ISLAMIC REPUBLIC OF MAURITANIA

Honor — Fraternity — Justice

Ministry of Economy and Finance

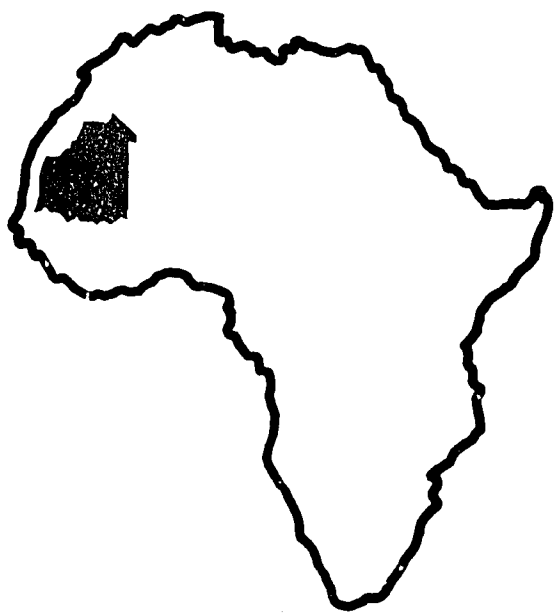
Directorate of Studies and Programming

RAMS PROJECT

Rural Assessment and Manpower Surveys

Irrigated Agriculture

SS-1



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Introduction

Mauritania's agricultural economy has always been based on extensive livestock raising, which accounts for 16 % of the GNP. Dryland (rainfed) and irrigated agriculture represent only 4 to 5 % of the GNP.

Several years ago, revenue from livestock was sufficient to allow the export of excess livestock and to satisfy the national demands for imports of cereals, vegetables and other products.

The drought which has stricken this area for over ten years has broken this fragile equilibrium. Though still important in the agricultural economy, livestock has suffered enormous losses. Sedentarization is increasing and the food deficit continues to worsen.

These difficulties have been perceived by the government authorities as a grave warning that the developement of irrigated cultivation is now no longer a simple alternative, but an obligation. Crop irrigation is, in fact, the only means to assure high productivity and security during difficult years.

Since the creation of SONADER, this sector has received particular attention from both government officials and international organizations. Several studies have been conducted on the different aspects of irrigation. Several projects have been implemented, particularly along the Senegal River Valley.

This report will present an evaluation of the existing situation. It will attempt to show how existing organisation and legislation have responded and can respond in the future to the objectives established by the economic and social development plans and the real constraints of the environment.

The first chapter will analyze the existing situation and constraints as concern irrigated cultivation along the Senegal River. Particular emphasis will be given to the questions of agricultural credit, communications, infrastructures, marketing, storage facilities and the processing of agricultural products. Land tenure problems and training will be discussed briefly, as they have been treated in separate, more detailed reports.[1)]

The second chapter will present the country's possibilities for irrigation using both underground and surface water.

The main objective of this study is to define the real bottlenecks to development: during a second phase, long and short term actions to correct them will be presented.

As concerns marketing, storage and processing of agricultural produce (besides rice, for which the price controls and marketing are

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1) See Report of RAMS Sociological and Education Unit.

handled by the OMC), there is not yet a marketing system, so that the market price of produce often has no relation to real production costs.

The policy of pricing for rice is not sufficiently encouraging to producers: although the small individual farmer may benefit from it, the large farmer who employs hired labor receives no return from rice growing. Even with high yields, the current market price of rice covers only the costs of production factors (amortization, diesel fuel, fertilizer) and labor. There is practically no profit, and therefore, no possibility of saving. This problem is aggravated by the lack of any real integration of cultivation and livestock raising.

Table 1 : Cost Price of a Ton of Rice (in ouguiyas)

Yield Hypothesis per Hectare Rice	Traditional Farming		Modern Farming	
	Single Crop	Double Crop	Single Crop	Double Crop
3 tons/hectare	14	11,3	14	12
4 tons/hectare	10,5	8,4	10,5	9
5 tons/hectare	8,4	6,7	8,4	7,2
6 tons/hectare	7	6,7	7	7,2

Source : RAMS

This table shows that in order to break even, it is necessary to grow at least 4 tons per hectare. With a yield of 5 tons and with double crops, a profit margin of 3 UM per kilo of rice is possible.

Therefore, in order to make rice cultivation more profitable, one

of the following two measures should be adopted

1. Raise the market price of a kg of rice. (However, such a measure seems rather difficult given the social consequences it is likely to create)

2. Or, encourage farmers to practice double croppings, to modernize their production system and to integrate livestock in order to use sub-products. Allocation of larger parcels of land will encourage this intensification. However, it should be noted that for those perimeters in the lower valley, the yearly rise of the salt tongue will prevent double crops until the Diama dam has been completed.

Agricultural development in Mauritania until now has been characterized by both regional and structural disequilibrium:

- regional disequilibrium resulting from the fact that most current or projected projects are concentrated in the immediate area of the Senegal River.

- structural disequilibrium in that, at present, although the livestock sector is incomparably larger than the cultivation sector, it benefits from fewer projects (there is only one fodder cultivation perimeter on the Mauritanian bank).

In the interior of the country, there exist large underground water ressources as yet untapped. Use of these resources for irrigation could lessen the impact of livestock migrations and help decrease the rural exodus.

In this perspective, the future projects concerning oasis improvement, the projected dams in the Hodhs region and the projected Tartega dam at Tamourt Ennaj, in addition to the wells which have been recently drilled, will all permit creation of other zones of irrigated agriculture outside the Senegal River valley and thus assure better use of the national territory. A coherent improvement program is required, especially in the case of drilling wells,

for the choice of sites, crops to be planted and means of exploitation.

Finally, this analysis of the present situation shows that a coherent policy to promote irrigated cultivation so as to permit the country to rise to the level of a developed nation and assure food self-sufficiency would require the following measures :

serious examination of the communication links along the river in order to facilitate produce evacuation and supply distribution. Studies in this area have been performed. Financing sources are available: they must be convinced to participate and the other problems which have until now hindered these improvements must be resolved.

Promulgation of equitable land reform legislation and the will to apply these necessary laws

revisal of the PPVI policy, to attempt to decongest the old perimeters by improving the sites already prospected and by restructuring the PPVI's

improvement of marketing and storage conditions and creation of agro-industries

use of agricultural credit to encourage cultivators and cooperatives

training of managers and machine specialists

creation of specialized mechanical units for the improvement of new perimeters and of the CUMA.

study of institutional problems.

The objective of the second phase of this study will be a detailed examination of these different measures.

Chapter 1 : EXISTING SITUATION ALONG THE SENEGAL RIVER

1.1. Basic Data

Data concerning climate, pedology, demography, water resources, etc have been given in seperate studies.[1)]

This chapter will review the essential data of two important factors

- Population and employment
- Irrigable soil possibilities

1.1.1. Population and Employment

The river region is favored by natural conditions and has the highest population density of Mauritania's regions.

1.1.1.1. Total Population

Total population is estimated at 591 243 inhabitants, or more than 1/3 the total population of the nation. The population is distributed as shown in Table 4 (page 13).

1.1.1.2. Active Population (12 and over)

The population is estimated at 366,535 and is distributed as follows :

A. Sedentary population: 254,980 (12 and over), of which 132,720 are classified as inactive. These are mainly women, young

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1) See Unit Report : Geography and Environment, Unit B_5 Report : Population and Employment

Table 2 : Population Distribution of the River Area by Region

Region	Total N° of Inhabitants	Nomads	Residents
Trarza	216 000	106 100	109.900
Brakna	151 400	50 600	100.800
Gorgol	165 400	16 400	149 000
Guidimaka	83 200	9 067	74 200
Total	616 000	182 100	433 900

students and young people who have dropped out of school, and are not in search of employment.

The active sedentary population: 121,660 (12 and over), of which 11,070 are unemployed and 110,590 employed

The active sedentary population (12 and over) is distributed among the following fields of activity:

- Agriculture 56,215
- Livestock 16,306
- Forestry 2,879
- Fishing 4,590
- Handcrafts 5,183
- Trade 10,094
- Other services 15,323

Source : RAMS

B. Nomadic population : in the census only the heads of household are classified as active; the heads of household are presented here by their different activities; an estimation is then given of the number of active nomads (10 years and over) and their distribution amongst the activities.

- heads of household: 38,973 out of which 1,345 do not have an activity and 37,628 are distributed as follows :

Agriculture	6,901
Livestock	26,963
Handcrafts	711
Trade/Commerce	2,056
Other	977

- estimation of nomads : 121,866 (10 years and over)

Agriculture	25,596
Livestock	86,539
Handcrafts	1,218
Trade/Commerce	6,...
Others	2,439

Source : RAMS

Population Presently [illegible] in Irrigated Agriculture

On the basis of 0,5 hectare per active inhabitant, we can estimate the population involved in irrigated agriculture along the river at 8,000 persons, or 10 % of the total active population practising agriculture.

This estimate demonstrates the current under-employment of considerable human resources. These figures show that addition of 100,000 hectares or more will create no difficulties in terms of employment. To the con-

trary, such extension would help absorb the present disguised unemployment and eventually create conditions favoring the return of the populations having migrated to the large towns in search of more stable work and higher pay.

1.1.2. Irrigable Soil Potentials

Pedological studies conducted by the FAO in 1975 along the Senegal River showed that on the Mauritanian bank it is possible to irrigate more than 200,000 hectares. In general, the following soil types were found (see Figure 1, page 17) :

1.1.2.1. Hollaldé (or Oualo)

These soils cover the largest surface area in the river valley. They are formed of clays deposited by sedimentation or settling during the successive floods; their composition is approximately :

- about 60 % clay
- about 20 to 30 % silt
- less than 1 % organic matter
- about 10 to 20 % sand.

These are generally fertile soils, with excellent water retention capacity (about 30 %). However, the high humidity at the wilting point (about 20 %) means that the RFU is low.

Given these characteristics, the crop most adapted to this type of land is rice, due to the clay's impermeability. It is also possible to grow corn, if water control is excellent and the terrain's topography is such as to prevent asphyxiation of the plants' roots.

1.1.2.2. Fondé

These soils are coarser than Oualo soils, due to the manner in which the materials were deposited. They are sometimes clayey soils and often contain concretions. Their composition is much more irregular than that of Oualo soils.

One can find clay contents of from 10 to 30 % and silt contents of from 20 to 60 %. The rest consists of more or less fine sand. Organic matter content is usually less than 1%.

Fondé lands are suitable for more varied crops than Oualo soils. If clay content is 22 % or more, rice crops are possible. Corn, sorghum, niébé and vegetables are also well suited to this type of soil.

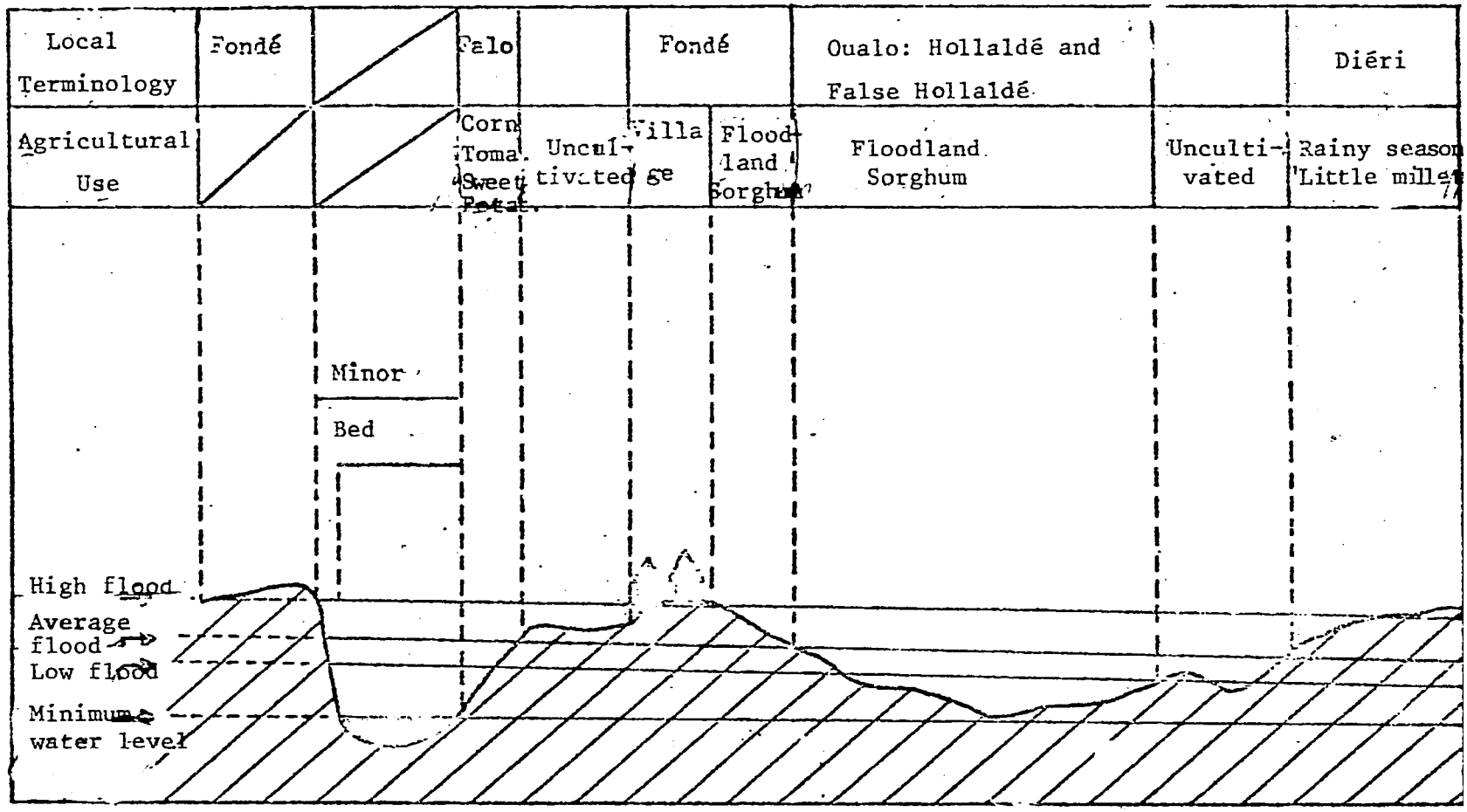
1.1.2.3. Diéri

The original matter is sandstone-like. These lands are never flooded: the soils formed are brown steppe or isohumic soils. They are distinguished from ferruginous tropical soils by their finer texture and less acid Ph.

In general, they present a greyish, sandy-textured surface horizon of variable thickness, covering a massive brown or reddish brown horizon of finer texture, at times even consolidated.

They have poor nutrient reserves and poor humidity retention. They are suitable for millet and fonio, but success depends on the rainfall.

Figure 1 : Cross Section of Senegal River Valley Lands



Extract from "Etude du barrage hydroélectrique de Manantali. Rapport Général- Annexe 4- Agriculture."

1.1.2.4. Falo

These soils ressemble those of the Fondé. Fertility varies according to flood deposits. They are often excellent soils for sweet potatoes, niébé and corn.

It should be noted that in the Delta and the low valley (up to about Boghé), salinity problems often occur due to fossil salt water (Nouakchottian transgression) and the rise of the salt tongue. Leaching of these soils appears difficult because of their poor structure.

Studies have shown that the surface area of perimeters from M'Pourié on represent 208,000 hectares, including the Gorgol Noir and Gorgol Oualo projects.

- Net Arable Surface Area suitable for vegetable and forage crops (mainly Oualo lands) : 111,300 hectares or 53 %
- Net Arable Surface Area suitable for industrial crops, diversified crops or forage (Fondé or Oualo lands) : 24,200 hectares or 12 %
- Other : Zones not suitable for intensive agricultural production : existing classified forests, village and drainage structure rights-of-way : 72,500 hectares or 35 %
- Total : 208,000 hectares or 100 %.

In addition to these perimeters, the areas included between the diéri lands and the river represents : 95,000 hectares.

There are pedological and 1/50 000 scale aptitude maps covering the entire Senegal River region. The aptitude maps were established using the U.S.B.R. system. Six soil classes are identified :

Class 1 : Easily Irrigable

Lands which are permanently suitable for good production of different crops adapted to the climate. The texture is average, allowing good penetration of water, air and roots. Water retention permits good spacing of adequately dosed irrigations. Fertility is average and easy to maintain or improve. These soils are not affected by salts or sodium. Their topography is such that they require only minor levelling work, and installation of irrigation, fencing or drainage networks will present no difficulties.

Class 2 : Irrigable

These lands permit permanent average or good production of crops adapted to the climate, but the range of crops is less extensive than that of Class 1. These lands are less permeable than Class 1 soils, where sands require greater frequency of irrigation. Improvement works or operating costs are higher due to the topography, the presence of acquifers or salinity.

Class 1 R : Rice Cultivable

The lands in this class contain more than 60 % clay; all other factors are comparable to those of Class 1. Since irrigation water does not penetrate these soils well, flooded rice cultivation is advised. Improvement and operation costs are low. Permanent field cultivation is possible.

Class 2 R : Rice Cultivable

This class ressembles the preceding one, but these soils are affected by salt and their improvement can only be envisaged after its elimination, which increases the costs. Permanent field cultivation is possible.

Class 6 : Non-Irrigable

Soils for which irrigation is not advisable due to their poor characteristics.

Class 6 R - Non-Irrigable

Possibly rice cultivable on the condition that very difficult improvements be made.

1.2. Structure of Production and Extension Services

1.2.1. Structure of Production

At present, there are three main types of operations along the Senegal River :

- small village perimeters managed as autonomous cooperatives, with extension services provided by SONADER or other organizations
- large perimeters around major towns
- privately owned perimeters

Table 3 : Relative Size of Surface Areas by Method of Operation[1)]

Method	Surface Area (hectare)	Percent
Small village perimeters	1,796	41.5 %
Large perimeters	1,806	42.0 %
Private perimeters	589	13.5 %
Others (research)	120	3.0 %
Total	4,311	100.0 %

Source : RAMS Survey

1) See Surface Area and Production Break-down in Annex

It is still too soon to compare these three forms of agricultural exploitation. Hydroagricultural improvement of the valley is still quite recent, dating from 1965. However, some of the positive and negative aspects of each of these three methods will be briefly presented.

1.2.1.1. Small Village Perimeters

These perimeters are of from 20 to 30 hectares in size and are generally located on fondé lands. They are exploited by a cooperative and extension services are provided by SONADER or other organizations. Some of these perimeters are totally independant and are directly managed by the owners without outside assistance.

- At present, there are 73 small village perimeters for which SONADER provides extension services. Their surface area is 1 338 hectares, of which 713 hectares correspond to 41 perimeters to be irrigated during the coming season.

- There are 34 small village perimeters without extension services or for which extension services are provided by organizations such as Caritas, Lutheran Federation, etc. They cover 578 he tares.

Usually, the choice of the site of cooperative members and the realization of improvements is conducted with the participation of the inhabitants of the nearby villages. In theory, thus motivated, the farmers will furnish maximum efforts to exploit the plots allocated to them. SONADER provides the necessary facilities to each group, for a fee which has been calculated in advance.[1] Decision making is the responsibility of the

1) This fee covers the price of fertilizer, diesel fuel, amortization of motor-pumps, seeds and the different operations performed by SONADER on the plot. It averages about 9 000 to 10 000 Ouguiyas per cooperative member.

boards of directors of the cooperatives. The strategy to create small village perimeters has two objectives :

- To allocate individual plots to the greatest possible number of the valley's farmers, so that they may have supplementary food during good years or as a sole source of revenue during dry years. Given this strategy, the surface areas allocated to each farmer can only be small (10 to 20 ares).

- To familarize the greatest possible number of farmers with the techniques and operations necessary for intensive agriculture.

This strategy is part of the long term improvement plan for the Senegal River Valley. It has the advantage of assuring wide distribution of irrigation among the rural populations and of providing rapid training for intensive agriculture to large numbers of farmers.

However, it must be noted that results would be better if each farmer could receive a surface area of 0.5 hectare at least. The SONADER could easily collect its fees and continue its improvement work.

Recently, the SATEC conducted a study of the inventory of potential sites for small village perimeters. These sites were censused according to the following criteria :

- Human or sociological criteria : priority given to perimeters near villages and concerning a maximum number of farmers.

- Technical criteria : surface area, configuration of land, etc.

- Economic criteria : cost of improvements, etc.

The following results were obtained :

Table 4 : Potential Sites

Sector	Surface Area	Number of Sites	Population
Rosso	2,739 ha	146	20,042
Boghé -	917 ha	57	26,075
Kaëdi	466 ha	21	36,323
Sélibaby	599 ha	31	22,560
Total	4,721 ha	255	105,000

Source : Etude de faisabilité d'un programme d'aménagement des périmètres villageois, (SONADER).

This study shows that :

- 284 sites could be equipped. The program was divided into two stages, due to the difficulties in improving some of the perimeters :

  - Phase 1 : Simple improvements which can be carried out under natural conditions = 200 perimeters covering 3,591 hectares.

  - Phase 2 : More complex improvements, usually required by hydrological conditions (protection against floods, water supply possibilities, etc.) = 84 perimeters covering 1,133 hectares. It should be noted that some Phase 2 operations concern extensions of perimeters planned for Phase 1.

The total cost of improving these perimeters is estimated at 511,956,000 Ouguiyas. The improvement schedule (over 4 years) for the 200 perimeters

is given below :

Table 5 : Number of Perimeters Improved By Sector

Sector	Year of Project					Total per Sector
	(0) 1981	(1) 1982	(2) 1983	(3) 1984	(4) 1985	
Rosso	16	24	18	24	30	112
Boghé	6	10	10	13	-	39
Kaédi	6	6	7	-	-	19
Sélibaby	-	-	10	10	10	30
Total	28	40	45	47	40	200

Source : Etude de faisabilité d'un programme d'aménagement des périmètres villageois, (SONADER).

It is certain that, in the future, improvement of these sites will permit decongestion of the existing perimeters and thus avoid the problem of the small surface areas allocated per farmer.

It will then be possible to create, within each perimeter, small livestock units, managed by the cooperatives and operated by cooperative members. Such a system would permit the dissemination of intensive livestock raising techniques, provide additional income for farmers and, of course, furnish by-products for cultivation.

In our Second Phase study, we will propose the means to attain this objective so that both the existing and potential sites can be exploited as viable cooperatives or groups of cooperatives, where each cooperative

member has a plot of at least one hectare. It will then be possible :

- to involve more farmers and thus, to assure better land use through less expensive irrigation;
- to obtain better returns from equipement, as some of the farmers will already be experienced in irrigation techniques.

However, in spite of the size of these new sites, their improvement will not be sufficient to absorb the active rural labor force available in this area. Therefore, it is indispensible to complement these small sites by large improved sites.

1.2.1.2. Large Improved Sites

There are, at present, two large improved sites in Mauritania :

- The M'Pourié perimeter at Rosso (1,426 hectares)
- The Gorgol perimeter at Kaédi (380 hectares, on an improved surface area of 700 hectares).
- A third perimeter is now being improved at Boghé, covering 1 000 hectares (out of an area of 4 000 hectares).

These perimeters are located quite near to large towns where abundant labor is available.

The advantage of these large perimeters is that they favor the concentration of means (personnel and equipement) and faster dissemination of technical progress. Marketing and processing of produce are also facilitated.

However, the lack of land legislation may render useless the efforts undertaken so far. At M'Pourié, land problems have largely been avoided

by appropriate local initiatives(respect for the farmers' contributions, and the quality of extension services). However, at the Gorgol perimeters, the situation worsens steadily from year to year. Of the original 4,000 hectares, only 700 have been improved. Of these 700 improved hectares, only 380 were cultivated in 1978 and only 105 in 1979. During 1980, it is hoped that 380 hectares will be exploited.

Apparently, this under-exploitation can be explained by the farmers' refusal to pay the SONADER fees. However, the problem is much more complex.

Given the difficulties encountered with the Gorgol perimeters, some people affirm that large improvements are to be avoided. They believe that such improvements require a level of organization and technicality at present lacking in Mauritania.

This is a grave error, in our opinion. Small perimeters, while easier to manage, do not provide the surface areas required to satisfy the nations's needs.

An OMVS survey was conducted in 1979 in order to determine the differences between the theoretical list of perimeter allocations and the actual working farms existing at present. This survey also studied the status of the allocation-receivers as compared to the land allocation criteria. The results were as follows[1]:

- For land allocations :

  - 39 % of the receivers of land allocations fulfilled the requirements for both allocation and cultivation;

1) Etude socio-économique du bassin du Fleuve Sénégal, OMVS, 1980

- 23.5 % of allocation-receivers did not reside in Kaédi

- 25.5 % of allocation-receivers practiced in the town of Kaédi a non-agricultural economic activity which prevented them from farming their own plots;

- 12.5 % of the allocation-receivers were not able to perform agricultural work, due to age, illness or handicaps.

- For cultivation :

- 39 % of allocation-receivers farmed their own plots or had them farmed by their sons;

- 7 % were replaced by paid workers or almoudés (Marabout's students who live with them);

- 54 % of the allocation-receivers confided their land to others to farming, either on the assakal system or by sharecropping. Some of these use almoudés also for farming.

The above results show the complexity of the land structures. In the future, the State must be firm in defining institutional limits which will help solve land problems and permit a means of land allocation which will not hinder the rythm of production.

1.2.1.3. Private Perimeters

Having seen that substantial profits were possible from irrigated agriculture, certain merchants, livestock owners and even government officials have recently begun to create irrigated perimeters.

At present, more than 580 hectares are being farmed; the total improved surface area is 1,370 hectares. The 580 hectares are distributed among 19 private owners. Most of these perimeters are found in the Rosso region, where the proximity of the Nouakchott road permits easy transport

of produce.

Since they are concerned with financial profit, these farmers cultivate more profitable crops than rice (mostly vegetables).

All complain of the lack of an agricultural credit structure and are discouraged by the lack of spare parts, equipment and processing factories.

While the State must give priority to encouraging the more needy peasants and cooperatives, these private investors must not be ignored, as they are indispensible "agents of change".

1.2.2. Extension Services Structures

The introduction of new agricultural techniques tending to reduce or even reverse rural exodus requires the installation of appropriate institutions to carry out organizational functions.

In Mauritania, these functions are carried out by the SONADER, the Direction of Agriculture, and other separate organizations working for the most part under the aegis of the Direction of Agriculture.

1.2.2.1. The SONADER

The SONADER (Société Nationale pour le Développement Rural) was created by Decree N° 75.237 of July 24, 1975. It is an industrial and commercial State company, having individual status and financial autonomy.

Modifications to the SONADER's charter in matters of extension services and management were made by Decree N° 76.036 (Feb. 12, 1976) and 78.188 (June 22, 1978).

At present, the SONADER has four functions :

- Studies
- Implementation
- Extension services
- Management

It is therefore able to follow a project from conception to completion.

Personnel consists of 120 persons : 34 engineers, of which 23 are expatriates under technical assistance contracts financed by foreign aid (IBRD, France, Canada, West Germany, Netherlands, etc.).

Although the SONADER's means are modest compared to its real needs, it has nevertheless been in the avant-garde of the other professional organizations dependent on the Ministry of Rural Development. This has led to its diversifying its actions, at the risk of over-spreading.

- In principle, the marketing of rice is the responsibility of the OMC. As the OMC does not have the necessary financial means, the SONADER has equipped itself with hullers and assures the collection and processing of the rice from the perimeters it supervises.

- The lack of an agricultural credit structure has led the SONADER to assume the role of a bank for the perimeters it supervises, giving advances in kind to farmers and collecting repayment.

- Since there are no hydro-agricultural improvement units, the SONADER is often required to perform this work itself.

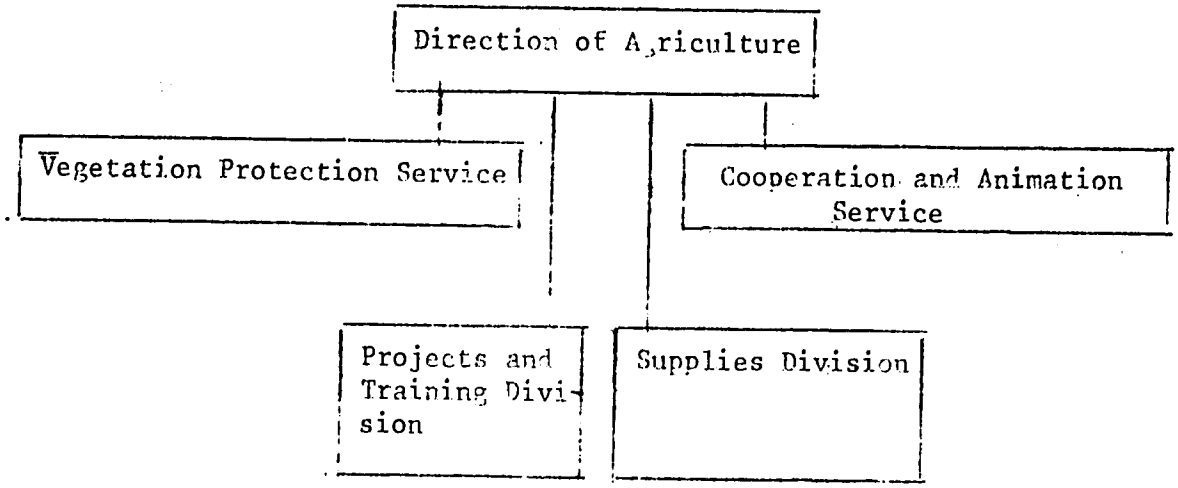
Detractors think that rather than "developping" the farmers, the SONADER tends to "envelope" them.

However, when consideration is given to the diversity of studies and popularization actions the SONADER has undertaken, the positive effects cannot be denied, even though they may be costly and are only just beginning.

1.2.2.2. Direction of Agriculture

Since the creation of SONADER, the role of the agricultural sectors along the Senegal River has markedly decreased. Having limited means of transportation and personnel, these sectors provide only extension services for private farmers and follow-up for organizations like the Lutheran Federation, the COSSOC project, the Caritas project, etc.

The organization chart at the national level of the Direction of Agriculture is given below :



The Cooperation and Animation Service is in charge of the legal constitution of the cooperatives, granting tax relief and fuel coupons, and animating the cooperative movement.

The Vegetation Protection Service is responsible for advising the farmers about destructive insects and other parasites and formulating preventive measures.

The Project and Training Division manages and follows-up on operations contracted with foreign financing organizations.

The Supply Division supplies the different sectors with fertilizers, pesticides, equipement, vegetable and fodder seeds, etc.

Each region has an agricultural sector: in certain prefectures, there are rural expansion centers, such as at :

- M'Bout
- Bousteïla
- R'Kiz
- Maghta - Lahjar

1.2.2.3. Other Services, Organization Problems

In addition to the SONADER and the Direction of Agriculture, other services are concerned more or less directly with the promotion of irrigated agriculture. Some of these services are :

- the Direction of Livestock
- the Rural Engineers Corps
- the OMC
- the CNRDA and CNERV
- the ENFVA
- the M'Pourié Farm

It should be noted that in general these existing structures are hinderied by the low level of extension services and limited financial resources: therefore, there is lack of coordination between the main services. Popularization actions are thus often sporadic (vegetable farming operations,

motor-pump operations) and intermittent.

In summary, the present organization of the Ministry of Rural Development is characterized by :

- A strongly centralized organization, with an over-sectorial structure, leaving little room for an integrated view of development and characterized by lack of planning, imprecise actions and over-extension of means.
- Very limited finances, equipement and personnel in terms of the quantity and urgency of the work to be performed.
- Inefficient use of technical staff.
- Concentration of means at the central level, at the expense of the regions and the development programs (see following table).

On the other hand, the SONADER, which has an individual status and relatively large means, has attempted to remedy this situation by reinforcing the sectors and reducing the staff at central headquarters. However, this attempt has been accompanied by a trend towards diversification.

Given the number of tasks to be undertaken and in order to avoid the risk of over-extending, the Ministry of Rural Development decided to ask the FAO to conduct a study in order to restructure the Ministry along the following principles[1)]

Principle 1 : To create, at the central level, structures for planning, programming and orientation of rural development. To make available a technical staff, unencumbered by daily managerial problems, which can provide pertinent technical advice and assure technical supervision of regional services and other supervized programs.

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1) Etude sur la restructuration du Ministère du Développement Rural, Mission FAO, Avril 1979.

Principle 2 : The progressive implementation of regional directions of the Ministry of Rural Development with sufficient means to realize and supervize integrated development actions.

Principle 3 : To make available, for each major ecological zone, inter-sectorial agents in order to realize major programs and projects defined by the Ministry.

Principle 4 : To create commercial and industrial organizations in order to improve marketing circuits, to evacuate agricultural produce, to supply means of production, to regulate surplus supplies, to maintain prices and to integrate agriculture and livestock with agro-industries.

Principle 5 : To create training, research and experimental facilities adapted to the needs and specifications of the ecological regions.

Principle 6 : To create public production companies serving as intensive agricultural production centers (rice, sugar cane, animal products, etc.) and as a basis for demonstration and dissemination of techniques.

In Phase 2 of this report, this important restructuring study of the Ministry of Rural Development will be reexamined, taking into account all agricultural activities : irrigated crops, oasis crops, rainfed crops, livestock.

Table 6 : Break-down of Staff of Ministry of Rural Development

1. Speciality : Agriculture

Administration	Engineers	Assist. Engineers	Middle and Lower Staff
Central level	6	1	4
Regional level	-	2	43
Sub total	6	3	47
Teaching and research :			
CNRADA (Kaëdi)	4	1	16
ENFVA (Kaëdi)	1	-	6
Lab./Entomology (Nouakchott)	-	-	2
Vegetable Farming Station (Nouakchott)	-	1	1
Sub Total	5	2	25
Supervised Organizations :			
OMC	1	1	2
SONADER	11	5	16
M'Pourie	2	2	5
Sub total	14	8	23
Total Agriculture	25	13	95

Table 6 : Cont'd : 2. Speciality : Animal Health

Administration	Veterinary	Assist. vet.	Vet. Nurse
Central level	5	-	-
Regional level	-	31	95
Sub Total	5	31	95
Supervised Organizations :			
CNERV	2	-	-
ENFVA	-	-	-
Sub total	2	31	95
Total Animal Health	7	31	95

3. Speciality : Forestry

Administration	Engineers	Asst. Engineers	Supervisors and employees
Central level	3	2	-
Regional level	1	-	50
Total Forestry	4	2	50

4. Other

Rural Engineer Corps	3	-	4
Statistics	..	1	1
Total Other	3	1	5
Gen al total	39	47	245

An analysis of this table shows the following :

i. The heavy concentration of upper level managers in the central services

ii. The scarcity of staff in training, research and experimentation institutions.

iii. The disequilibrium in distribution of upper level staff between administrative services and supervized organizations.

Source : FAO report (updated)

1.3. Situation of Mechanized Agriculture

The problem of agricultural mechanization in the irrigated perimeters is seen on two different, although complemetary levels :

a) on the level of improvement of the small and large perimeters
b) on the level of the actual farming of these perimeters.

1.3.1. Improvement of Small and Large Perimeters

Experience has shown that improvement costs can be very high. They range from 100,000 to 200,000 UM for small village perimeters up to 500,000 and more for large perimeters. These high costs are caused by :

- lack of trained labor and supervision,
- lack of and high cost of equipment and spare parts,
- the defective condition of communication links.

These factors cause the rare contractors who bid to ask for higher and higher prices.

In order to remedy this situation, the SONADER and the OMVS have conducted studies on the cost of hydro-agricultural improvements.[1)2)]

These studies concluded that improvement costs can only be lowered by the creation of State-controlled mechanized work units :

-The units are to be mechanized in order to correctly improve perimeters of viable surface areas within a reasonable period of time.

-These units are to be State-controlled in order to permit inexpensive improvements.

According to these studies, it is possible to save from 20 to 40 % as compared to the same work performed by contractors.

Such units would permit better dissemination of technology and follow-up maintenance, while avoiding foreign currency costs.

More emphasis must be placed on training machine operators and mechanics.

The creation of several small mechanized units could be partially financed by improvement credits. Management of the units could be provided by a specialized service of SONADER. These small units would serve as a basis for the progressive creation of large units, such as that currently working at Boghé.

1.3.2. Farming

Given the availability of abundant and inexpensive labor and the diffi-

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1) SONADER : Coût des aménagements hydro-agricoles, 1978

2) Dachraoui, OMVS/FAO : Mécanisation des aménagements, December 1978.

culty in providing rational maintenance of equipment, mechanized farming is not very developed in Mauritania.

However, interest in intensifying mechanized agriculture is increasing, thanks to Irakian aid, which has placed at the disposal of the Mauritanian government a large quantity of equipped tractors.

Private farmers especially are beginning to employ mechanization.

Table 7 : Present Situation of Mechanization of Small Irrigated Village Perimeters

	Surface Area (ha)	Number of Tractors	Number of Months Treshers	Number of Hullers	Number of Motor-Pumps
Small Village Perimeters Supervized by SONADER	1,338.25	1	-	-	55
Small Village Perimeters Supervized by different organizations or unsupervised	578	8	-	6	36
Private Perimeters	589	22	2	8	33
Total	2,505.25	31	2	14	124

The motor-pump equipment of the 41 new small irrigated perimeters is not included in this table.

The above table shows that of a total of 31 tractors for small irrigated perimeters, 22 are owned by private farmers, although the total surface area they farm is hardly more than 580 hectares, or 23 % of the total surface area exploited (2.5 hectares).

Certain persons feel that given the present state of Mauritanian agriculture, mechanization should not be undertaken, due to the multiple and complex problems involved :

- the existing machinery is insufficient and in poor condition,
- the lack of agricultural machine specialists; insufficient training,
- the lack of credit financing for purchase and operation of agricultural machines; the farmers' difficulty in repaying loans,
- the fairly high price of equipment and spare parts,
- the perimeters are often parcelled in such a manner as to make mechanization unprofitable,
- the lack of a road network in order to move agricultural machines,
- the lack of means for maintenance and repair of agricultural machines,
- the lack of experimentation and application research in the area of agricultural mechanization.

In order to solve these agricultural mechanization problems, the OMVS, in collaboration with the SONADER and the FAO, are creating autonomous agricultural production units (CUMA = Coopérative d'Utilisation de Matériel Agricole). When similar units were tested in Senegal, the results were fairly satisfactory.

While over-mechanization is indeed very expensive, mechanization is indispensable for certain operations. Plowing, threshing and even harvesting require so much effort that in the long run, labor will become more ex-

pensive than machinery. In addition, as mechanization reduces fatigue, it has the advantage of interesting young people in agriculture. These young people leave the contryside in search of less tiring employment in the towns. The current trend to progressively introduce mechanized agriculture is to be encouraged, in that it may help decrease rural exodus.

In addition :

1. The hydro-agricultural improvements and the construction of the two dams cost a great deal. Amortization will depend on double or even triple crops. With double rice crops, harvesting and threshing will occur right before soil preparation and transplanting for the following season, and there will not be sufficient time and labor to perform all these tasks without mechanization.

2. In the perspective of integration of livestock with intensive irrigation, harvesting and processing must be performed in a short period of time, which only mechanization will allow.

3. Experiments conducted by the FAO on the left bank of the Senegal River showed that the real investments for mechanized agriculture are on the order of 40 000 UM/hectare. Such an investment, repayable over a four to five year period, represents about 12 % of the harvest, an insignificant percent as compared to the benefits of mechanization. (See table p. 50 and following pages).

4. Walo soils, which make up most of the rice-cultivable lands, are very difficult to plow using animal traction.

However, mechanization cannot be profitable unless the plots are of relatively large surface area.

A survey of the number of large farms (Etude CNEEMA, France) determined multiplying coefficients modifying the lenght of time required for various mechanized operations, according to the dimensions of the plot.

Table 8 : Time Required for Mechanized Operations According to Size of Plot

Mechanized Operation	Plot Surface Area		
	1 to 2 ha	2 to 5 ha	10 ha
Disc Plowing	X 4,5	2	X 1
Offset Pulverizing	X 5,5	X 1,5	X 1
Plowing up the stubble	X11	X 2	X 1
Line sowing	X 2	X 1,5	X 1
Spreading fertilizer	X 2	X 1,2	X 1
Harvest (combine harvester)	X 4	X 1,6	X 1
Mowing (bale cutter)	X 5,5	X 2	X 1
Collecting (press-collector)	X 5,5	X 1,4	X 1
Picking press halter			

Source : Développement de la mécanisation rurale dans la vallée du fleuve Sénégal, O.M.V.S., 1979.

The work time increases considerably with the decrease in plot size.

This is one of the favorable arguments for reorganization of the small village perimeters so that each farmer has a plot of at least one hectare and to encourage collective farming.

In summary, agricultural mechanization is necessary for both technical and economic reasons.

We do not agree with those who fear that mechanization will increase unemployment. Of course, all farming procedures will not be mechanized. However, plowing and threshing are so laborious and slow that mechanization becomes an absolute necessity.

1.4. Constraints Due to Land Tenure

The social aspects of land tenure problems are treated in more detail in the Sociological Unit Study (see Study B 5).

In this chapter, we will briefly examine land tenure problems in relation to agro-economics.

The land tenure situation is quite different for fondé and walo lands.

1. Fondé : The fondé are highlands, irregularly flooded and thus irregularly cultivated. Appropriation rights exist, but are less complex and less binding than the land rights for walo lands. These lands were selected for the small village irrigated perimeters because of their proximity to the river and their height (in normal years fondé lands are not flooded). They have been selected for the installation of PPVI. Thanks to this situation it can be stated that no serious problem has arisen either when they were created or when the parcels were distributed.

2. Walo : These lands are lower, more regularly flooded, and thus, more often cultivated. They are the more prized lands, and therefore, there exists a very precise and rather complex system of appropriation rights: rights of the landowner, crop rights, entry rights, inheritance rights, rights of usage ... all sanctioned by the payment of different fees.

When large perimeters are to be improved, land problems must be solved;

otherwise, the success of any improvement program is seriously impeded :

- The cost of improvement cannot be made profitable unless the farmers are assured of their inalienable right to the land. At present, these farmers are often required to pay fees simul[illegible]usly to the landowner and to the SONADER for improvement costs.

- Lender[illegible] are more and more reluctant to finance projects where land problems may prevent positive results.

It should be noted that, for fondé lands, many farmers are becoming aware of the substantial profits possible with irrigation. The interest in these new techniques is demonstrated by the many private investors currently improving irrigated perimeters in the zone upstream from Rosso. The spread of these new techniques will ensure rapid development in this area if land problems can be solved. Otherwise, a state of "frozen land ownership" will occur.

The future of large improvements in Mauritania (and to some extent, of small improvements, also) is directly linked to the promulgation of land legislation adapted to the socio-economic conditions. This legislation must be applied by the State. Whatever the orientation selected (pure and simple State appropriation of the land, indemnization of farmers, reorganization and reduction of "ceiling" surface areas, etc.), the application of these laws will help avoid the difficulties caused by major landowners.

1.5. Communication Links

The natural conditions in Mauritania and its vast surface area have, until now, made it difficult to create a road network linking the different regions.

The network in 1980 is as follows (see following map)

Table 9 : Road Network

Category of Roads	Km.	Percent
Paved Roads	1,530	21.5
Paved Urban Roads	85	1.2
Improved Earth Roads (unpaved)	500	7.1
Tracks	4,975	70.1
Total	7,090	100

Source : BCEOM, updated study

The Paved Network is composed of two main axes :

- Rosso - Nouakchott - Akjoujt, built between 1969 and 1971
- Nouakchott - Boutilimit - Aleg - Kiffa, built between 1975 and 1978. This is the first half of the "Road of Hope", which should be constructed to Nema before 1982.

The Improved Earth Roads are

- Kaedi - M'Bout - Kiffa (350 km), built in 1964-66. Its present condition is deplorable.

- Akjoujt - Atar (195 km), infrequently maintained.

All other existing road links between towns are earth tracks, in varying conditions.

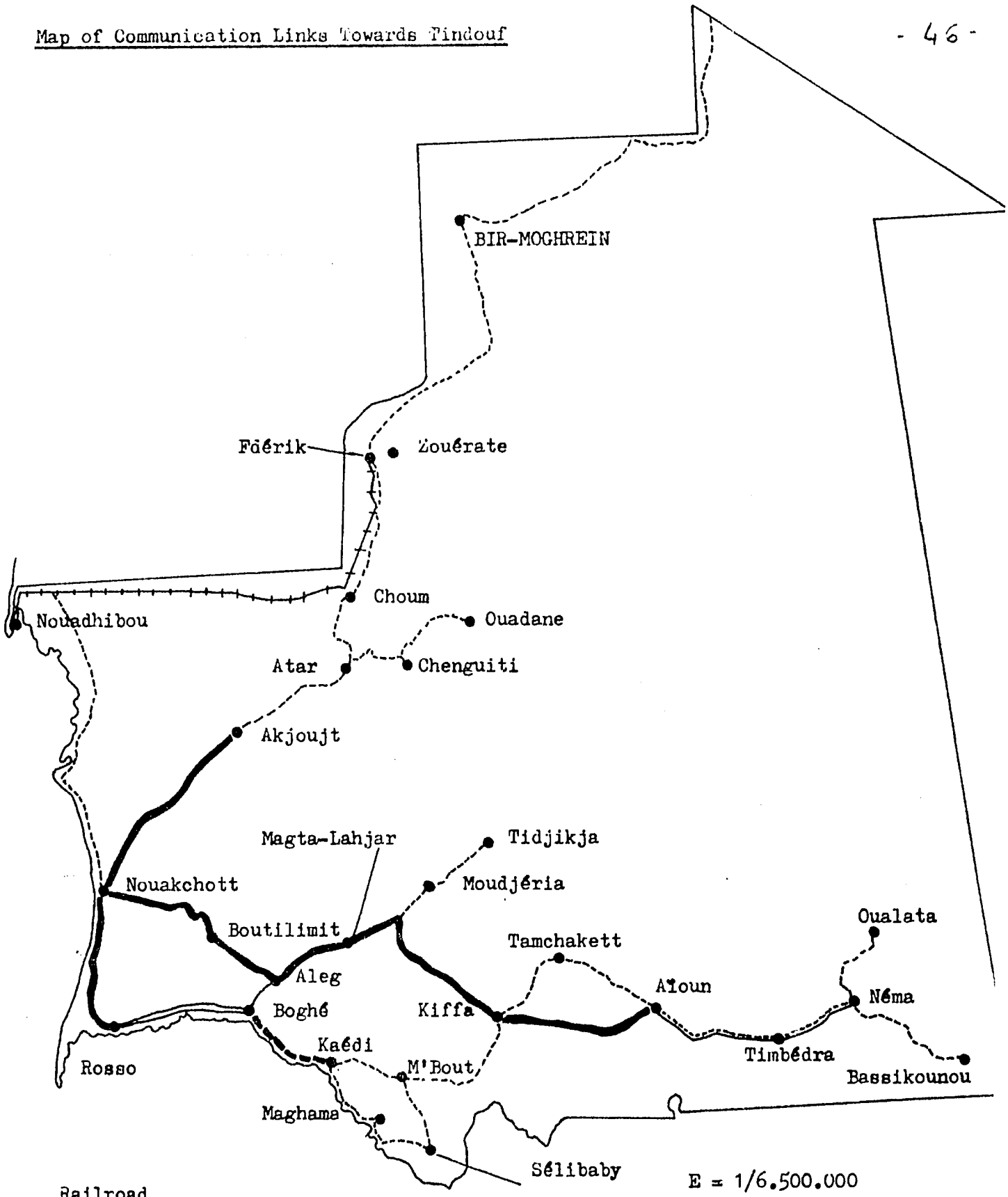
Unfortunately, the tracks linking the zones of highest agricultural potential are those that present the most problems. For instance, the track along the Nouakchott-Nouadhibou coastline, which could induce rapid development of artisanal fishing, is often impracticable. The track along the Senegal River, which serves the region expected to become the "breadbasket" of Mauritania, is impracticable during the entire rainy season (more than six months per year).

During recent years, major hydro-agricultural improvements have been undertaken along the Senegal River. The objective is to attain food self-sufficiency around the year 2 000. However, the lack of a permanent road is a serious handicap to future agricultural development. At present, it tends to increase the urbanization of Nouakchott and create additional unemployment.

The construction of a permanent road in this region would :

- greatly decrease the perimeter improvement costs by bettering equipment transport conditions,
- reduce transport costs of supplies and produce,
- facilitate population mobility and thus increase dissemination of technical progress,
- permit evacuation of agricultural produce at a reasonable cost and without delays, thereby eliminating spoilage,
- permit private investors to initiate commercial or even industrial agricultural activities,
- facilitate an agricultural credit policy, in that farmers will be

Map of Communication Links Towards Tindouf



Railroad

Paved Road

Road Under Study

Dryweather Track

Prepared Paved Road

Improved Tracks (under construction)

Towns

better able to repay loans if they can easily evacuate their produce.

In view of this situation, several road studies have been performed, concerning :

- the Rosso-Boghé road,
- a highway maintenance program,
- reinforcement of roads in Sahelian zones,
- the Aleg-Boghé road, financed by Germany and the EEC whose construction should be started in September 1980.

Other studies concerning the improvement of navigability on the Senegal River have been undertaken.

In fact, the Mauritanian government has a good portfolio of serious studies. At present, the bottleneck is rather in financing implementation of these projects.

The slowness of implementation of agricultural improvements causes road construction costs to appear high. However, one of the causes of this slow development is the lack of roads. This is, in fact, one of the vicious circles of underdevelopment, which must be solved. Given the real potential of the river region, the eventual feasibility of roads in this area is assured.

It should be noted that, at present, river transport is relatively minor. Once the Manantali dam is finished and a year-round minimum water height can be assured, conditions will favorize navigational development. However, this type of transport will not be a complete substitute for road transport.

Thus, the problem of communications and transport is a serious block to development.

To ignore this problem and to think only in terms of hydro-agricultural projects is to "put the cart before the horse". Transport problems may not appear too serious when only rice or other non-perishable crops are produced. However, when Mauritania begins to change from a subsistence economy to a market economy, the transport factor becomes predominant.

For the economy of the nation, the communication links are like the arteries and veins of the human body.

1.6. Agricultural Credit

The present situation in Mauritania is rather paradoxical : although the major part of the population depends exclusively upon agriculture for its livelihood, there is no specialized financial institution for agricultural credit. Several attempts have been made in the past to create such an organization. The two largest experiments were: the Hodhs region experiment in 1965 and the on-going SONADER project.

1.6.1. Hodhs Region Experiment

This agricultural credit operation lasted from 1965 to 1970 in the Hodhs region, located in the southeast of Mauritania. The operation was initiated by rural communities, which distributed 600 plows in 1965; it was continued by the Mauritanian Development Bank (BMD), which, in 1966, distributed 800 oxen, 670 plows and a demonstration sower. While this experiment does not directly relate to irrigated agriculture, the results are interesting to observe, as they permit a better understanding of the constraints to implementation of an agricultural credit system. These constraints are essentially the same for dryland cultivation, livestock raising, fishing and irrigated cultivation. A report

by the BPDA summarized the results of this operation[1)]

- On the technical level, a slight improvement of yields was noted, favorized by rainy years, a major increase in the surface areas cultivated and increased production, but to the detriment of techniques (late sowing, poor maintenance of fields, wear and poor maintenance of equipment).

- On the management level : initially, the rural communes were not included in management; later, they were required to handle the problem of repayment "in kind", but without having the means to resolve it. The Agricultural Service found that its tasks rapidly extended beyond the simple popularization of new farming techniques, although funds and means from the government were parcimoniously allocated.

  The stocks of millet resulting from the farmers' loan repayments were immobilized for lack of a market. The roads were so defective that transport to Nouakchott or other towns was not possible.

- On the financial level, it was noted that :

  a) The rural communes were required to pay for the work demanded of the farmers, as well as to reimburse those debts which were partially or totally unpaid. They were also required to market the millet received as repayment "in kind".

  b) The repayment annuities were too expensive for the farmers, as the millet did not sell well (due to auto-consumption, competition from Malian millet, etc.) and thus the equipment distributed could not be made profitable.

  c) On the economic level, while adequate cereal supplies were assured for the sedentary farmers, the price of millet sharply decreased, making it difficult to make any profit from sale of surplus production.

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1) "Culture vivrière dans la zone pluviale du Sud-Est mauritanienne", BPDA, 1975.

d) At the level of the farmers, the choice of equipment to be distributed did not correspond to the very limited repayment capacity of the farmers. In spite of a net increase of the surface areas cultivated, this was not sufficient to cover fixed equipment costs and cereal coverage, as millet cultivation is marginal and thus, prices have a tendency to collapse.

1.6.2. The SONADER Credit Activities

In order to conduct its extension service and improvement activities, the SONADER created the "Credit and Marketing Service", to assist the farmers of small village perimeters and of the Gorgol perimeter by extending credit in kind, repayable annually. However, here again, the SONADER encountered difficulties in collecting repayment. Among the obstacles to the success of this operation, the following can be noted :

1. The current rice-pricing policy does not allow the farmers to earn enough profit from their harvests to satisfy their own needs and repay their debts at the same time.

2. This difficulty is compounded by the lack of any clear land laws, as in the case of the Gorgol perimeter. This causes confusion among the farmers and seriously hinders SONADER's work.

3. The small surface areas allocated to each farmer increase these difficulties, especially as some farmers (such as at Gorgol) must pay half of their harvest to the landowner.

4. Those farmers who cultivate more profitable crops (tomatoes, vegetables, etc.) are not always able to market their produce due to poor communication links and transport.

All these reasons account for the fact that the small village perimeters have not paid their debts. Table 12 presents the financial position of these perimeters for 1979.

Table 10 : Financial Situation of Small Village Perimeters

Perimeter		Status before campaign	Fee - Winter 1979	Production Factor	Total Yield	Payment	Percent	Status as of 12/31/1979
1 Guidakar	FAC	0	25.000	109.868	134.868	133.028	99 %	- 1.840
2 Jeder Mohgen	FAC	0	35.000	48.461	83.461	81.669	98 %	- 1.792
3 Tekane	FED	66.468	60.000	36.741	163.209	0	0 %	- 163.209
4 Salde	FAC	4.738	35.000	43.492	83.230	67.400	41 %	- 15.830
5 Dar Salam I	FAC	0	25.000	31.866	56.866	40.820	72 %	- 16.046
6 Dar Salam II	FAC	10.858	25.000	56.060	91.918	52.722	57 %	- 39.196
7 Bouldem	FAC	27.833	25.000	8.082	60.918	60.915	100 %	0
8 Diatar 1	FAC	+ 17.240	35.000	11.290	28.960	28.160	97 %	- 800
9 Diatar 2	FAC	0	35.000	53.683	88.683	79.060	89 %	- 9.623
10 Dar el Barka	FED	- 134.459	84.620	194.636	413.715	90.900	22 %	- 322.815
11 Leboudou	FED	- 441.384	137.132	188.190	766.706	211.392	27 %	- 555.314
12 Beilane	FAC	- 90.636	0	86.634	177.270	106.675	60 %	- 70.595
13 Olo Ologo	FED	- 284.770	125.580	114.311	524.661	141.365	27 %	- 383.296
14 Ngorel Guidal	FED	- 42.983	166.296	176.833	386.112	121.321	31 %	- 264.791
15 N'Diorol	FAC	- 32.278	45.400	31.399	209.077	115.038	55 %	- 94.039
16 Dakhao	FED	- 213.354	109.064	82.346	404.764	210.418	52 %	- 194.346
17 Canky	FAC	0	58.250	19.100	77.350	57.350	74 %	- 20.000
18 Wothie	FAC	0	49.500	37.155	86.655	61.175	70 %	- 25.480
19 Seno Boussobe	FAC	+ 10.492	25.000	38.631	53.139	30.508	57 %	- 22.631
20 Dioube	FAC	- 31.028	56.600	125.650	213.278	104.028	49 %	- 109.250

Table 10 : Cont'd

Perimeter		Status before Campaign	Fee - Winter 1979	Production Factor	Total Yield	Payment	Percent	Status as of 12/31/1979
21 Bababe	FAC	0	122.850	91.780	214.630	136.459	64 %	- 78.171
22 Sori Male	FED	- 306.621	0	0	306.621	69.900	23 %	- 236.721
23 Winding	FED	- 101.090	0	0	101.090	0	0 %	- 101.090
24 Sinthiou	FED	- 83.734	27.840	188.163	299.737	0	0 %	- 299.737
25 Rindiao	FED	- 202.962	106.720	384.204	693.886	20.000	3 %	- 673.886
26 Diovol	FED	- 235.928	97.440	210.569	543.9 7	0	0 %	- 543.937
27 Cive	FED	- 107.492	0	0	107.492	10.000	9 %	- 97.492
28 Garly	FAC	0	78.000	91.033	169.033	116.233	69 %	- 52.800
29 Bedinki et	FED	- 34.728	143.240	112.529	290.497	0	0 %	- 290.497
30 Waly	FED	- 50.242	31.580	167.460	349.282	0	0 %	- 349.282
31 Toulele	FAC	+ 10.000	61.050	150.411	107.489	165.430	82 %	- 36.031
32 Sagne	FAC	+ 16.661	35.000	89.150	57.489	38.000	82 %	- 9.489

This debt is contested by the cooperative (ex FED-project)

Amortization for the 1978/79 off-season (and 1978 rainy season) are included in the 1979 fee.

The fee for the 1980 off-season is included in 1979 fee.

It is obvious that if the SONADER, in spite of its considerable logisitc means (extension services, permanent contact with farmers, relative mastery of techniques) was not able to assure total coverage of its loans, a specialized agricultural credit bank would have encountered even more difficulties.

Therefore, the proposals to create a national rural development fund associated with the BMDC or a regional development fund (including a real-estate bureau), will not be successful nor allow development of agriculture in Mauritania unless the above-cited difficulties are resolved. The success of such financial institutions is directly linked to finding solutions to the constraints of land problems, communication problems and problems of improvement strategies. If these constraints continue to exist, it is probable that the current situation will continue, i.e. any credit operation will be subject to the same difficulties as those experienced in the Hodh region 15 years ago and those seen at present by the SONADER.

The lack of an agricultural credit policy is a serious handicap for agricultural development; however, the creation of an agricultural credit institution must be accompanied by other measures. In the Second Phase of this study, these measures will be discussed. The following will be defined :.

1) The agricultural credit needs of both existing and projected irrigated perimeters
2) The agricultural credit needs of rainfed and oasis cultivation
3) Finally, the credit needs of livestock raising and fresh and salt water artisanal fishing.

The calculation of these credit needs, when compared to existing and future development potential, will help define the means to implement

the financial plan.

1.7. Crops and Production Costs

The Senegal River region is the focal point of the government's irrigated cultivation policy.

Exploitation of these perimeters will not be limited to cereals and vegetables; it will also permit rational integration of cattle and sheep raising with irrigated agriculture.

At present, the main crop in this zone is rice. It is also possible to produce wheat, corn, sorghum, niébé, sugar cane, cotton, tomatoes, cabbage, melons, onions, peppers and fruits such as bananas, mangos, guavas, citrus fruits, etc. Some of these crops will open perspectives for the creation of agricultural industries (processing, storage and packaging) : rice-processing factories, flour mills, sugar refinind, cotton gins, weaving, livestock feed plants, fabrication of tomato paste and fruit juice, canning.

1.7.1. Crops : Rice

Agronomic research in the Kaédi region (Wandama and Rinjao stations) determined three main rice variations adapted to the zone :

Variety	Cycle	Yield (tons)
Very Quick Growing Varieties		
IR 747-B 2 - 6	90	5
Tchung Fung n° 1	85-87	5.5

Variety	Cycle	Yield (tons)
Quick Growing Varieties		
Native Trichung 1	92-115	10.8
Hong Sung	85-110	10.7
TTW	95-100	-
IKP	95	10
Average Cycle Varieties		
IR 28	125-140	10 - 8
IR 20	125-140	10 - 8
Jaya	125-140	7 - 8

Theoretically, it is possible to obtain three harvests a year on the same land : a rainy season rice crop, wheat or sorghum in the cold season, and another off-season rice crop. However, this is not yet possible in the lower valley because of the rise of the salt tongue during the low-water period.

Wheat

The best adapted variety is MEXIPAX; yields are 3 to 3.5 tons/hectare; off-season cultivation is possible.

Tomato

Tomatoes are grown mainly by private farmers in the Rosso region, for sale as fresh produce on the Nouakchott market. The tomatoes are sown in seed beds from September through November and seedlings are transplanted by hand, after 25 days. Transplanting is staggered in order to have weekly

harvests from December through April. The ROMA variety usually yields 25 tons/hectare: research has shown that up to 60 tons/hectare can be attained. Tomatoes can only be cultivated on the same land once every four years if nematode infestation is to be avoided.

Potato :

With off-season irrigated cultivation, using the BINTJE variety, 20 to 25 tons/hectare are attained. The main problem seems to be in obtaining seed potatoes during the proper season, as the harvest is not yet ready in Europe.

Bananas :

The most widespread variety is M'POYO; yields were 20 tons, 15 tons and 10 tons for the first, second and third years respectively (at the M'Layga farm).

Fodder Crops :

As of yet, fodder crops are not well developed in this zone. Research has demonstrated that good results can be obtained with :

- elephant grass
- forage sorghum
- brachiari, which can withstand temporary flooding and a certain degree of salinity
- niébé (Vigna Sinensis)
- alfalfa

Even though fodder crops are well adapted to hollaldé and false hollaldé lands the immediate perspective for development is limited, as the farmers will give priority to cereal crops. However, increased cereal production

will create by-products (rice straw, stalks of other cereals) which will already improve the animal feed situation in Mauritania.

Rice straw is a good, high-energy food. Its forage value is about 0.4 UF. However, it must be supplemented with nitrogen. The main problem with cereal by-products is transport, given the lack of time between 2 cycles and the quantities to be evacuated (another favorable argument for mechanization).

1.7.2. Production Costs (see Tables 14,15,16,17 hereafter)

Production costs are usually high. This is due to :

- the cost of fuel and motor-pumps
- the cost of improvements
- the cost of in-puts.

a) Rice producers are the most affected by the high production costs, as the market price of rice is government-controlled and hardly covers production expenses. Using the tables given hereafter, we have calculated the cost price of a ton of rice according to several different hypotheses. The following results were obtained :

Table 11 : Cost Price of a Ton of Rice (in Ouguiyas)

Yield Hypotheses per Hectare Rice	Traditional Farming		Modern Farming	
	Single Crop	double Crop	Single Crop	double Crop
3 tons/hectare	14	11.3	14	12
4 tons/hectare	10.5	8.4	10.5	9
5 tons/hectare	8.4	6.7	8.4	7.2
6 tons/hectare	7	6.7	7	7.2

This table shows that in order to break even (no profit), yields must be at least 4 tons/hectare. With a yield of 5 tons and double crops, a margin of 3 UM per kilogram of rice is possible.

In order to make rice cultivation profitable for the farmer, one of the following two measures must be taken :

1) Raise the market price of a kilogram of rice. This may prove to be rather difficult, given the social consequences it could create.
2) Encourage the farmers to practice double cropping, to modernize production systems and to integrate livestock, in order to use by-products.

Allocating larger plots will encourage this intensification. However, for the low valley perimeters, double crops will not be possible (due to the rise of the salt tongue) until the Diama dam is finished.

b) There are few fruit and vegetable producers at the present time, but market prices are very high (about 10 times the cost price). Nevertheless, the quantities produced are still insufficient. This paradox can be explained by the total lack of marketing policy.

Table 12 : Cultivation of One Hectare of Rice (Single Crop)

Operation	Traditional Farming		Mechanized Farming	
	Quantity	Cost	Quantity	Cost
Preparation of land	40 days	6.000 UM	8h x 400 UM	3.200 UM
Sowing (selected seeds)	150 kg x 30 UM	4.500 UM	1[illegible] kg x 30	4.500 UM
Weeding	20 days	2.400 UM	20 days	2.400 UM
Irrigation	20 days	2.400 UM	20 days	2.400 UM
Fertilizer	200 kg	3.600 UM	200 kg	3.600 UM
Harvest plus transport and thrashing	34 days	4.080 UM	6 h x 1.200	7.200 UM
Amortization motor-pump, spare parts and repairs		4.000 UM		4.000 UM
Diesel Fuel		1.280 UM		1.280 UM
Amortization improvements to land		10.000 UM		10.000 UM
Other		3.826 UM		3.858 UM
Total		42.086 UM		42.438 UM

Average Yield : 5 tons/hectare

Average production cost per kg : traditional farming = 8.4 UM
modern farming = 8.4 UM

Note : These calculations were based on data from M[illegible]ga farm (Tekane) for modern farming and Dar El Barka for traditional farming.

Table 13 : Cultivation of One Hectare Rice (Double Crop)

Operation	Traditional Farming		Modern Farming	
	Quantity	Cost	Quantity	Cost
Preparation of land	60 days	7.200 UM	12 h	4.800 UM
Sowing	300 kg x 30 UM	9.000 UM	300 kg x 30 UM	9.000 UM
Weeding	40 days	4.800 UM	40 days	4.800 UM
Irrigation	40 days	4.800 UM	40 days	4.800 UM
Fertilizer	400 kg	7.200 UM	400 kg	7.200 UM
Harvest, transport and threshing	68 days	8.160 UM	12h x 1.200	14.400 UM
Amortization motor-pump, spare parts, and repairs		8.000 UM		8.000 UM
Diesel Fuel		2.560 UM		2.560 UM
Amortization improvements to land		10.000 UM		10.000 UM
Other		6.172 UM		6.556 UM
Total		67.892 UM		72.116 UM

Aver e yield : 9 tons - for double crop

Average production cost/kg :

- Traditional farming (Dar El Barka) = 7.5 UM
- Modern farming (Mlaïga) = 8 UM

Table 14 : Cultivation of One Hectare of Tomatoes

Operation	Quantity	Cost
Preparation of land		
- Plowing and replowing	6 h	
- Pulverization	3 h	6.000 UM
- Mounding	6 h	
Maintenance of mounds	10 days of labor	1.200 UM
Purchase of plants and planting	15 days	2.000 UM
Irrigation	23 days	2.760 UM
Weeding	40 days	4.800 UM
Fertilizer	300 kg	5.400 UM
Chemical treatment		1.500 UM
Harvest and transport (10% of production)		15.000 UM
Amortization of motor-pump, spare parts and repairs		4.000 UM
Diesel Fuel		1.280 UM
Amortization of land improvement		10.000 UM
Other (10 %)		5.394 UM
Total		59.334 UM

Mlaïga Farm (Tekane)

Average Yield : 25 tons/hectare

Average Production Price/kg = 2.3 UM

Table 15 : Cultivation of One Hectare of Bananas

Operation	Quantity	Cost Year 1	Cost Year 2	Cost Year 3
Preparation of land :				
- Deep plowing	1.200 UM x 8 h	9.600 UM		
- Pulverization	400 UM x 3 h	1.200 UM		
- Furrowing	400 UM x 6 h	2.400 UM		
- Manual maintenance furrows	10 days of labor	1.200 UM		
Pulling up plants	46 days	4.800 UM		
Planting	20 days	2.400 YM		
Weeding	40 days	6.000 UM	6.000 UM	6.000 UM
Irrigation	46 days	6.900 UM	6.900 UM	6.900 UM
Fertilizer	1.000 kg/ year	19.440 UM	19.440 UM	19.440 UM
Chemical treatment	100 kg/year	17.000 UM	17.000 UM	17.000 UM
Harvest, transport	18 harvests/ year with 3 workers and for 54 days	6.480 UM	6.480 UM	6.480 UM
Amortization of motor-pumps, spare parts and repairs		9.000 UM	9.000 UM	9.000 UM
Diesel Fuel		2.560 UM	2.560 UM	2.560 UM
Land improvements		10.000 UM	10.000 UM	10.000 UM
Other (10 %)		9.898 UM	7.738 UM	7.738 UM
Total		108.878 UM	85.118 UM	85.118 UM

Yield over three years : Year 1 = 20 tons
Year 2 = 15 tons
Year 3 = 10 tons
15 tons average per cycle and per hectare

Annual average cost/hectare = 93,038 UM
Average production cost per kg = 6 UM
Wholesale market price per kg 30 UM
Margin = 24 UM

Note : These calculations are based on data from the Mlaïga Farm (Tekane)

1.8. Marketing, Storage and Processing

1.8.1. Marketing and Storage

An agricultural development program requires a rational marketing system if it is to encourage farmers to increase production.

1) So far, there are few problems with the major crop, rice, which is either consumed by the growers or purchased directly from the farmer. In addition, the SONADER has created its own marketing system and has purchased rice hullers.

However, in the future, with the projected increase in production and the fact that SONADER will be more concerned with technical problems, improvements and popularization, the OMC will be called upon to provide marketing and storage systems for rice.

2) For vegetables and fruits, there exists no marketing structure at the present time. Private farmers try to sell their produce in the large consumer centers. They are not always able to find a market due to competition from Senegalese produce or a lack of programming. In addition, the demand for fruits and vegetables is relatively small; Mauritanian diets include few vegetables and prices are so high as to limit vegetables and fruit to upper class consumers.

A survey of the Nouakchott market showed the following market prices :

Table 16 : Market Price Per Kg of Main Vegetables

Month	Tomatoes		Potatoes		Onions		Carrots	
	Produce Price	Market Price	Produce Price	Market Price	Produce Price	Market Price	Produce Price	Market Price
January	50 UM	60 UM	30 UM	35 UM	30 UM	40 UM	50 UM	55 UM
February	30 UM	50 UM	30 UM	35 UM	30 UM	40 UM	50 UM	55 UM
March	25 UM	35 UM	30 UM	35 UM	30 UM	40 UM	50 UM	55 UM
April	20 UM	30 UM	30 UM	35 UM	30 UM	40 UM	20 UM	35 UM
May	20 UM	30 UM	30 UM	40 UM	30 UM	40 UM	20 UM	35 UM
June	25 UM	40 UM	35 UM	45 UM	35 UM	45 UM	20 UM	40 UM
July	45 UM	60 UM	50 UM	80 UM	35 UM	45 UM	20 UM	40 UM
August	50 UM	70 UM	30 UM	40 UM	35 UM	45 UM	40 UM	60 UM
September	50 UM	70 UM	30 UM	40 UM	30 UM	40 UM	40 UM	55 UM
October	50 UM	70 UM	30 UM	35 UM	30 UM	40 UM	40 UM	60 UM
November	50 UM	70 UM	30 UM	35 UM	30 UM	40 UM	40 UM	60 UM
December	50 UM	60 UM	30 UM	35 UM	30 UM	40 UM	40 UM	60 UM

Source : Survey of Nouakchott Market

Table 17 : Other Products

Product	Retail	Wholesale
"Big" Millet	50 UM	30 UM
Sorghum	45 UM	25 UM
Mettri ("little" millet)	23 UM	17 UM
Corn	35 UM	25 UM
Niébé	30 UM	20 UM
Watermelon	20 UM	18 UM

By comparing these figures with real production costs, we see that for fruits and vegetables, there is a wide difference between producer price and market price (from 1 to 10 times greater). This is due to several factors : scarcity of these products, transport difficulties, etc. This sector would benefit from the creation of an interprofessional organization grouping vegetable and fruit growers. This organization could study markets, both interior and exterior, sell seeds, and program the surface area to be planted each year, in advance. The creation of such a group will be examined in the Second Phase Study. This type of organization might also serve for the collection and packaging of crops such as potatoes.

1.8.2. Processing

With the exception of rice milling, at present there are no other processing facilities in Mauritania. Present production is too limited to justify the creation of agro-industrial facilities. However, once larger surface areas are irrigated, it seems possible to create processing

facilities for tomatoe paste, livestock feed, sugar refining, etc.

Even if, in financial terms, these facilities hava a low rate of return, they will nevertheless be justified by their induction factor for agricultural development : decreasing foreign currency costs, creation of jobs, improvement of products, improvement of quality of life, and structuring of the agricultural economy.

In summary, it appears that in the case of marketing rice, the essential problem is to review market prices. On the other hand, for fruits and vegetables, there is as of yet no market organization or processing infrastructure.

Chapter 2 : SITUATION OF IRRIGATED CROPS IN THE INTERIOR

2.1. Introduction

Outside the Senegal River region and the rainfed cultivation zone, the two major agricultural activities are : livestock raising and oasis cultivation.

1) Livestock raising is a major activity in Mauritania. It employs more than 75 % of the active population and accounts for 16 % of the GNP (whereas agriculture represents only 4 to 5 %).

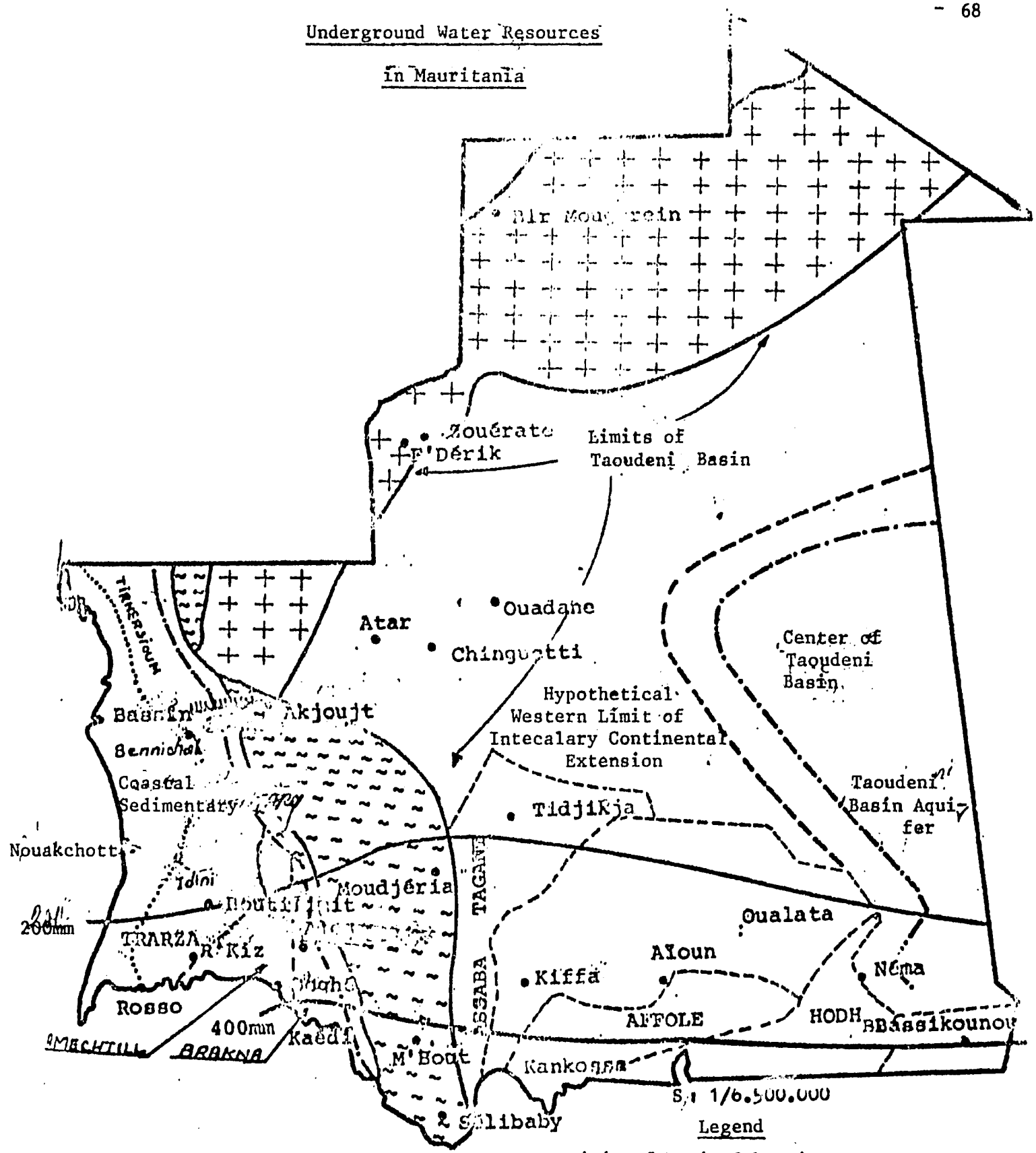
   This major resource is seriously endangered by progressive desertification. In order to safeguard livestock resources, there must be rational land use to allow regeneration of the vegetable cover, soil protection and production of irrigated fodder crops. Integration of livestock and irrigated cultivation becomes a necessity. It is nonexistant at the present time.

2) The Mauritanian oases have not attained a degree of modernization permitting them to contribute significantly to agricultural revenues. Nevertheless, the oases are important centers of activity. In addition to cultivation of dates, they produce vegetables, fruits and cereals. As elsewhere in Mauritania, the drought has decreased aquifer replenishment and seriously reduced the quantity of water available for cultivation. As of present, no major modernization projects have been undertaken in the oasis sector.

Livestock raising and oasis cultivation maintain a large population in the interior of the country. To allow these activities to decline is to exacerbate the rural exodus, with resulting socio-economic consequences. In order to maintain and reinforce these activities, a policy is required for the reconnaissance and use of water resources. Until now,

Underground Water Resources

in Mauritania



Legend

- Limit of Basin Sub-Unit
- Limit of Sedimentary Basin
- Approximate Limit of Dry Wedge
- Water Mains
- Limit of Intercalary Continental
- Mauritanides Arc
- Limit of Salt Wedge
- Cristalline Base

the agricultural development policy in Mauritania has been characterized by both regional and structural disequilibrium :

- regional disequilibrium, as most of the current or projected programs, are concentrated along the Senegal River valley.
- structural disequilibrium, in that although livestock raising is much more important as an economic activity than cultivation, has benefited from very few projects (there is only one fodder cultivation perimeter on the Mauritanian bank of the river).

Mobilization of water resources in the interior will permit the production of fodder and thus reduce the current degradation due to uncontrolled ranging. This will help decrease the vulnerability of livestock herds to adverse climatic conditions.

This chapter will briefly survey the hydraulic resources in the interior of the country.

2.2. Hydraulic Resources

The following resources will be examined

- Underground water
- Surface water

(Dams for floodland cultivation will be discussed in the "rainfed agriculture" report).

2.2.1. Underground Water

Different studies have shown that Mauritania possesses large underground aquifers. The largest aquifer zones are :

2.2.1.1. The Coastal Sedimentary Basin

The total resources of this basin are estimated at 70 billion m^3, on the basis of a thickness of 20 m and a porosity of 5 %. The amount of water currently drawn from this aquifer is about 40 000 m^3/day (or 146 million m^3/year), an insignificant quantity compared to the size of the aquifer and the present replenishment rate (estimated at 15 million m^3).

The basin extends southwards to Senegal and north as far as Nouadhibou. The different porous or impermeable layers of the basin create water-bearing rocks which contain the best aquifers in the country.

The sedimentary formations date from the Secondary (Maestrichian) and Tertiary Eras. They continue towards the west.

Water is present in most of this formation. However, there are several levels and several different aquifers due to the unequel progression of the base to the west, the existence of clayey minerals at the base of the Eocene or Continental Terminal (continental deposits at the end of the Tertiary), the variations of lateral facies, particularly at the Tertiary formation level (Eocene), which are sandy in the east and become limestone in the west. The different aquifers are :

- the Brakna aquifer
- the Amechtil aquifer
- the Trarza aquifer
- the Inchiri aquifer
- the Tirhersioum aquifer (Boulannouar)

1) The Brakna Aquifer

Located on the eastern border of the Senegalo-Mauritanian basin, this aquifer is contained in sandy Tertiary materials (coastal sands of Middle Eocene).

This is a good aquifer, attained by wells of 20 to 30 meters deep. However, towards the east, the rise of the impermeable base of the Mauritanides range causes a sterile band 20 to 30 km wide (parallel to the Mauritanides range).

2) The Amechtil Aquifer

Located to the west of the Brakna aquifer and exploited over an area of 30 to 40 km wide, it flows in dolomitic-limestone dating from the Tertiary Era (Eocen).

Wells vary from 40 to 85 meters deep. Yields, due to fissuration of the limestone, are mediocre or very low : 5 to 20 m^3/hour. Salinity is from 0.2 to 3 grams/liter.

3) The Trarza Aquifer

Located in clayey sandstone. This particularly large aquifer extends from the Senegal River valley up to Inchiri in the north.

From west to east, it extends from the Aftout Sahéli on the Atlantic Coast to the Aftout Chargui, east of Boutilimit.

Unit yields are 15 to 100 m^3/hour.

This aquifer supplies the city of Nouakchott, from 18 wells located at Idini (about 60 km south of the capital on the Boutilimit road). Some of these wells furnish 25 to 35 m^3/hour (at the hydraulic service). The city of Nouakchott alone consumes from 12 000 to 15 000 m^3/day during the hot season. Wells are from 30 to 70 meters deep. In the east, some wells are as deep as 100 m (the depth of wells increases from west to east).

2.2.1.2. The Mauritanides Arc

In the northern part of the Mauritanides Arc, yields are from 0.1 to 10 m^3/hour in sandstones, jaspers and dolomites. In the south (Guidimakha), yields are from 0.1 to 3 m^3/hour in schists and volcanic rocks. In the Aftout between Sélibaby and M'Bout (in Anticambrian schists) yields vary from 0.1 to 0.5 m^3/hour.

In the southern zone, the Mauritanides Arc contains major faults: the water is usually of good chemical quality (Akjoujt, Maghta-Lahjar, M'Bout). This is a narrow folded range of indeterminate age, extending from the coastal sedimentary basin in the west to the Taoudeni or cristalline base in the east.

There are three different types of aquifers, according to the lithological formations :

1) Aquifers of volcanic-sedimentary formation (Cambro-Ordovician). These aquifers are seldom exploited and can be contained in the same formation as primary aquifers. They are usually localized and fragmented. The best aquifer of this sort was found by a project in the Amnekar zone; it flows in very fragmented limestone and sandstone. Yields are 50 to 100 m^3/hour and the water is of good chemical quality. These aquifers are also tapped by a few wells in the Idjibitene and

the Tamkarkart.

2) Aquifers in the green schists and volcanic rocks of the Sélibaby series. They are essentially exploited in zones of fracture, diaclasis or alteration of schists. Yields can be high (up to 50 m^3/hour), but the water is rarely of good quality. These aquifers are found in the Guidimakha, Agan, the Akjoujt region and the Amnékar region.

3) Aquifers of chloritoschists and quartzites of the M'Bout-Bakel series : a more or less dense network of fractures exploited by a relatively large number of wells. Yields are generally low (less than 5 m^3/hour), but the water is fresh. They are particularly found in the Aftout and the Inchiri.

2.2.1.3. Southeastern Mauritania

These are regularly replenished aquifers located to the south of the 200 mm isohyetal line. They can be found in the many wind-borne sand zones to the south of this isohyetal line, especially in the Aoueker, the Hodh, the Affolé, etc.

Yields are variable, from a minimum of 0.1 m^3/hour to 10 m^3/hour. These shallow aquifers exist when rainfall volume permits and where an impermeable subbase prohibits deeper infiltration.

In the case of the Assaba, many aquifers are found at the foot of the cliffs bordering this massive. They probably result from direct rain-water infiltration in the diaclases of the sandstone plateau.

The extension of these aquifers is limited by major fractures and folds which have fragmented the rocks, particularly in the southern zone.

From west to east the following formations are found :

1) Guidimaka :

Aside from the shallow deposits which usually contain only small quantities of water, most of the sub-surface is composed of metamorphics of the Mauritanides Arc range (schists, micaschists and quartzites). This naturally impermeable formation does not lend itself to creation of extended aquifers. However, faults and diaclases in the base favorize the creation of natural drains; when these are well developed, it is possible to drill wells having yields up to 20-30 m^3/hour.

Before drilling wells in favorable zones, hydro-geological prospection must be performed (including geophysical studies and exploratory borings).

2) Assaba

The sandstone mountains and diaclased quartzites do not contain major resources. However, in this zone, there is considerable potential in the strip of sand dunes bordering the mountains on the east. Intensified cultivation may be possible here. The Karakoro alluvia contain an easily exploitable aquifer.

3) Affolé

The large Affolé aquifers are primordial. The soft sandstone aquifer of Aïoun is located to the west of the Hodh pelite aquifer. The Aïoun sandstone, due to its little consolidated characteristics and the tectonic vicissitudes to which it has been subjected, is good aquifer material. In 1975, exploratory borings showed that there is a large generalized aquifer in this sandstone. Yields vary from 0.2 to 2 m^3/hour.

4) Hodh

About 450 cimented wells currently exploit either the fissured fringe of the Hodh pelites (siliceous schists), the dolerite veins, or the alluvial aquifers. The largest of these resources have been heavily drawn upon during the recent drought years.

New wells can be drilled in fracture zones (dolerite veins). The precise locations for drilling must be determined by geophysical prospection and mechanical exploratory boring (slim hole). These new wells may permit the "Aghaourt" (sandy plateaus) to become sub-pastures for livestock.

5) Aoueker

This aquifer, under the Aoueker wind-borne sands, occupies a sandy massive and is from 15 to 60 m thick. It is exploited by more than 350 wells and oglats. Yields are on the order of 1 to 3 m^3/hour.

2.2.1.4. Taoudeni Basin Aquifers

At present hardly exploited (some 70 wells), the resource of these aquifers are estimated to be about the same as those of the Trarza : on the order of 1 million m^3/km^2 (or more than 19 billion m^3).

Exploitation by borings having yields up to 200 m^3/hour should pose no technical problems and would be economically feasible.

This basin covers about 2/3rds of the nation. It is limited on the west and north by the base of the Arc of Mauritanides and the Requaibatt Dorsal, against which lean the sandstone massives of Assaba, Tagant and Adrar.

This basin occupies the eastern center of the country and extends into Mali, into Senegal, and on to Algeria, Niger, Upper Volta and Guinea. The hydro-geological conditions of this Upper Precambrian and Paleozoic basin are different on its borders and at its center.

Borders (Hank, Khatt, Tagant, Assaba) :

Conditions are more difficult. Positive results have been registered near Zouérate (Azrag, Oued El Gah) and in the Achram region (Tagant/Assaba), but further reconnaissance is required.

Center :

In the immense central part of the basin, conditions should favorize the existence of generalized deep aquifers; however, precise data is difficult to obtain. The Dhar of Néma aquifer, in the far east of the country (100 km east of Néma) is one of the largest known aquifers in Mauritania.

Two aquifers have been identified; they do not appear to be continuous, but separated by a WSW-ENE fault, which may be impermeable. The relatively small number of wells at the present time does not provide enough information on this problem. A dry wedge is found in the west, near the edge of the cliffs bordering the plateaus. These two aquifers are :

1) The Dahr Nema-Oualata Aquifer : flowing in more or less clayey sandstone; contains fresh water.
2) The Ouartemachet Rift Valley Aquifer : flows in an older sandstone formation of the Intercalary Continental, in contact with the above aquifer at the level of a large displacement fault.

2.2.2. Surface Water

When surface water is easily usable, it is more readily used in place of underground water. Within the country, there are several run-off zones near aquifers; oases have been developped in these zones. However, exploitation of these aquifers is not controlled or supervized. For instance, in the Atar region, abusive use of motor-pumps together with the effects of the drought have lowered the aquifer levels and have contributed to the disappearance of several oases. Elsewhere, particularly in the Assaba region (N'Takat, Sani, ...), water-drawing methods are still arachic and therefore, the relatively abundant water supply is vastly under-exploited.

Most of these aquifers have not been studied and their real size is not known.

2.3. Present State of Irrigated Cultivation in the Interior of the Country

2.3.1. Oasis Cultivation (see Report on Oasis Cultivation)

The surface area of all the oases in Mauritania is estimated at 4 500 hectares, having about 1,025,000 palm trees. Future potential seems promising, with the use of underground water and improvement of techniques.

Present production is estimated at 10,000 to 15,000 tons of fresh and ripe dates and at 1 500 to 2 000 tons of vegetables.

A large USAID project will soon begin for oasis cultivation. The objectives of this project are :

1) To introduce new varieties and develop the existing improved varieties;

2) To popularize chemical or biological pesticide treatment techniques;
3) To make pollinization techniques more efficient;
4) To use the micro-climate of these oasis to introduce new crops ;
5) To develop fruit crops (which have already given positive results at Sani): oranges, lemons, guavas, etc ;
6) To improve the varieties of sorghum, millet and other cereals ;
7) To improve henna cultivation techniques;
8) To introduce cereal crops which might improve the population's diet ;
9) To produce forage crops for animals;
10) To grow hedges to protect crop fields from animals;
11) To construct wind-breakers ;
12) To supervize the use of ranges in order to protect the environment.

As for water resources, this project proposes :

1) To use the most appropriate well construction techniques;
2) To use the best-adapted water-drawing methods : chadouf, windmills, motor-pumps, etc., taking into account the farmers' technical level and interest in modernization;
3) To use the most economical irrigation systems;
4) To provide water treatment for drinking water.

The rational supervision of this project and its eventual integration in a framework of a regional oasis development organization will permit the revitalization of this important sector which offers possibilities for training and capital investment by herders.

2 3 2. Irrigated Perimeters Around Large Towns

Except in the oases, irrigated cultivation is very limited in the interior of Mauritania. There are a few small perimeters located around the larger towns (especially Nouakchott and Akjoujt).

1) Akjoujt

The Akjoujt perimeters cover about 15 hectares, divided into 2 perimeters: both are managed by cooperatives:

- The Lajouad cooperative (10 hectares) is financed by the Commissariat de l'Aide Alimentaire. Its well produces 700 m^3/day.
- The Louebda cooperative (4.5 hectares) : 150 cooperative members having 300 m^2 each to farm.

These perimeters contribute to supplying the city of Nouakchott where they already have an available market.

2) The Nouakchott Perimeters

Around the city of Nouakchott, several small vegetable gardens are irrigated with residual water. These perimeters provide the city with vegetables; production is estimated at 600 tons. There are three cooperatives :

- Nouakchott cooperative (32 hectares) - 470 cooperative members
- Red Crescent cooperative (8 hectares) 250 cooperative members
- Tensweïlem cooperative (2 hectares) - 41 cooperative members

In addition to the above, about 10 hectares are farmed as private gardens belonging to merchants or government officials of Nouakchott.

2.3.3. Use of Existing Wells

The Direction of Hydraulics manages 67 wells of the 94 wells drilled and placed under its supervision.

Of the 67 wells, 23 are equipped and 44 are not. These 67 wells are distributed as follows :

- 20 are part of the "36 Wells Project" (158/FED/PU)
- 28 were built for the construction of the Nouakchott-Kiffa road
- 9 were built for pumping stations equipped in 1975
- 1 at Lake R'Kiz
- 1 at Benichab

It is strange that the Direction of Hydraulics continues to equip newly drilled wells, instead of exploiting existing, but abandoned, wells. There is no coordination between the Direction of Hydraulics and the Direction of Agriculture, which should have the necessary means to encourage the creation of irrigated perimeters.

The major constraint to the exploitation of underground aquifers for agriculture is financial.

It has been said that the cost per m^3 of water is quite high. According to a study by a United Nations consultant, the cost per m^3 of water varies from 5.4 UM for the shallow aquifers at Tamourt Ennaaj to 29.1 UM for the Intercalary Continental aquifer in the extreme southeast of the country.

It is obvious that, at these prices, no crops can be profitably grown using the water from these aquifers. However, these costs are greatly over-estimated and do not reflect reality. The consultant undoubtedly included other expenses (administration, etc.) and did not account for the

scale of savings which can be realized with a series of wells. An estimate for 10 wells drilled at Tamourt Ennaaj shows that the real costs would be on the order of 2.2 UM/m^3. (See following table).

Table 17 : Price per m^3 of Water Produced by Well (10 Wells)

		Unit Price	Cost	Life Span
1.Site Mobilization - demobilization	10	100.000	1.000.000	1 to 20 yrs
2.Site implantation	10	104.000	1.040.000	"
3.Drilling 12"/20 m	200 m	8.000/m	1.600.000	"
4.Casing 08"/20 m	20 m	2.400/m	480.000	"
5.Strainer 08"/	10	190.000	1.900.000	"
6.Gravel filters	10	20.000/F	200.000	"
7.48 hours development	10	269.000	2.690.000	"
8.Transport Costs	4.000 t km	4 t km	16.000	"
9.Site equipment	10	75.000	750.000	"
10.Other costs		10% Tot. 1-9	967.000	"
11.Total well implantation	10	1.064,360	10.643.600	"
12.Underwater pump	10	300.000	3.000.000	20 yrs.
13.Generator		300.000	3.000.000	7 yrs.
14. Operating and maintenance costs G + P	10	300.000	3.000.000	1 yr.

Source : Etude de la région du Tagant. Agrar und Hydrotechnik

Financial cost per m^3 water produced at the rate of 150.000m^3/well/year for a perimeter of 8 hectares.

Capital Expenses :

0 %	2.226 UM
2 %	2.255 UM
4 %	2.291 UM

Given the depth of 100 meters and yields on the order of 320,000 m^3, the cost would be about 1.5 UM/m^3.

In any case, even if these costs remain higher than the cost price of water from the Senegal River, it is very important to bring a minimum of hydroagricultural improvement to these Sahel and desert regions, where a majority of the nation's population lives.

The current project to equip 36 wells, which will be financed if successful, will serve as a point of departure and incite even private farmers to drill and equip their own wells.[1)]

However, in order for this project to be successful, conditions must be favorable. To our knowledge, at the present time, there have been no studies of these wells on the agronomic level (pedology, crop varieties, etc.) or on the land tenure level.

It would be advisable within the Second Phase to conceive a project of creating a small perimeter around the wells taking into consideration the pedological, agronomical, financial and social factors involved.

In addition to the "36 Wells Project", the SONADER's Direction of Studies and Works has established a "Sahel-Desert Bureau", whose objective is to promote irrigated agriculture in the interior of the country. This Bureau will supervise :

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1) See Table on "Yields of 36 Wells" in the Annex.

- The project to create 10 irrigated perimeters per well in the M'Beika plain (FAC/CCCE);
- The integrated rural development of the Tagant Region (Achram Diouk);
- Various small projects ;
- Dams : at Tamourt Ennaaj
  in the Tagant
  in the Assaba, Gorgol and Brakna
  in the Hodhs

All these projects, although delated, will certainly have a favorabal influence on livestock raising and the stabilization of the population.

Conclusions

Irrigated agriculture in Mauritania appears to be characterized by :

- Under-utilization of the land in the river region and interior of the country. Of an irrigable potential of 300,000 hectares, hardly 4 300 hectares are being farmed (to which must be added the 4 500 hectares of under-exploited oases).

- Insufficient production as compared to potential demand and even to real demand itself. In order to satisfy the interior market in 1990, production should equal : 261,000 tons of rice, 44,000 tons of wheat, 112,000 tons of corn, sorghum and millet, 40,000 tons of sugar. Present production hardly covers 20% of real demand.

- Isolation of the irrigated perimeters, rendering difficult the possibilities of extension services, supplies and marketing.

- The absence of any kind of agro-industry.

- The lack of integration between agriculture and livestock raising.

- The lack of land legislation and an agricultural credit structure.

In spite of these insufficiencies, the future appears promising, in that :

- Over the past few years, the farmers have demonstrated their faculty to adapt to new techniques.

- The nation has an impressive portfolio of recent studies; if implemented, they could serve as a basis for the revitalization of the Mauritanian economy.

- The construction of the Diama and Manantali dams will induce planned and supervized development. The cost of these dams being very high, amortization will be impossible without rapid intensification and accelerated improvement of agriculture.

Therefore, special attention must be given to general organizational problems : agrarian reform, agricultural credit, restructuring of the Ministries, etc.

The next decade should be a period of structural reform. These reforms will require :

- Serious review of communication links along the river, in order to permit rapid evacuation of produce and distribution of supplies. Studies in this area have been conducted; financing sources are available. These financing sources must be convinced to participate and the other problems which have until now hindered these improvements must be solved.

- Promulgation of suitable and equitable land reform legislation, and the will to apply these laws.

- Revisal of the PPVI policy, to attempt to decongest the old perimeters by improving the sites already prospected and by restructuring the PPVI's.

- Improvement of marketing and storage conditions and creation of agro-industries.

- The use of agricultural credit to encourage farmers and cooperatives.

- The training of agricultural managers and machine specialists.

- The creation of specialized mechanical units for the improvement of new perimeters and of the CUMA.

- The study of institutional problems.

The objective of the Second Phase of this study will be a detailed examination of these different measures.

Economic Importance of Irrigated Cultivation

Irrigated cultivation has not yet become an important subsector in Mauritania.

Based on the quantities mentioned in Table 21 one can estimate the contribution of irrigated cultivation to GDP as follows :

Product	Quantity
Rice	9.133 t
Corn-Sorghum	540 t
Cereals	10.500 t, including 1,500 t coming from the interior of the country.
Fruits (Bananas)	790 t

Value in current prices : (millions of UM)

Rice	100.463
Corn-Sorghum	10.800
Cereals	210.000
Fruits (Bananas)	19.750
Total	341.843
Intermediary Consumption :	153.000 UM
GDP in current prices	188.813 UM.

Table 19 : Status of Surface Areas and Production Along Senegal River -- 1979 Campaign

	Rice		Corn		Vegetables		Fruits (Bananas, Melons)	
	Surface Area (ha)	Production (t)	Surface Area (ha)	Production (t)	Surface Area (ha)	Production (t)	Surface Area (ha)	Production (t)
1) Large Perimeters :								
M'Pourie :	1,200	5,640						
- State	624	2,683.2						
- Farmers	576	2,937.2						
Gorgol :								
- State	35	157.5						
- Farmers	70	385						
2) Small Village Perim. supervised by SONADER								
- Rosso	128.9	476.6			70	1,400		
- Boghé	249	710.3	100	300				
- Kaédi	108.7	451.5	50	150				
- Sélibaby	52.3	131.4	20	60				
3) Other Public Village Perimeters :								
- Rosso	89	445			50	1,000		
- Boghé	10	40			20	400		
- Kaédi	33	165	10	30				
4) Private Perimeters :								
- Rosso	113.5	340.5			416	6,247	4	40
5) Research Center :								
- Boghé							10	100
- Kaédi	25	150					65	650
Total	2,114.4	9,133.3	180	540	556	9,047	79	790

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ANNEX 1

Irrigated Perimeters - Rosso Zone, 1980/81 Campaign

Name of Perimeter	Number of Co-operative Members	Improved Surface Area (ha)	Farmed Surface Area (ha)	Extension Services
Diatar I	66	18.5	18.5	SONADER
Diatar II	69	12.3	12.3	"
Bouldem I	64	9.6	9.6	"
Dar-es-Salam I	60	16	16	"
Dar-es-Salam II	60	14.6	14.6	"
Saldé	67	10.9	10.9	"
Teïkane	81	33	23	"
Jedrel Monguen	63	7.4	7.4	"
Guidakhar	48	18	18	"
New SONADER Perimeters :				
Dara Ouest	50	20	20	"
Garack	70	18,5	18,5	"
Tendgha	40	20	20	"
Inthienou	60	16	16	"
Gâni	60	9,5	9,5	"
Sifara	35	10	10	"
Gourel Boubacar Sy	70	16,5	16	"
Ganki Tori	60	15	0	"
Fada	59	16.4	16.4	"
Bouldem II	60	12	12	"
Houboïra	70	20,5	20.5	"

Irrigated Perimeters Rosso-Zone - 1980/81 Campaign (Cont.)

Name of Perimeter	Number of Co-operative Members	Improved Surface Area (ha)	Farmed Surface Area (ha)	Extension Service
Nawlé	65	18	18	SONADER
Dabaye	59	17	17	"
M'Pourié				
- State Farm		624	624	Dirct. of Farm
- Farmers	30 cooperatives	1,176	802	" "
Nkheyla	45	10	10	None-Village Perimeter
Association des Jeunes de Keur Macène	60	20	20	" VP
Tifass	50	50	30	" VP
Bren Gouillard	150	60	60	" VP
Bren Darrou	89	44	44	" VP
Dieuck	80	50	50	" VP
Moultegha (Baghdade)	30	20	8	" VP
Chgara	55	2.5	2,5	" VP
Tazaye	20	8	8	" VP
Makheynate	20	2	2	" VP
Famille à Jedrek Moghuen	10	5	5	" VP
Madina Gaye	80	35	20	" VP
Gani femmes	52	2	2	" VP
Gani hommes	109	20	20	" VP
Niang Boulé	56	10	10	Lutheran Fed.
Keur Nour	42	5	2	" "

Irrigated Perimeters - Rosso Zone - 1980/81 Campaign (Cont.)

Name of Perimeter	Number of Co-operative Members	Improved Surface Area (ha)	Farmed Surface Area (ha)	Extension Service
Tounguen	50	10	9	COSSOC
Keur Madiké	98	9	8	"
Rougheïwatt	80	8	8	"
Fass I	58	9	9	"
Fass II	Privé	12	12	"
Sidi O/El Bou	"	8	8	"
Kamaré Maciré	"	12	12	"
Sidi El Moctar N'Diaye	"	2	2	"
Mod. Mahmoud O/Bourdil	"	32	32	Private
Ismaël Fourrié	"	32	32	"
Mod. O/Labgheïl	"	50	20	"
Mod. Cheikh O/Amara	"	680	250	"
Abdoul Khadre	"	50	10	"
Diop Alioune (de Keur Mour)	"	50	35	"
Cheikh Niang	"	50	30	"
Alioune Diop (Jedrel Moghuen)	"	50	20	"
Iba Niang	"	20	12	"
Ablaye Bâ	"	15	11	"
Goueïtil	"	11	11	"
Brahim Sy	"	40	6	"
N'Djimtyr (Abass Sy)	"	6	4	"
Gouthouthy (Sy Alioune)	"	45	5.5	"
Melayre	"	205	76.5	"
Total = 62 perimeters		3,898.7	2,666.7	

A N N E X 2

Irrigated Perimeters - Boghé Zone, 1980/81 Campaign

Name of Perimeter	Number of Co-operative Members	Improved Surface Area (ha)	Farmed Surface Area (ha)	Extension Service
Dar El Barka	120	80	40	SONADER
Leboudou	218	37	will not be farmed, as debts not repaid	"
Beïlane	90	14	14	"
Olo-Logo	142	41	41	"
N'Goral Guidal	130	42	42	"
N'Diorol	65	13.5	13.5	"
Bakhao	75	33	33	"
Ganki	71	10	10	"
Wothie	77	8.5	8.5	"
Sénébousobé	80	8	8	"
Dioudé	73	12	12	"
Bababé	77	15.5	15.5	"
New SONADER perim.				
Donaye	120	21	21	"
M'Boye	130	24	24	"
Sinthiane	70	23	23	"
Ali Guelol	80	26	26	"
N'Daw Réo	75	25	25	"
Ando	90	22	22	"
Silbé	60	15.75	15.75	"

Irrigated Perimeters - Boghé Zone, (Cont.)

Name of Perimeter	Number of Co-operative Members	Improved Surface Area (ha)	Farmed Surface Area (ha)	Extension Service
Bolol Dogo	90	15	15	SONADE
Saré	80	17	17	"
Aïré M'Baré	80	19	19	"
Plaine de Boghé			being improved	
Sibé	60	8	2	Lutheran Fed.
Small Village perim.	?	50	50	Agric.Sec.VP
N'Gorel	?	10	10	Research Cent.
Total = 26		1,590.25	507.25	

A N N E X 3

Irrigated Perimeters - Kaédi Zone -- 1980/81 Campaign

Name of Perimeter	Number of Co-operative Members	Improved Surface Area (ha)	Farmed Surface Area (ha)	Extension Services
Sori Malé	84	36	36	SONADER
Winding	165	32	32	"
Sinthiou	183	41	8	"
Rindiao Sylla	137	51.5	46	"
Djeol I	234	42	42	"
Civé I	78	19.5	19.5	"
Garli	57	15.5	12.5	"
Casier du Gorgol		700	380	"
New SONADER perim.:				
Néré Walo	130	17	17	"
Djeol II and III	240	40	40	"
Dindi	120	13	13	"
Koundel	115	17	17	"
Tokomadji	80	11	11	"
Civé II	70	21	21	"
Youmane Yiré	95	17	17	"
Bélinabé I	56	10	8	None VP
Bélinabé II	81	36	23	" "
Paliba/Tillude	149	32.5	16.25	CARITAS
Dao	50	40	20	"
Taga	60	30	15	"
Tifundé Civé	70	32.5	16.25	"

Irrigated Perimeters - Kaëdi Zone (Cont.)

Name of Perimeter	Number of Co-operative Members	Improved Surface Area (ha)	Farmed Surface Area (ha)	Extension Services
Rouffi Awdi		15	15	Research Cent.
Rindiao I		10	10	"
Rindiao II		15	15	"
Bélinabé		70	50	"
Total : 27 perim.		1,364.5	900	

A N N E X : 4

Irrigated Perimeters -- Sélibaby Zone - 1980/81 Campaign

Name of Perimeter	Number of Co-operative Members	Improved Surface Area (ha)	armed Surface Area (ha)	Extension Services
Bedenky	132	29	19	SONADER
Waly	142	31	25	"
Toulel	112	10,3	8.3	"
Saghé	126	15	9	"
New SONADER Perim.:				
Wompou I and II	260	35	35	"
Diaguili	120	18	18	"
Moulessimou	99	15	15	"
Diojountourou I and II	280	43	43	"
Sanlou I and II	230	35	35	"
Khabou I and II	180	30	30	"
Total : 14 perim.		261.3	237.3	

ANNEX 6

Estimate of Surface Areas To Be Farmed During 1980/81

Type of Perimater		Surface Areas Improved (ha)	Surface Areas Farmed (ha)
1) Large Perimeters :			
M'Pourié	1	1,800	1,426
Plaine de Boghé	1	1,000 (being improved)	-
Gorgol	1	700	380
2) Small Village Perimeters - E.S. by SONADER			
Rosso	22	349.2	324.2
Boghé	22	522.25	324.2
Kaédi	15	373.5	331.5
Sélibaby	14	261.3	237.3
3) Other Public Village Perimeters :			
Rosso	20	379.5	327.5
Boghé	2	58	52
Kaédi	7	181 (being improved)	98.5
4) Private Perimeters :			
Rosso	19	1,370	589
Boghé	-	-	-
Kaédi	-	-	-
Sélibaby	-	-	-
5) Research Center :			
Rosso		10	10
Boghé	1	10	10
Kaédi	4	110	90
Sélibaby	-	-	-
Total : 129 perimeters		7.114.75	4.311.25

ANNEX 5

Summary of Irrigated Perimeters In Mauritania - 1980/81 Campaign

Name of Region	Number of Perimeters	Percent	Surface Areas Improved (ha)	Percent	Surface Areas Farmed (ha)	Percent
Rosso	62	48.5 %	3,898.7	55 %	2,666.7	62 %
Boghé	26	26 %	1,590.25	22.5 %	507.25	11.5 %
Kaédi	27	21 %	1,364.5	19 %	900	21 %
Sélibaby	14	10 %	261.3	3.5 %	237.3	5.5 %
Total	129	100 %	7,114.75	100 %	4,311.25	100 %