricultural credit, supply of farm inputs and equipment, maintenance of GMPs, guidance in development of small cultivation areas at the village level, farm mechanization, extension/training, management, etc.).

Under the new policy of restructuring the agricultural sector adopted since 1988, the duties of SONADER have been modified to include development of farmlands, study and implementation of irrigation and drainage projects, and organization of farm cooperatives. SONADER has a head office in Nouakchott and six Regional Offices: Rosso, Boghé, Kaédi, Fom, Gleita, Gouraye, and Tagant. The Rosso Regional Office is in charge of the development of the Delta where the Project will be realized. The Delta consists of five areas (Keur Macène, Rosso, Koundi, Tékane, and Lexeiba) and has a larger development potential of the river valley. SONADER has an official staff of about 350, including 100 engineers and technicians in the fields of civil works and agriculture.

In accordance with the law No. 92-069, SONADER is composed of a high commission (9 members, including seven appointed by the Government, one representative of farmers, and one representative of SONADER personnel) and one executing office at the lower level.

The organization chart of the head office and regional office of SONADER is illustrated in the figure below:



The Rosso Office has 33 staffers at present. The Manager of O&M Section (SE) under the Regional Office is also Deputy Office Manager. The Expert on Organization of Farmers (SOP), the Extension Supervisor (SV), and the Specialized Technician (TS) under SE are responsible for promotion of activities and training on operation of

farmers' organizations, promotion of extension services and management of results thereof, and supervision of construction works and O&M of facilities, respectively. Moreover, AVBs under SV visit each village for extension and promotion of activities of farmers' organizations.

The basic annual budget of the Rosso Office, like that of other regional offices, covers mainly costs for operation of the office (personnel cost and operation cost) amounting to about 1 million UM, and other costs relating to the Project (to be provided by financing organizations and the Government of Mauritania).

The table below shows the budget of SONADER in 1993 - 1996, consisting of a component financed by financing organizations and a component by the Government. In recent years, the component financed financing organizations has been on the decline.

(Unit: 1,000 UM)				
Budget Components	1993	1994	1995	1996
Component financed by financing organizations	285,850	207,350	67,350	31,050
Component financed by the Government	167,900	199,060	263,085	316,913
Total	453,750	406,410	330,435	347,963

### 3.11.3 Issues Relating to Existing Project Management System

The problems of the project management system in the Senegal river basin may be summarized as follows:

- (1) The project operation and management should, in principle, be handed over to farmers, who are the project beneficiaries, immediately upon completion of construction works. In the case of small- or medium-size projects, the number of beneficiaries amounts to some tens of people from one or two villages, thus the O&M of these projects can be undertaken by the households. In the case of large-size projects, however, the users' associations cannot adequately adapt themselves to the project management, due to the complexity of project components and the large number of beneficiaries.
- (2) For large scale projects, SONADER not only undertakes the management and operation of important hydro-agricultural facilities but also plays the role of advisor on project operation and management to beneficiaries' organizations formed by farmers. In fact, as many beneficiaries and villages are involved, the organization of beneficiaries and the establishment of an operation and management system take a lot of time and require long coordination on many aspects.
- (3) The agricultural development projects of a large scale implemented up to the present had not adequately taken into account the socio-economic context and local adaptability of techniques in the project design phase, so that farmers are able to operate them effectively. As a result, there are many cases in which the project O&M by farmers after handing-over of project facilities are not done so effectively.
- (4) Since farmers have not sufficient financial means, they could not pay maintenance charge for projects completed in the past; this fact leads in many cases to difficulties in operation and management of the entire project.
- (5) Due to the fact that SONADER still has neither experienced trainers nor training programs aimed at improving farmers' capability in operation and management of projects, it is essential to improve these issues during the implementation of future projects.

SONADER is strengthening its structure through the execution of a certain number of big projects.

### 3.12 Environment

#### 3.12.1 Present Condition

The Environment Law is still under preparation and the Guideline on Environment Protection which was scheduled to be published at the end of the year, is not yet available. Therefore, there is no basis for evaluation of environmental impacts in Mauritania at present.

It is noteworthy that many national and international non governmental organizations (NGOs) are playing prominent roles in the field of environment; they are CARITAS, AFRICA 70, Mauritanian Red Crescent, SAS SAHEL, Pharmacists Without Frontiers, Eco-operation 66, and Catholic Relief Service.

Within the framework of international cooperation, many studies on the environmental aspects have been conducted for Mauritania. These aspects include in particular the problems of desertification, and those relating to the development of the Senegal river basin. Many partners, namely UNSO, United Nations Development Program (UNDP), Germany, France, the World Bank, and World Alliance for Nature (IUCN) assist the Government of Mauritania in dealing with a large spectrum of environmental challenges.

IUCN provided technical assistance for formulation of strategies on environment and conservation of biodiversity of two national parks of world reputation (Sites designated by the Ramsar Convention), Arguin Ban and Diawling. For this purpose, IUCN has established an office in Nouakchott and worked with DEAR and other departments concerned with conservation of nature and natural resources.

By Decree No. 91-005, the Diawling National Park (PND) located in the vicinity of the Study Area has been created in 1991 over an area of 15,600 ha of former flooding area of the Lower Delta. PND has been included in the list of wetlands of international importance (Ramsar Convention) since August 23, 1994. The delineation of the park is shown in Figure 3.12.1.

On the periphery of PND there exists the Chott Boul area over which the National Navy Department has a particular concern. In addition to this military interest, important censuses of species of piscivorous and nest-building birds and remarkable faunal and floral species have been conducted in the area. This has induced the National Navy to classify the area's natural reserves under its jurisdiction and submit a draft decree on this matter. If the decree is signed, IUCN plans to promote the inclusion of this area in the Ramsar Convention.

The lower delta composed of PND and its surrounding areas may be divided into seven hydrological units (see Figure 3.12.1). These basins are drained by many ponds and backwaters interconnected by permanent or temporary canals. A number of hydraulic structures have been constructed with a view of restoring rich ecological resources that existed before the dam construction. The opening and closing of these structures in the rainy season restore the natural conditions of flooding in the area and allow fresh water to reach up to Chott Boul and Aftout es Saheli located further to the north. In the dry season, during the periods of high tide, water from Chott Boul may reach the park through the South Tombous and the Hassi Baba canal.

### 3.12.2 Initial Environmental Evaluation (IEE)

The table at the end of this chapter summarizes the major points of IEE for this development project. These points are described below:

#### (1) Natural Environment

##### a) Salinity and Deterioration of Soil Quality

Salification of the delta's soils is due to the combined effect of two processes: Influx of salt by surface waters, including relatively less saline waters, as a result of their evaporation in more or less locked depressions; and influx of salt from groundwater due to capillary rise.

Most farmlands in the Study Area had been developed preliminarily without any prior studies, therefore many of them have become salinized after a period of irrigation without drainage. Besides, due the lack of cleaning of canals and ponds, the irrigation water conveyance to farming areas located relatively far from the river has caused flooding to some extent in the lower lands which are abandoned due to loss of fertility resulting from excessive salification or where drainage is not possible. The Project envisages to improve drainage in the area and clean canals and ponds to increase their capacity.

##### b) Desertification, Degradation of Hinterland and Deforestation

Desertification represents a serious problem in the area. The area is characterized by the presence of sand dunes on high plateaus and vast pastures. The vegetation cover is composed of various types of acacia and annual graminaceae. Overgrazing, human pressure through collection of wood for fuel, and successive droughts have thinned the vegetation, facilitating the development of bare sand surfaces destabilized by wind erosion. The Project will introduce methods of improvement and control of desertification and sand deposition.

##### c) Effect of Lagoonal Formation by Drainage Waters and Impact on Wet Ecological Areas

The settlement of this issue, which is directly related to the implementation of the Project, will depend on the final plan of disposal of drainage waters under the Project. At present, three main alternatives are retained for disposal of drainage waters: i) conveyance via the N'Diadier to the Chott Boul depressions; ii) discharge by pumping into the Senegal river; and iii) drainage by evaporation only.

The first alternative, which is likely the less expensive, corresponds to the plan adopted by SONADER (GERSAR 1991) for development of the Dioup basin. This alternative is preferred by the Government authorities because its operation and maintenance will be simpler, but would probably affect the environment in the Chott Boul area (a draft law is under preparation to classify this area as a natural reserve) and that in PND (covered by the Ramsar Convention).

The effects would include fluctuations of water level in ponds and backwaters in the area due to additional inflows generated by the Project, and risks of contamination from toxicity of residual phytosanitary products and fertilizer concentration which is low at present but will increase with the new development activities.

The environment in PND and Chott Boul areas shall be carefully taken into consideration in relation to the development prospects of the entire Senegal river delta. It is therefore necessary for the Government to conduct a detailed environmental impact assessment (EIA) and to work out recommended countermeasures to limit potential damage.

## (2) Social Environment

### a) Population Settlement and Involuntary Exodus

The expected development activities would intensify the settlement of farmers, even camps of stock breeders around the irrigated areas. On the other hand, the operation of project structures may pose the risk of flooding in the lowlands of the Project area, such as Beni Nadji, N'Degue and N'Djella villages, due to the lack of protection embankment, and this may result in an exodus from these areas. At present, due to poor water management and no cleaning of canals and backwaters, flooding risks are observed in N'Degue and in some isolated places in Beni Nadji. Besides, some cases of floods occurred in Breune and Dieuk Fleuve located in proximity to Gouère where part of the population of these villages were moved to the sand dune bands on plateaus. MDRE's Regional Delegation agencies confirmed with the Study Team that the relocation of these villages did not pose any problem to the inhabitants because they were relocated within the same area. The people concerned did not feel unfamiliar with their resettlement place in sand dunes because these are quite near their original living place. The agencies also confirmed that compensations are not considered in the policy of OMVS but the Government and local NGOs have provided assistance. With the cleaning of canals and backwaters and continued water control, these problems would not arise under the Project. Further detailed studies will allow to decide this matter and to work out solutions, if necessary.

### b) Spread of Water-born Diseases

An epidemiological survey conducted by DRAST (Regional Department of Sanitary Actions in Trarza) and the regional hospital of Rosso reveals a fresh outbreak of water-born diseases in the area, with malaria being dominant in Rosso, R'Kiz, and Keur Macène. Diarrhea comes to the second place among the diseases diagnosed. Among the 10 top diseases in the Trarza area, parasitosis, especially bilharziosis in intestinal form affects 11% of patients checked in 1993, 7% in 1994, and 9% in 1995. Parasitosis will spread in the coming years due to the impounding of the dams and rice cultivation. Malaria remains a cause of concern in view of its exponential growth. Cholera occurs annually in the area and could become epidemic if proper sanitary measures involving water consumption, toilets, etc. are not taken.

### c) Conflict between Communities and People

Mauritanian authorities assure that there will be no conflicts between farmers and stock breeders because pasture lands will also be developed. From the experience of the completed Gouère project, cattle passing routes are planned for the Project. During daytime, farmers must undertake the watch of their fields, and in nighttime stock breeders must guard their animals. According to law, a fine will be imposed in case of non fulfillment of these duties. However, during our field survey, some minor incidents with causing substantial damage were reported here and there in the Study Area. Therefore, information and extension campaigns shall be carried out in farmers and stock breeders' cooperatives in order to make them aware of their roles and, thus, to create mutual understanding and to minimize the risk of conflict.

## Matrixes of Impact on the Environment

### I. Natural Environment

	Categories of Impacts	Evaluation	Positive Impact	Negative Impact	Evaluation Basis
1.	Salinity and Deterioration of Water Quality	A	O		Some developed lands are left uncultivated due to loss of fertility resulting from excessive salinization or excessive flooding without possible drainage. The encountered problems will continue to remain with the implementation of the Project, however, the latter will remedy this condition in most of the area by improving the drainage problems.
2.	Desertification, Degradation of Hinterland, and Deforestation	B	O		Desertification constitutes a serious problem of the area. This is aggravated by overgrazing, human actions, and drought. Many sand dunes are observed. The envisaged development will reclaim vast land areas, causing a reduction in vegetation. The Project, however, will propose measures for improving and controlling desertification and sand deposition.
3.	Effects of Lagoonal Formation by Drainage Waters and Impact on Wet Ecological Areas	B		O	The presence of wet ecological areas (PND and Chott Boul) is observed in the vicinity of a potential area for discharge of drainage waters. If this drainage alternative is adopted, this will generate harmful effects on the environment of these areas.

### II. Social Environment

	Categories of Impacts	Evaluation	Positive Impact	Negative Impact	Evaluation Basis
1.	Population Settlement and Involuntary Exodus	B		O	It is possible that the new development activities will attract settlement of new population, in particular nomads and new landowners. This will lead to the monopolizing of land ownership by foreign investors in the area and an accumulation of pressure on lands and pastures. On the other hand, the risk of flooding in the area may cause exodus of part of the population if adequate preventive measures are not taken.
2.	Spread of Water-born Diseases	A		O	With the development of rice cultivation and the impounding of land parcels in a longer period, these diseases will increase.
3.	Conflicts between Communities and People	B	O		Risks of conflict between farmers and stock breeders will always subsist, even though local authorities confirm differently.

(SIE: Sensitive Impact on Environment)

A : SIE will undoubtedly be induced by the Project

B : SIE will probably be induced by the Project

### 3.13 Women in Development

#### 3.13.1 General and Political Situation

Women account for more than half (50.3%) of the population and play an important role in socio-economic development in Mauritania. However, due to the traditional social system, the condition of women is still not favored by an environment suited to their social life (high rate of illiteracy, limited access to labor market, increase of divorces, etc.). The condition is harder in rural areas since a large number of women must do works such as fruit and vegetable production in addition to household work. The State Secretariat on Women Condition has been established in 1992 and has dealt actively with these issues. Following are the sectors targeted in its program of action:

- a) Women and public health
- b) Women and education/training
- c) Femmes, associative and social life
- d) Women and employment
- e) Women, familial life and debt
- f) Women and living framework

The Secretariat has prepared many documents on the basis of its activities in the four years from its establishment, and through seminars on women issues.

#### 3.13.2 Present Condition of Women in Development

Women groups have been organized in the Study Area to promote handicraft production and fruit and vegetable cultivation on small family farmlands. Many groups are engaged in both activities. Most popular handicraft products are mats (carpets) which are sold in Keur Macène and Rosso markets. In addition, in Keur Macène a group of about 50 women members (Keur Macène Women Center) manufactures clothes with five sewing machines. The major problem facing women groups generally in handicraft production is the lack of capital for construction of adequate buildings for their work, as well as for purchase of equipment and tools.

With regard to fruit and vegetable cultivation, the most serious constraints to production are the lack of fund and price increase that restrict the purchase of equipment and inputs such as seeds, fertilizer, and irrigation pump. But in spite of this fact, women are very active and cooperative. At present most of women groups are registered as female cooperatives.

The findings from surveys on the condition of women and development conducted within the framework of this Study are described in the following sub-sections:

##### (1) Social Status of Women

With regard to the present social regime, 80% of the surveyed women have not expressed dissatisfaction with the actual social conditions of women.

##### (2) Situation in the Family

About 20% of the women said they clearly note a predominance of males, 10% indicated they are conscious of the male predominance, but 40% do not see such predominance.



### (3) Equality between Men and Women

Eighty per cent (80%) of the women recognize the equality between men and women in the social system, but, as to equality in the family, the number of affirmative answers reduces to 70%. With regard to social activities, 55% of the women see there is equality between men and women.

### (4) Participation in Social Activities

To the question on constraints to participation in social activities, about 42% of the women cited the social notion. Only 32% replied that the constraints are due to social rules.

### (5) Women's Expectations from the Project

About 80% of the surveyed women said they will rely on the Project. More concretely, about 80% wish to receive assistance in supply of materials for farm production, and establishment of a marketing system for handicraft products. Expectation in fruit and vegetable cultivation is in particular most strong, and about 45% of the women desire to obtain a crop land of more than 100 m<sup>2</sup> per person.

## 3.14 Public Meetings with Beneficiaries

### 3.14.1 Summary of Meetings

Two meetings were held on February 18 and March 12 1997 in the Regional Office of SONADER in Rosso. The first meeting's objective was to explain the main features of the development plan in the Study Area to the beneficiary farmers and local governmental agencies concerned, and to grasp the problems and their wishes relating to the development plan. Representatives from farm cooperatives, female groups and agricultural producers in the 15 villages involved with the Project were invited along with the representative of MRDE's local office. After distribution of a summary of the draft development plan prepared in French and in Arabic to all attendants, a brief description of the Project was presented and discussions followed. All the attendants expressed a strong desire to see the realization of the development plan, and raised the problems to be taken into account in the Project formulation. The attendants decided, at the end of the meeting, to examine the contents of this meeting in the villages or within the groups in order give their opinions at the second public meeting.

The second meeting was also held in SONADER's Rosso office and attended by the representatives from all villages and from cooperatives. The attendants presented, as results of discussions of each group, the elements they wished to be taken up under the Project. Table 3.14.1 shows the problems and expectations relating to the Project, indicated by the representatives of villages and agricultural groups after the two public meetings. The principal requests can be summarized as follows:

- Irrigation water supply;
- Development of pastures;
- Formulation of a pasture development plan that will not incite traditional conflict between farmers and stock breeders;
- Drinking water supply and development of farm roads;
- Water supply to the desert depressions located at the northern edge of the Project area;
- Concrete support plan for women groups;

- Development of equipped farmlands to compensate for the loss due to the construction of the embankment of the Senegal river;
- Protection of houses against flooding; and
- Technical assistance from foreign countries.

#### 3.14.2 Subjects Confirmed during Meetings

For smooth implementation of the Project as well as its operation and maintenance, the Study Team requested to confirm the following subjects to the beneficiaries:

- Establishment of Water Users Association (AUD);
- Necessity of strengthening of farmers' organizations; among others, joint management of pastures through the creation of a future cooperative; and
- Operation and maintenance of the Project facilities by the beneficiaries at their own costs.