NATIONAL SOCIETY FOR RURAL DEVELOPMENT
THE ISLAMIC REPUBLIC OF MAURITANIA

THE DEVELOPMENT STUDY FOR THE PROJECT ON REVITALIZATION OF IRRIGATED AGRICULTURE IN THE IRRIGATED ZONE OF FOUM GLEITA IN THE ISLAMIC REPUBLIC OF MAURITANIA

FINAL REPORT
MAIN REPORT

OCTOBER 2010

JAPAN INTERNATIONAL COOPERATION AGENCY
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THE DEVELOPMENT STUDY FOR THE PROJECT ON REVITALIZATION OF IRRIGATED AGRICULTURE IN THE IRRIGATED ZONE OF FOUM GLEITA IN THE ISLAMIC REPUBLIC OF MAURITANIA

FINAL REPORT

LIST OF VOLUMES

VOLUME-I MAIN REPORT

VOLUME-II ANNEXES

PREFACE

In response to a request from the Government of the Islamic Republic of Mauritania, the Government of Japan decided to conduct a Development Study for the Project on Revitalization of Irrigated Agriculture in the Irrigated Zone of Foum Gleita and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Michimasa Menjo of NTC International Co., Ltd. between November 2008 and September 2010.

The team held discussions with the officials concerned of the Government of the Islamic Republic of Mauritania and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Mauritania for their close cooperation extended to the study.

October 2010

Izumi Takasima,
Vice-president
Japan International Cooperation Agency

October 2010

Mr. Izumi Takasima
Vice-president
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

We are pleased to submit to you the final report on "The Development Study for the Project on Revitalization of Irrigated Agriculture in the Irrigated Zone of Foum Gleita in the Islamic Republic of Mauritania." This report compiles the results of the study which was conducted both in Mauritania and Japan during the period of 23 months from November 2008 to September 2010.

The target area of the Study is the watershed of Gorgol River, a tributary of Senegal River. The study was conducted aiming the improvement of food security of the region through "formulation of a model for revitalization of irrigated agriculture in the region", "formulation of an action plan for revitalization of irrigated agriculture in Foum Gleita, where potential is high" and "capacity building of SONADER (National Society for Rural Development of Mauritania), and beneficiary farmers and concerned agencies". A verification trial was also conducted with participation of farmers. Besides, emergency remedial works were implemented to repair major canals of deteriorated irrigation facilities in Foum Gleita for stable farming. We also held series of meetings with farmers for sustainable agriculture and farmers recognize the necessity of reorganization of farmers' groups. They actually established a new union. Those processes, analyses and formulated plans are reported in this document.

In submitting this report, we would like to express our heartiest appreciation for substantial cooperation and advice provided during the study period by officials of the Japan International Cooperation Agency, the Ministry of Foreign Affairs, and the Ministry of Agriculture, Forestry and Fisheries. During the field study, we were also given thoughtful cooperation and support from diverse local administrative institutions including the Ministry of Rural Development, Ministry of Economic Affairs and Development, Ministry of Environment, Regional Office of Gorgol, and National Center for Agricultural Research and Development. The JICA Office in Senegal, the Embassy of Japan in Mauritania, and other related institutions provided valuable advice and support, too. In writing this, we would send our sincere gratitude to them for the helpful advice, cooperation, and support.

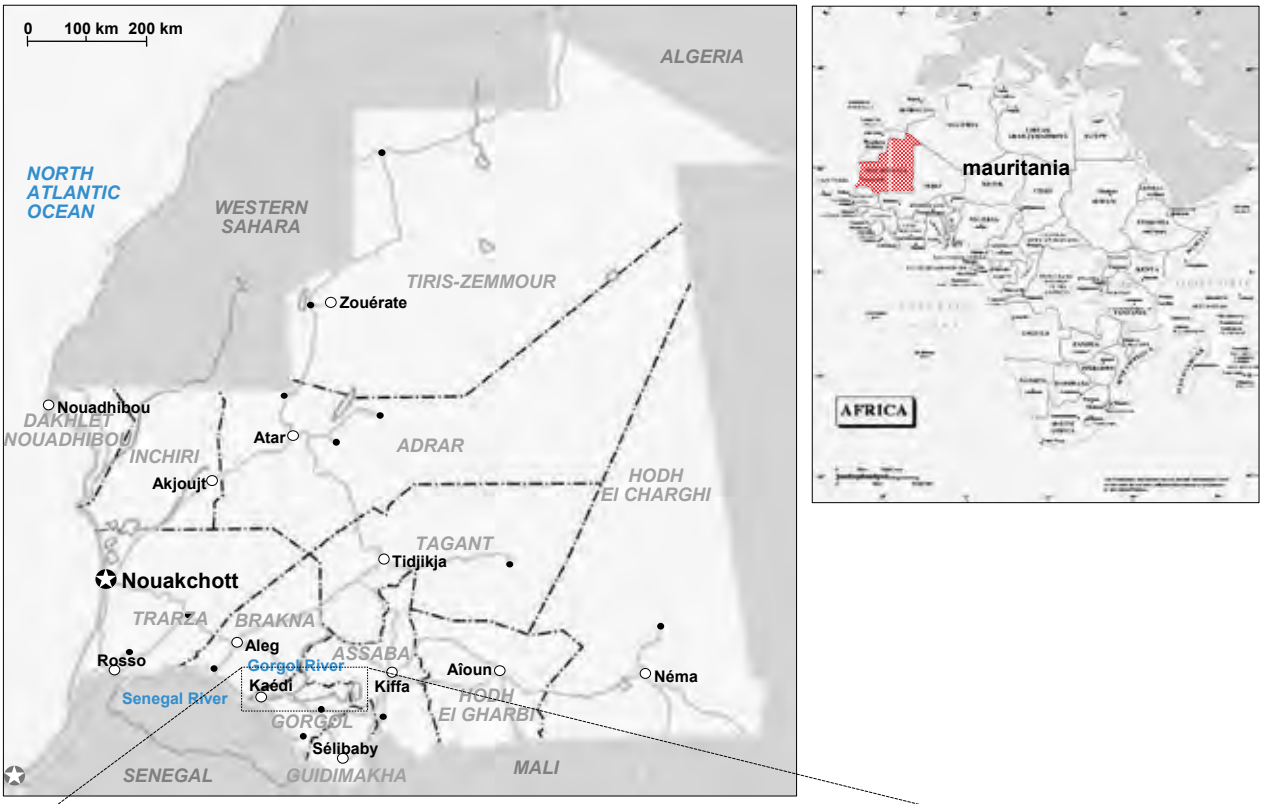
Finally, since a movement has been occurring among the farmers in the study area to reorganize themselves for a better life, we would like to sincerely request that Japanese aid and follow-up continue in the study area. By doing so, we are sure that the friendly relationship between Japan and Mauritania will be further reinforced.

Very truly yours,

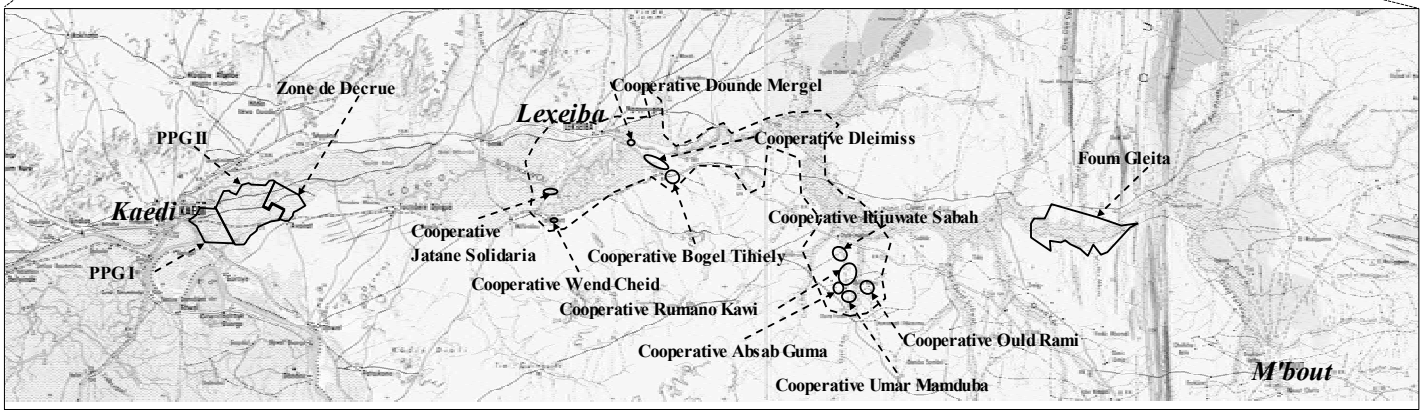
Michimasa Menjo
Team Leader
The Development Study for the Project on Revitalization of Irrigated Agriculture
in the Irrigated Zone of Foum Gleita in the Islamic Republic of Mauritania

The Development Study for the Project on Revitalization of Irrigated Agriculture in the Irrigated Zone of Foum Gleita in the Islamic Republic of Mauritania

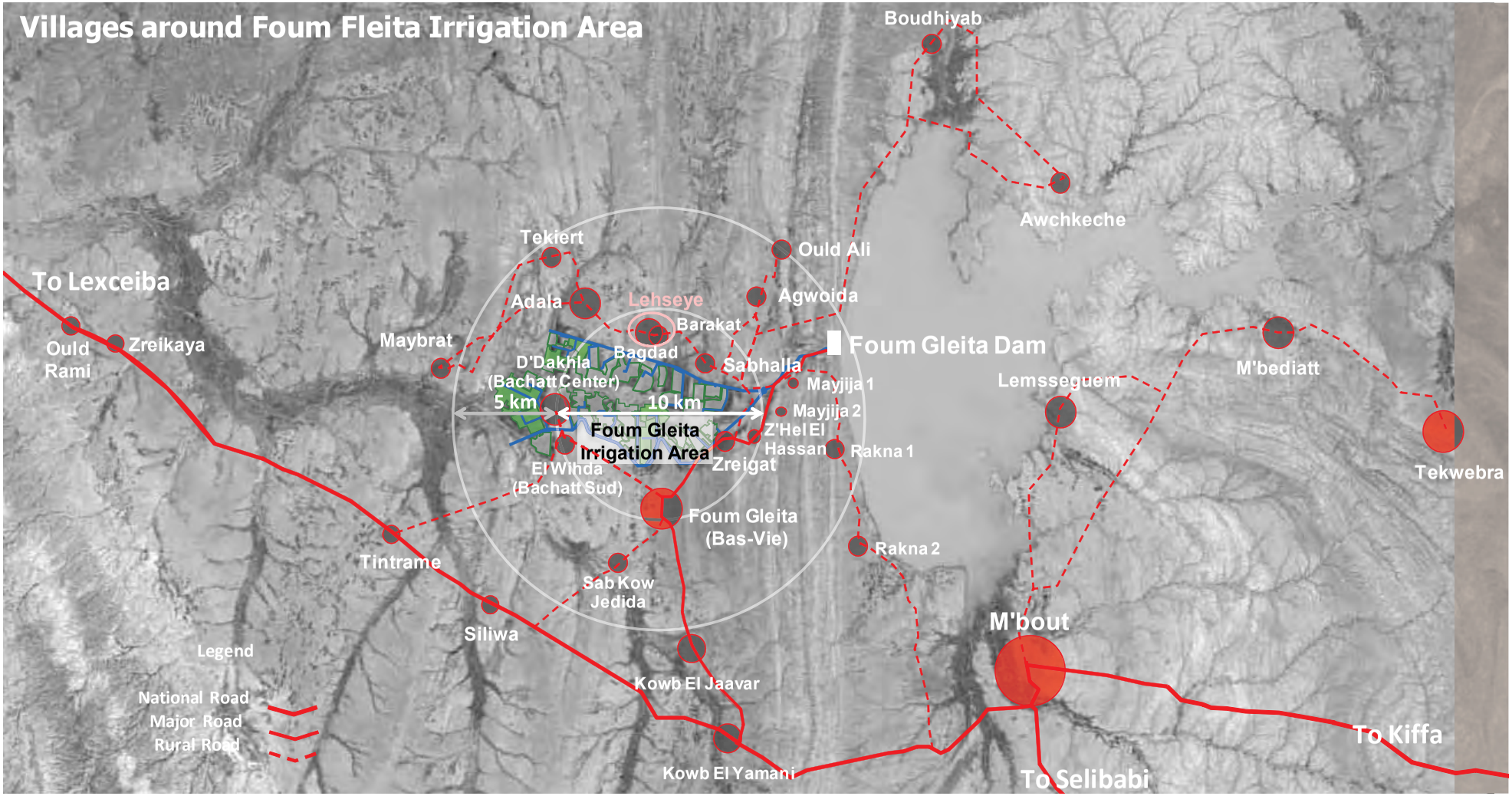
FINAL REPORT



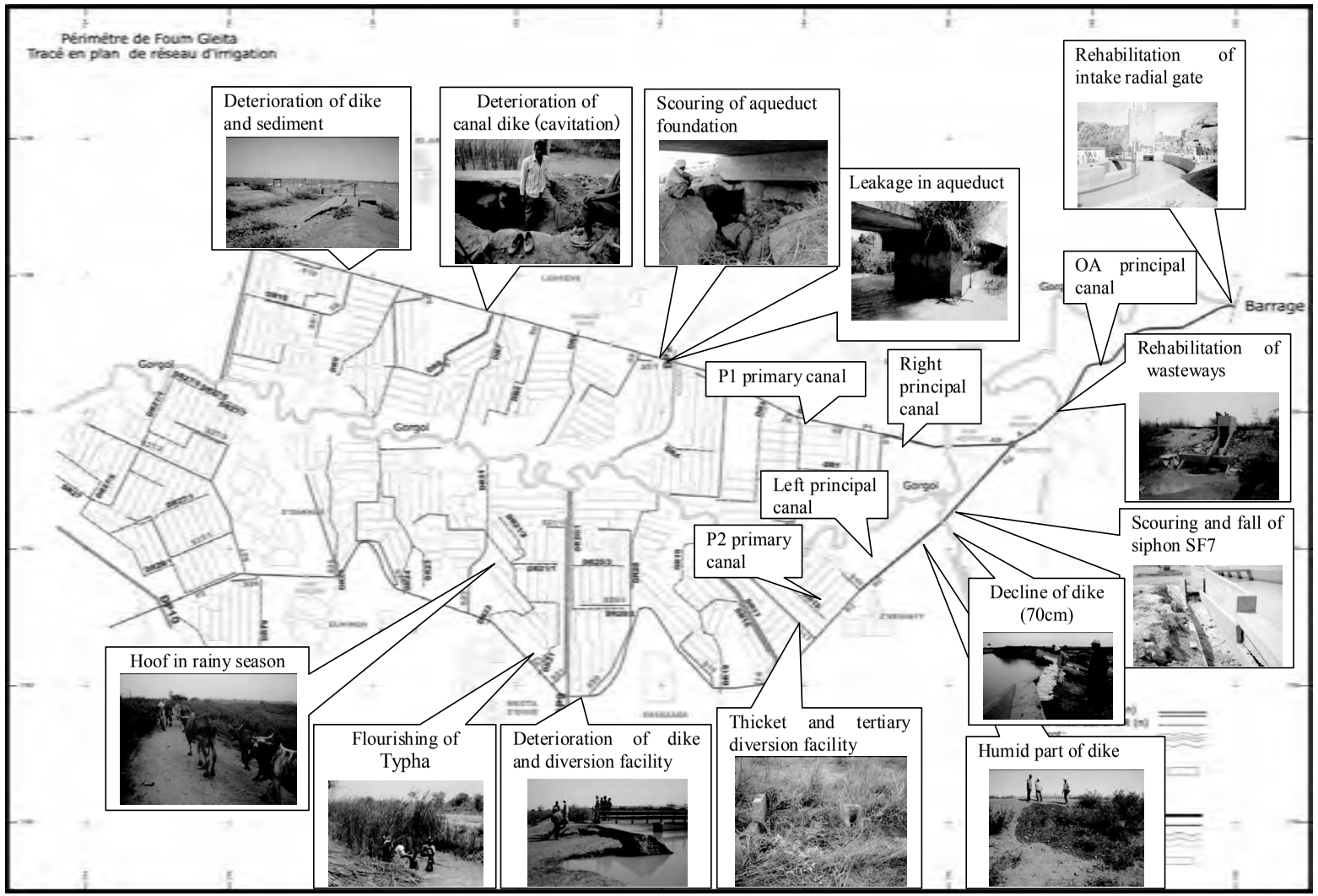
「Basin Gorgol」



Location Map of the Study Area



Map of the Foum Gleita Irrigation Project Area



Main facilities of Foum Gleita irrigated area and the deterioration

Photographs

Foum Gleita dam

Dam and the reservoir

Radial gate

Origin of headrace

Main canal（OA）

Diversion tank

Main canal covered with Typha（AD）

Main canal（AG）

Damaged siphon

Damaged dike in upper stream of siphon7

Repaired dike

Damaged primary canal（P1）

Damaged aqueduct

Damaged primary canal（P2）

Secondary canal

Tertiary canal

Primary drainage

Secondary Drainage

Damaged canal by livestock

Access of drinking water

Rice-Planting

Demonstration area P2
Before the rice harvest

Demonstration area P2
Foot-Pedaled thresher

Demonstration area P1
Vegetable and fruit plots

Planting of young banana plant

Installation of water troughs

Fence

Establishment of multi-purpose shed

Cutting down of Typha

Root of Typha

Rural society survey by individual interview

Warning sign of protection canals

Reinforced dike（OA）

Embankment in downstream of bridge

Reinforcement of dike with sandbags

Before reinforcement of dike with sandbags
Humid part of dike in downstream of SF7

Meeting for explanation of interim report

Weekly meeting with union and SONADER

Workshop

Campaign for reimbursement of funds by the Union

Irrigation area with hose

New road

List of Abbreviations and Local Words

Abbreviation	French	English	Japanese
A/P	Plan d'action	Action Plan	アクションプラン
ANEPA	Agence Nationale d'Eau Potable et d'Assainissement	National Agency for Drinking Water and Sanitation	国立飲料水・浄水機関
APD	Avant Projet Détaillé	Project Details	実施計画
AVB	Agents de Vulgarisateurs à la Base	Extension agents	農業普及員
BDFG	Banque des Femmes du Gorgol	Women's Bank of Gorgol	ゴルゴル女性銀行
CAPEC	Caisses Populaires d'Épargne et de Crédit	Popular Bank of Savings and Credit	貯蓄・融資大衆銀行
CARD	Coalition pour le développement du riz en Afrique	Coalition for African Rice Development	アフリカ稲作振興のための共同体
CGEMAT	Cellule de Gestion et d'Exploitation du Matériel Agricole et de Terrassement	Management and Exploitation Unit of Agricultural Equipment and Earthworks	農業機材・土木工事管理および開発室
CGIAR	Groupe Consultatif pour la Recherche Agricole Internationale	Consultative Group on International Agricultural Research	国際農業研究協議グループ
CIRAD	Centre de Coopération lnternationale en Rechèrche Agronomique pour le Développement	International Cooperation Center for Agricultural Research for Development	開発のための農学研究・国際協力センター
CNRADA	Centre National de Rechèrche Agronormique et de Développement Agricole	National Center for Agricultural Research and Development	国立農学・農業開発研究センター
CNERV	Centre National d'Elevage et de Rechèrche Vétérinaires	National Centre for Breeding and Veterinary Research	国立畜産・獣医研究センター
CORAF/ WECARD	Conseil Ouest et Centre Africain pour la Recherche et le Développment Agricoles	West and Central African Council for Agricultural Research and Development	農業研究・開発のための中・西部アフリカ会議
CSC	Comité de Surveillance et de Contrôle	Committee of Supervision and Control	監視・調整委員会
ENFVA	École Nationale de Formation et de Vulgarisation Agricoles	Natural School for Training and Agricultural Extension	国立農業研修・普及学校
EU	Union européenne	European Union	欧州連合
FAEM	Fédération de l'Agriculture et de l'Elevage de Mauritanie	Federation of Agriculture and Livestock of Mauritania	モーリタニア農業畜産業者連盟
FAO	Organisation des Nations Unies pour l'Agriculture et l'Alimentation	Food and Agriculture Organization	国際連合食糧農業機関
FND	Funds National de Développement de la Mauritanie	National Fund for Development of Mauritania	国家開発基金
GIE	Groupement d'Intérêt Économique	Economic Interest Group	経済利益グループ

Abbreviation	French	English	Japanese
IAV	Institut Agronomique et Vétérinaire Hassan II	Agronomy and Veterinary Institute Hassan II	ハッサンⅡ世農学・獣医学研究所
ICARDA	Centre international de recherche agricole dans la zone sèche	International Center for Agricultural Research in the Dry Area	国際乾燥地農業研究センター
ICRAF	Centre mondial d'agroforesterie	World Agroforestry Centre	世界アグロフォレストリーセンター
ICRISAT	Institut international de recherche sur les cultures des zones tropicales semi - arides	International Crops Research Institute for the Semi - Arid Tropics	国際半乾燥地熱帯作物研究所
IDA	Association Internationale de Développement	International Development Association	国際開発協会
IER	Institut d'Economie Rurale du Mali	Institute of Rural Economy of Mali	マリ農村経済研究所
IFAD	Fonds international de Développement agricole	International Fund for Agriculture Development	国際農業開発基金
IMF	Fonds monétaire international	International Monetary Fund	国際通貨基金
INSAH	Institut du Sahel	Sahel Institute	サヘル研究所
ISRA	Institut Sénégalais de Recherches Agricoles	Institute of Agricultural Research of Senegal	セネガル農業研究所
JICA	Agence Japonaise de Coopération lnternationale	Japan International Cooperation Agency	国際協力機構
M/M	Procès-verbal de la réunion	Minutes of Meeting	協議議事録
M/P	Schéma Directeur	Master Plan	マスタープラン
MAGHAMA III	Maghama décrue amelioree agriculture Phase III	Maghama lmproved Flood Recession Farming Project Phase III	マガマ氾濫源営農改善プロジェクト フェーズ3
MDR	Ministére du Développment Rural	Ministry of Rural Development	農村開発省
NERICA	Nouveau riz pour l'Afrique	New Rice for Africa	ネリカ
OFCF	D'outre-mer Fondation de coopération de la pêche	Overseas Fisheries Cooperation Fundation	海外漁業協力財団
OMVS	Organisation pour la mise en valeur du fleuve Sénégal	Organization for the Development of the Senegal River	セネガル川開発機構
PAHABO	Projet d'Aménagement Hydroagricole du Branka Ouest	Project of Hydro-agricultural Management of Branka West	西ブランカ農業水利整備プロジェクト
PDDO	Programme de Développement Durable des Oasis	Sustainable Development Program of Oasis	オアシス持続的開発計画（IFAD プロジェクト）
PDIAIM	Programme de Développement Intégré de l'Agriculture Irriguée en Mauritainie	Integrated Development Program for Irrigated Agriculture in Mauritainie	モーリタニア潅漑農業総合開発プログラム
PDRC	Projet de Développement Régional Communautaire	Regional Community Development Project	コミュニティ地域開発計画（世銀プロジェクト）
PGIRE	Programme de Gestion Intégrée des Ressources en Eau et de Développement des Usages à Buts	Integrated Water Resources Management and Development Program for Multiple Use in the Senegal	セネガル川流域多目的利用のための水資源総合管理・開発プログラム

Abbreviation	French	English	Japanese
	Multiples dans le Bassin du Fleuve Sénégal	Basin	
PNRA	Programme National de Recherche Agricole	National Agricultural Research Program	国家農業研究プログラム
PPG	Périmètre Pilote du Gorgol	Pilot Perimeter of Gorgol	ゴルゴルパイロット地域
PRSP	Document stratégique de réduction de la pauvreté	Poverty Reduction Strategy Paper	貧困削減戦略書
PSA	Projet de Service Agricole	Project of Agricultural Service	農業サービスプロジェクト
PVS	Cépages de sélection participative	Participatory Varietal Selection	参加型品種選定
RADHORT	Réseau Africain pour le Développement de l'Horticulture	African Network for the Development of Horticulture	園芸発展のためのアフリカネットワーク
ROCAFREMI	Réseau Ouest et Centre Africain de Recherche sur le Mil	West and Central Africa Millet Research and Development Network	中・西部アフリカミレット研究開発ネットワーク
ROCARIZ	Réseau Ouest et Centre Africain du Riz	West and Central Africa Rice Research and Development Network	中・西部アフリカ稲研究開発ネットワーク
ROCARS	Réseau Ouest et Centre Africain de Rechèrche sur le Sorgho	West and Central Africa Sorghum Research and Development Network	中・西部アフリカソルガム研究開発ネットワーク
S/W	Etendue des travaux	Scope of Work	実施細則
SNDE	Société Nationale de l'Eau	National Water Company	水道公社
SNFP	Société Nationale des Forages et Puits	National Society of Drilling and Wells	井戸公社
SNAAT	Societe Nationale des Amenagements Agricoles et de Travaux	National Society of Agricultural development and Works	農業開発・事業公社
SONIMEX	Société Nationale d'Importation et d'Exportation	National Society of Import and Export	輸出入公社
SONADER	Société Nationale pour le Développement Rural de la Mauritanie	National Society for Rural Development of Mauritania	農村開発公社
SPFS	Programme Spécial pour la Sécurité Alimentaire	Special Program on Food Security	食糧安全保障プログラム
TICAD	Conférence internationale de Tokyo pour le développement africain	Tokyo International Conference for African Development	アフリカ開発会議
UCAF	Union des Coopératives Agricoles de Foum Gleita	Union of Agricultural Cooperation of Foum Gleita	フーム・グレイタ農業共同組合連盟
UM	Ouguiya Mauritanien	Mauritanian Ouguiya	モーリタニアウギア（通貨単位）
UNCACEM	Union Nationale des Coopératives Agricoles de Crédit et d'Epargne de Mauritanie	National Union of Agricultural Cooperatives of Credit and Savings of Mauritania	モーリタニア農業融資・貯蓄協同組合連合
WARDA/ADRAO	Centre du Riz pour l'Afrique	Africa Rice Center	アフリカ稲作センター
WFP/PAM	Programme Alimentaire Mondial	World Food Program	世界食糧計画

SUMMARY

1. OUTLINE OF THE STUDY

1.1 Background of the study

The Islamic Republic of Mauritania (Mauritania) has a population of 3.1million with a per capita income of US$ 580, and agricultural sector occupies 23.7% of the national GDP. According to the Human Development Index (HDI) (World Bank, Human Development Report 2007), Mauritania is placed at the 137th place out of 171 countries. It covers an area of 1.03 million sq.km, which is 3 times the area of Japan, having 90% of the area as the desert area. The Senegal river basin is the most of appropriate area for agriculture, and the development of agriculture using the Senegal river is absolutely essential to ensure the national food supply.

A Program of Integrated Development of Irrigated Agriculture in Mauritania (PDIAIM) is implemented during the period of 2000-2015, with funding from WB, ADB and IDB, with the aim of increasing the income and employment through the promotion of irrigated agriculture in the Senegal river basin. Presently, the Phase-Ⅱ of the program is on-going. One of the main cornerstones of the PDIAIM is the maintenance of irrigation facilities and as a part of this program, a Master Plan (M/P) was prepared for the irrigation facilities in the Gorgol river (a tributary of the Senegal river) basin where the big irrigation schemes exist.

Based on this M/P, the Government of Mauritania sent a request for the cooperation to the Government of Japan, for a grant as the “Program of Integrated Development of Gorgol river basin”, which aims to assist integrated farm management of the Gorgol river basin and to rehabilitate the irrigation facilities in the irrigated zone of Foum Gleita, where only 400 ha is presently cultivated in the area of 1,950 ha, which was developed in 1980.

In February and April 2005, JICA dispatched a study mission from the Middle Western Africa Assistance Office to check the validity of the project site and to discuss with the government officials of Mauritania. The mission revealed that the irrigated zone of Foum Gleita has great potential for irrigated agriculture and also proposed that priority should be given to the management and maintenance of irrigation works by the participation of farmers, more than the rehabilitation works.

Then the Mauritanian government revised its application in January 2006 for a “Project on Integrated Development of Irrigated Zone of Foum Gleita”, more focused on a development study of the management and maintenance of irrigation works and integrated development of agriculture in the surrounding areas. Based on the request, the Japanese government sent a baseline survey mission in April 2008, and agreed and signed the Scope of Works and Minutes of Discussions on 8th and 9th April, 2008 respectively.

1.2 Objectives of the Study

The objectives of the Study are as follows:

- To formulate a model for the revitalization of irrigated agriculture in the Gorgol river basin so to improve the food security of the area;
- To formulate an action plan (A/P) for revitalization of irrigated agriculture in the irrigated zone of Foum Gleita, which has a high agricultural potential.
- To strengthen the capacity of the counterpart (C/P) organization National Society for Rural Development of Mauritania (SONADER), other relevant agencies of the project area, and the farmers organizations through the technical transfer of the Study.

1.3 Study area

The model of revitalization of irrigated agriculture in this Study focuses on the Gorgol river basin of 25,000 ha area, and 400,000 inhabitants. The action plan (A/P) focuses on Foum Gleita project area of 1,950 ha, and 9,000 inhabitants.

1.4 Study period

Fiscal Year (April to March)	Contents of the Study
First Year (November2008 to March2009)	Implementation of "Preparatory Works in Japan", "First Field Survey" and "First Home office Works in Japan". Formulation of a model plan (draft) and an action plan (draft). Preparation of the Progress Report 1 in Mauritania and the Interim Report in Japan.
Second year (April2009 to March2010)	Implementation of the "Second Field Survey". Implementation and monitoring of Verification Study, and Preparation of Progress Report 2 and 3 in Mauritania.
Third year (April to October2010)	Implementation of the "Third Field Survey" and "Second Home office Works in Japan", "Fourth Field Survey", and "Third Home office Works in Japan". Preparation of Draft Final Report in Japan.

1.5 Counterpart Organization

The main counterpart organization of this Study is SONADER. The counterparts include the officers of the Department of Study and Development (Direction Etudes et Aménagements) of the Head office, SONADER Gorgol branch office (Direction Régionale du Gorgol) and Foum Gleita branch office (Antenne de Foum Gleita).

2. SOCIOECONOMY AND AGRICULTURAL DEVELOPMENT

2.1 Socioeconomic Background

Regarding administration, the country is divided into 13 regions or wilayas, consisting of 53 departments or moughataa), which are further divided into districts (Arrondissement), communes and villages. The Mayors and Chief of the villages are elected by the people, but the governor of regions (Wali), prefectures (Hakem) and districts are appointed by the Ministry of Interior.

In regard to country's economy after the independence in 1960, the economic development has focused on development of mining, agriculture, fisheries and livestock and the effective use of the products from these developmental activities. Currently, the main industries of agriculture (sorghum, millet, rice) and livestock (cattle, sheep) contribute 23.7% of GDP (2005) and occupy 52.9% of the total work force (624, 000 in 2000), and make it as a major socio-economic sector. There are revenues from the foreign trade by the export of fishery products (octopus and squid) and iron ore. The petroleum and natural gas were found in Nouakchott offshore and oil production began at Chinguetti oil field in February 2006. The income from fishery accounted for 45% of total exports, of which 70% are exported to Japan. The export of iron ore from the town of Zouerate in the north accounts for 20% of the export revenues. Besides, copper and phosphate are also exported. In 2006, the GNI was 2.3 billion (740 USD per capita).

2.2 National Development Plan

2.2.1 Poverty Reduction Strategy Paper (PRSP)

The Mauritanian government prepared the first full version of PRSP in December 2000 with development goals in the medium and long-term for the period of 2001 to 2015. Its goals are (1) economic growth and poverty reduction, (2) the quantitative and qualitative improvement of basic social services, and (3) the abolition of regional and gender disparities for access to economic infrastructure. In particular, it is necessary to improve the rate of poverty, literacy rate, access to education, health care and water access, all of which are the striking problems in rural areas.

This study is placed as a high priority project for measures to fight poverty and to revitalize rural area through rehabilitation of the Gorgol river basin and Foum Gleita irrigated area along the basin, which is a tributary of the Senegal river.

2.2.2 Program for Integrated Development of Irrigated Agriculture in Mauritania（PDIAIM）

PDIAM is a Program implemented with the assistance of the World Bank (WB) and Mauritanian government. The Ministry of Rural Development (MDR), SONADER, and the National Union of Agricultural Cooperatives of Credit and Savings Mauritania (UNCACEM) are the implementing agencies of the program. It consists of three phases that are implemented between 2000 and 2015 (projected), and currently the program is in its phase II. The program aims at revitalization of

irrigated agriculture to increase productivity, to generate income, to provide access to credit institutions and to bring a range of employment opportunities for the residents of the Senegal basin. For this purpose, the irrigation facilities will be rehabilitated in 25,000 ha area in the Senegal river basin. In this program, the rehabilitation APD study (Avant Projet Détaillé) was carried out for the large scale irrigation areas including the irrigated zone of Foum Gleita.

2.3 Outline of Mauritania Agriculture

2.3.1 Classification of Cropping Systems in Mauritania

There are 4 agro-ecological zones in Mauritania which are classified in terms of agricultural production, Arid Saharan zone, Semi-arid Sahel, the area of Senegal river basin and (Atlantic) coastal zone. This study target area belongs to the zone of the Senegal river basin. This area is located on the right bank of the Senegal river, with a population of 900,000, containing most of the development potential of irrigated agriculture in Mauritania on 2% of its land. Apart from the irrigated agriculture in rainy and dry seasons, animal husbandry and fisheries are also practiced in the area. This zone consists of regions Trarza, Brakna, Gorgol and a part of the region Guidimakha.

2.3.2 Agricultural Land Use

Based on the natural conditions and the characteristics of the region, the agriculture lands of Mauritania can be classified as follows.

1) The rainfed area (Dieri)

This area is located along a narrow strip of land along the border of Mali and along the Senegal river, where the rainfed agriculture is possible. Sorghum, millet and maize are grown. The planting is normally done at the time of the arrival of rains in the early June; the harvest is done at the end of the rainy season in November.

2) Recession area (Décrue: Flood recession, Lowland)

In this area that was over-flowed by the high level waters of the Senegal river and its tributaries in the rainy season, sorghum, maize, and wheat are cultivated, after the water subsides the area leaving the soil saturated with water. The recession area consists of flood plains area submerged by the rising waters of river and submerged upstream of the dam or in depressions. The largest floodplain (Maghama) development along the Senegal river is controlled by SONADER.

3) Irrigated area

This area of the Senegal basin and tributary consists of private farms irrigated by pumps and the farms, which were established by national project. Some lands are administered by unions and cooperatives, and are growing rice during the rainy season from June to October, and rice

and vegetables during the dry and cold season from November to February are commonly practiced.

4) Oases Area

In the oases of the arid Sahara, dates and alfalfa for fodder are grown. Besides, wheat, barley, sorghum are cultivated under dates as mixed farming.

2.3.3 Agricultural Production

The major crops in Mauritania are sorghum, maize, millet and rice. The country's total food production is 159,691 tons (2007) of which 68,241 tons (2007) were produced on the lands controlled by SONADER.

2.4 Development Plan of Gorgol Region

2.4.1 Outline and Objectives

The drought that hit the country in the early 1980s has generated a massive exodus of population from rural areas to urban, which resulted in the impoverishment of the rural economy. The government of Mauritania established a Foum Gleita dam and developed 2,000ha of the farmland through the cooperation by the World Bank. The main objective was to settle populations on their land, provide irrigated land, and improve their livelihood.

The project aimed to provide irrigation water to farmlands in Kaedi by releasing water into the Gorgol river from the largest dam in Mauritania in dry season, and it was completed in 1983.

The stable water supply from the Senegal river led to develop Gorgol perimeter PPGI established 1977 and PPGII, the perimeter of irrigated area located upstream of PPGI are established in 1997. With the PDIAIM support program, it contributes to the sustainable development using the discharge water of the Gorgol river. In the perimeter of Lexeiba, the cooperatives were founded in 1986, and the area has been expanded every year. The support started based on PDIAIM master plan and the diversification of agricultural products is strongly desired among the farmers with the ambition to supply to markets in the urban centers and outside the region.

Furthermore, the final program of the Foum Gleita irrigation program set the goal of 3,600 ha, of which 550 ha, and 1,400 ha were developed in the first and second period in 1984 and 1989 respectively. At the same time, people immigrated to this area to begin agricultural production, mainly rice cultivation. Between the late season of 1980s and the first season of 1992, double cropping was conducted, and the harvest area reached to 2,500 ha.

However, as countermeasure to the unpaid irrigation water charges, the supply of irrigation water was stopped in 1994. At the same time, the floods which occurred in this year have reduced the irrigated area, and there was another flood in 1999. Meanwhile, the “typha” and other aquatic plants

invaded the irrigation canals, which reduced the water transport capacity of the canals to 12% of the original plan. In addition, the livestock damages of the canal banks also reduced the stability of the canals.

The main canal was damaged in 2001 due to gradual deterioration of the banks by the watering of livestock. Several places are in dangerous situation, but the rehabilitation of collapsed banks is not easier because of the high embankment. Since then, SONADER has been supplying a fixed volume of water limited to 1.2 m^3/s (20% of 6 m^3, maximum water flow at the peak period). Many villages use impure canal water as drinking water, and hence it is essential to ensure maintenance once a year, but the repairs to provide the drinking water are not undertaken.

Though Foum Gleita has a modern irrigation system with abundance of water, it is one of the poorest regions of the country, and urgent measures are needed for the rehabilitation of the project.

2.4.2 Planning of Agricultural Water Use Facilities

The Mauritanian government currently imports 50% of its rice needs and plans to improve the self-sufficiency rate of rice which is the staple food of the population by increasing the irrigated area and the self reliance of finance of poor farmers. During the 9 years, the maximum irrigated area in the rainy season was up to 22,000 ha (average 15,900 ha), including a maximum of 3,675 ha in Gorgol basin (average 2,780 ha: 17% of the total irrigated area) having the rice production on the right bank of the Senegal river.

Gorgol river is a major tributary of the Senegal river bordering Senegal with 21,000 km^2 of basin area. It meets Kaedi at 320 km upstream of St.Louis, at the right bank of the Senegal river. At the junction of the Gorgol river and Senegal river, a gate valve is set up at Kaedi to prevent of flooding in Senegal and at the same time, when the valve is closed for Senegal river, it serves to keep the water level high and supply water to the PPG area by flood recession.

The Gorgol river crosses the Kaedi to M'bout road at 1 km east of Lexeiba. It traverses east to become the black Gorgol, and reach the Project area at 40 km east of Lexeiba. The Foum Gleita dam is located at 10 km east of the project area. The Assaba State is located at the further upstream of the dam of the black Gorgol river.

The Foum Gleita dam was completed in 1983. It is the largest dam in Mauritania with a maximum storage capacity of 400 million m^3. While the dam can provide water for irrigation development of over 20,000 ha area, only 4,500 ha of irrigated area has been developed until now.

2.4.3 Irrigation Development of Gorgol Region

In Gorgol river, 5 irrigated areas were developed. Outline of these are listed below.

Table 2.4.1 Outline of PDIAIM Projects in Gorgol river

	PPG I	PPG II	Flood Recession	Lexeiba	Foum Gleita
Development	1977	1997	1997	1986	1983-1989
Area (ha)	700	1200	700	650	1950
Irrigation Method	Pump - 4sets 1m dia. & canals	Pump - 6sets 1m dia., Canals & décrue	Décrue with 3 sets of sluice gates, no canal	Many small pumps (about 0.2 m dia. & canals	Gravity irrigation with complete system (silted and deteriorated)
Recent major rehabilitation	2009-10, pump, dike & canal	2009-10, dike	2008, dike	2008-09, river training. 2009, system of 2 large cooperatives	2008, dike 10 m, provisional repair
Water source	Senegal R.	Gorgol R.	Gorgol R.	Gorgol R.	Gorgol R.
Cooperatives	Active	Active	Active	Active	Not Active

Source: APD Vallée du Gorgol, SONADER, CID, SCET-RIM, 2004

These areas are studied and planned in the PDIAIM, and additional repair works have gradually started.

3 EXISTING CONDITIONS OF THE STUDY AREA

3.1 Location and Administrative Divisions

The Study area is located at the southern part of the Gorgol region (capital: Kaedi) and the lowland of Gorgol river basin. Gorgol region consists of 4 departments, Kaedi, M'Bout, Maghama and Monguel.

The Gorgol region has a relatively better access to the precious water resources in the Country with the Gorgol river at the north, and Senegal river running along the southwest of the region. Gorgol river stretches to the east to Assaba region and then to the north to Brakna region. Since irrigated agriculture is only carried out in Foum Gleita, Lexeiba, and the areas near Kaedi, the Study is focused on only these areas.

3.2 Natural Conditions

3.2.1 Climate (Kaedi meteorological station)

The monthly mean of maximum temperature is 41.6℃ in May and the minimum temperature is 17.2℃ in January. The maximum temperature of 40℃ lasts from May to July. The annual mean precipitation is 255.6mm concentrated between July to September in the rainy season. The monthly mean of maximum humidity is 81.8% in August, and the minimum humidity is 11.9% in April. As the characteristics of target area, heat wave of Sudan climate zone called 'Harmattan' often occurs in May. The maximum rainfall is usually 50mm/day, and based on a 10 year probability, it is estimated as 100mm/day, and a continuous spell of heavy rainfall is rare.

3.2.2 Hydrology

(1) Hydrographic Basin

The area of Gorgol river basin is 21,000 km^2, which is extended to 185km length. The sources of tributaries of the main white and black Gorgol rivers are located at the Assaba State with a low mountainous area (600 m high). The black Gorgol river traverses along Wa-Wa hills (100-170 m high) where the Foum Gleita dam is located. From the starting point, the black Gorgol river runs to the eastern side to the dam, where as the white Gorgol river flows to the south and western side, and finally both the rivers meet at the confluence. At the confluence, the basin area of black Gorgol river is a little larger than white Gorgol river, but the average basin area of each river is 8,000 km^2. The annual mean discharge of black Gorgol river is 343 million m^3, where as that of white Gorgol river is 87 million m^3. However, it was estimated that the annual storage of the reservoir is about 880 million m^3 based on the measured water level of the reservoir in the past 10 years.

(2) Flood

After completion of the dam in 1983, the major floods in Foum Gleita were recorded in 1994, 2007, and 2009. The largest flood, which occurs once in every seven years, occurred in 2007 damaged the low parts of the area, and almost all the area was flooded with the flood lasting for one month period. Even though the area was flooded, the damage was not so serious because of the recession of flood waters with a few days.

(3) Kaedi Floodgate and Foum Gleita dam

Kaedi Floodgate which is located at the junction of Gorgol river and its main river, Senegal river is operated intricately depending on the water level. On the other hand, there is no electricity, tap water and vehicle and it is especially a hard working environment for manager and operators in the rainy season. These impacts also influence on the flooding of the Study area.

3.2.3 Topography and Geology

On both the sides of the black Gorgol river at the downstream of the dam site, the conditions are extremely different with no fresh rocks out-cropping. In general, it is formed by gentle sloppy area and covered with fine sand, silt or clay-rich alluvial formation for a few meters of thickness which were transported by black Gorgol river. The alluvial area on both the sides of the black Gorgol river has a slope of 1/400～1/600 which are used as agricultural lands.

In a part of the area along the river, there is a reddish brown monogranular accumulation. The origin seems to be the sands which were blown by the wind from the desert area. This fine-grained sand is transported from mountainous slope of the dam site into the main watercourse at Foum Gleita in the rainy season and has been causing siltation in the area.

There are still moderate low hills around Foum Gleita farming lands. They are the monadnock formed by high angled decayed rocks running in N-S direction. The sediments are composed of quartz, and hence these areas are not suitable for farming.

Black Gorgol river is flowing down the center of the irrigated area of Foum Gleita from east to west direction. The riverbed around Foum Gleita has a low inclination of 1/4000. The inclination at further downstream is the same or lower and hence, the flood near to Kaedi and Lexeiba often affects Foum Gleita.

3.2.4 Groundwater

The Study area consists of schist and quartz, and hence, there is anisotropy on seepage of the rock. Since anisotropy and stratification on these strata permeability are high, vertical boring exploration for groundwater, capturing shallow groundwater is not easier. Therefore, Foum Gleita villages have only a few wells which are actually used among the wells which were dug for appraising groundwater. In this area, only 5 wells are available with good quality groundwater and are used to supply drinking water to the villagers. One of the wells is in D'Dakhla village located in the downstream edge of P-2 main watercourse. Two wells are in El Wihda and another two wells are in El Adala located at the downstream edge of P-2 main watercourse. There is one well in the right side at the downstream of Foum Gleita, but it is not used.

The sediments are deposited horizontally in the alluvial formation close to the Gorgol river which are used as farmland area. It is expected that the groundwater level of the area is the same as the black Gorgol river forming the groundwater surface parallel to the river. However, since the river course and the farmland area have a height differences of more than 2-3 m, agricultural products are not affected by the high water level, except during the flood periods.

3.2.5 Water Quality

Simple water quality tests were carried out to analyze the well water around Foum Gleita villages. The concentrations of NH_4, NO_2, NO_3, and PO_4 which indicate the pollution due to farm fertilizers, decomposed animal and plants and manures, were below the acceptable standard values, and hence the groundwater was not polluted. The pH values of the water measured were close to neutral, and the water quality was suitable for drinking purpose.

On the other hand, based on the results of water quality analysis of reservoir water and the main watercourse which receives its water from the reservoir of Foum Gleita dam, it was clarified that the NO_3 content of water of the watercourse is close to the marginal tolerance level and the NO_2 content of the water is not at the satisfactory level. It was informed that most of the people who drink this water newly would be affected by drinking this water. Moreover, the water contains lots of fine-grained suspended solids materials which are not settled under the natural conditions, and the suspended particles are highly visible.

3.2.6 Soils

The soil survey (soil map of 1/50,000) for the project area was carried out in 1977. The main soils in the project area are as follows.

- The soils of vertisols developed on alluvium with a minimum drainage capacity - These soils are distributed at the downstream area of the project area. They are fine textured deep soils with a low permeability.
- The humic soils developed under the climate of high temperature in rainy season - These soils are distributed in the base slope of the terraces and plateaus on both the sides of the valley and tributaries. They are characterized by fine to medium texture including the presence of a shallow stony horizon (quartzite, schist).

The aptitude of the soils of the Study area is classified into the following 3 categories:

1. The soils located along the alluvial valley, which are deep, having a fine texture (20-25% clay) with an average permeability, and are suitable for all crops including rice.
2. The soils located on the left bank with the same characteristics of the first group but are shallower, and are suitable for mixed farming.
3. The deep soils in the floodplain with a finer texture (25-35% clay), and are suitable for rice cultivation.

3.3 Agriculture

3.3.1 Agricultural Land Use

(1) Land ownership and use rights in Gorgol region

The Gorgol region has an area of 13,891 sq. km including 88,000 ha (6%) of cultivable area of which 41,000 ha (3%) is presently cultivated. The shares of SONADER's management area including controlled recession area, flood recession area, and irrigated area occupy 80%, 30%, 15% respectively, and occupy a high productivity area in the country. Although the 4,500 ha of irrigated area was developed already in the Gorgol region, only 2,000 ha, which is equivalent to less than half of the developed area was cultivated. It is because of the fact that the two major zones, PPG II had a serious damage by flood and the Foum Gleita irrigated project suffered from a drastic reduction of functions of the irrigated areas.

In regard to land use of each irrigated zone, rice monoculture is cultivated in PPG I and II in the rainy season. In Lexeiba, rice cultivation in rainy season, and vegetable cultivation in cold dry season are practiced. In Foum Gleita, rice cultivation in rainy season and vegetable cultivation in cold dry season are practiced in different farms (one seasonal crop).

In regard to land ownership, after the land legislation law in 1983, it is stated that the land ownership in general, belongs to the country. However, if the land is developed and used through a certain procedure, the user can maintain the land ownership by law. In order to standardize the land ownership, the Government recommends registration and approval of land ownership. However, generally, land is used in the regular habitual practice without following a legal procedure, except for the land areas which are developed by the government.

Land ownership and land use rights in Gorgol river basin are different from each area. In PPG I and PPG II, land ownership of farm lands was granted already for a part of the area, but in FG, only the land cultivation rights are given to the farmers.

(2) Land use in Foum Gleita

The developed area in Foum Gleita is 1,944 ha, but the actual cultivated area is decreasing after reaching the peak cultivation area in the beginning of 1990s.

From this Study, it was found out that the total cultivated area from 2007-08 to 2009-10, was 692.5 ha in total in 2009-2010, and 610.0 ha of them was cultivated inside the project area, and 82.5 ha was cultivated outside the project area.

The area outside the project area was initially called as illegal intake area, but in consideration of the fact that most of the cases are the farmers who have cultivation rights in the project area, and their relatives, and they moved their cultivation area close to the main canal where it is easy to obtain water due to declining of water in the main canal. Most of the farmers and SONADER do not consider it as a major problem since the cultivators are the farmers or their relatives. In some areas, rice production in rainy season and vegetable production is practiced, and SONADER also encourages vegetable farming. According to the personnel related to the project, there was no cultivation outside the project area when the facility was working well. It was recognized absolutely as a temporary provision and the problem can be resolved after rehabilitation.

3.3.2 Agricultural Production

(1) Agricultural Production in Gorgol Region

In Gorgol region, the agricultural practices are characterized by different systems based on the agro-ecological zones:

- Rainfed agriculture on the arable lands known as ‘Diéri’
- Flood-recession agriculture in the flood-prone areas of the valley known as ‘Walo’
- Controlled recession agriculture where ‘walo’ is enhanced by the presence of a dike to broaden the flooded area and retain water longer.
- Agriculture in lowland areas, known as ‘Bas fond’
- Irrigated agriculture along the Gorgol and Senegal river

Traditionally, rainfed (Diéri) cultivation is the most practiced method for a long time. However, because of the changes in the rainfall pattern, the area under rainfed cultivation is reduced. The major crops grown under rainfed condition are sorghum, millet and maize along with cowpea, water-melon and peanuts.

'Walo' (Flood recession) cultivation is the dominant type of cultivation in the Gorgol region. The cultivated area varies from year to year, but the flood recession cultivation is always practiced. Generally the farmers grow millet, sorghum, and maize.

The areas covered by different agricultural practices are shown below.

Table 3.3.1 Agricultural Area under different Systems in Gorgol Region

Agricultural Season (2004 – 2005)				Agricultural Season (2005 – 2006)		
System	**Area (ha)**	**Yield (t/ha)**	**Production(t)**	**Area (ha)**	**Yield (t/ha)**	**Production (t)**
Rainfed	20,400	0.2	4,080	17,580	0.6	10,548
Flood Recession	50,00	0.4	2,100	12,000	-	-
Controlled Recession	6,500	0.8	5,200	8,000	-	-
Lowland	1,600	0.7	1,120	3,000	-	-

Source: Gorgol En Chiffres, Office National de la Statistique, 2008

In Gorgol region, the introduction of irrigated agriculture started from middle of 1970s. PPG I was among the first irrigated agriculture projects in Mauritania. The rest of the irrigated agriculture projects started after 1980 after the construction of Foum Gleita dam.

The major part of irrigated agriculture areas are between Kaedi, where the two of the projects PPG I and PPG II are located, and, Foum Gleita where the Foum Gleita project was developed by the water from Foum Gleita dam. In PPG I and II , only rice is cultivated in rainy season. Some farmers whose areas in the range of 0.5 - 6 ha are located close to the Gorgol river, are cultivating some vegetables using their private pumps.

Rice is the major crop cultivated in the irrigated area of Gorgol region, and an average yield of 4.0 t/ha is obtained in PPG I and Lexeiba. In Foum Gleita, the average yield obtained is 3.2 t/ha, which is lower because of the sub-optimal farming practices including use of low inputs, improper farming schedule etc.

Vegetables are cultivated both in Lexeiba and Foum Gleita. In comparison between the vegetable areas of Lexeiba and Foum Gleita, the yield of Lexeiba, which is more organized and follows better agricultural practices, is higher than Foum Gleita, which follows poor agricultural practices. The ladies cooperatives in FG are interested in vegetable cultivation, but they do not have economic support to buy necessary inputs.

In addition to crops and vegetables, banana, lemon, guava and mango are cultivated in small scale in PPG I and Lexeiba.

(2) Agricultural Production in Foum Gleita

In Foum Gleita, cultivation is normally carried out in three seasons (rainy season, cold dry season and hot dry season) depending on the crop. While irrigated rice is cultivated mainly during rainy season (June to November), it is also cultivated during hot dry season ('Contre Saison Chaude' CSC; February to May) in some areas of the project, where the irrigation water is available. Maize and sorghum are cultivated during cold dry season ('Contre Saison Froide' – CSF; October to February-March), and rainy season either with or without irrigated conditions. Vegetables (onion, sweet potato, cabbage, carrot, tomato, and okra) are cultivated during cold dry season, and sweet potato & okra are cultivated throughout the year under irrigated condition.

The area of rice cultivation was at its peak during the two seasons of 1990-91 and 1991-92. Since there was a flood in 1993-4, the area of cultivation was reduced by more than 1,000 ha area. Similarly, the area of cultivation again reduced after the flood in 1999.

(3) Cropping Conditions in 2006-07

Rice and maize were cultivated in area of 501.5 ha (rainy and CSC seasons) and 117 ha (rainy and CSF seasons) respectively. The vegetables were cultivated 82 ha mostly during CSF season, while sweet potato was cultivated throughout the year.

3.3.3 Farm Management

(1) Availability of Inputs

Availability and accessibility of the inputs including seeds and fertilizers (especially for Foum Gleita) is a major constraint because of their high cost forcing the farmers to obtain loan from the government and private agencies. Because of the high interest rate (>14%), the farmers cannot obtain enough loan which force them to use lower amount of fertilizers than the recommended amount.

The credit is usually obtained from UNCACEM through the unions of the Agricultural cooperatives (guarantor of the credit) on the basis of area to be exploited. Having refunded of 100% of the loan is required to be eligible for a new credit. Although the cooperatives of PPG1, 2 and Lexeiba manages to obtain loans each year by proper repayment, Foum Gleita farmers could not repay the loan after 1999 flood, and therefore it is pending for the last 7-8 years. Therefore, the farmers are forced to borrow loans from private money lenders such as business merchants in Kaedi and thereby they are obliged to sell their products to those merchants at a lower price. In combination with degradation of irrigation canals, inability to buy inputs also forces the farmers to cultivate only in a smaller area. In addition, because of the improper management of union, purchasing of inputs is delayed, which also delays the cropping period.

(2) Farm Machinery

In Gorgol region, shortage of farm machinery is one of the serious constraints which are reported by almost all the farmers in the region. Currently, there are only 4 tractors and one harvesting machine in PPG I , and II , and there are 2 tractors in Lexeiba. These are owned by private farmers and are lent to the farmers with a rate of 12,000 UM/ha for the tractor and 22,000 UM/ha for the harvesting machine.

In Foum Gleita, all the farming operations are done manually using farm animals including cattle and donkeys. Since all the operations are done manually, the farming operations are delayed, and the farmers could not follow their farming schedules.

(3) Livestock Breeding

Livestock breeding is one of the socio-economical activities practiced by the population of the Gorgol region, and about 10% of the working population is involved only in breeding activities. Besides, most of the farming households breed livestock cattle, goat, sheet or donkey on a smaller scale. Apart from milk, these animals are also used for farming and transport purposes. Most of the farm household breed livestock as 'savings and prestige' for the family.

Drinking water facility for these livestock is not enough and watering livestock became social problem such as damages not only on agricultural crops, but also on canals and other public facilities. Drinking water is a major constraint for the livestock in Foum Gleita, too. They mostly drink in the canals, and thereby causing a lot of disturbance in the canals.

3.3.4 Agro economy

The median value of the respondents in Foum Gleita was 1,600 kg/ha of production (paddy), 47 UM / kg of selling price and 77,500 UM of income, if all the production were sold. Compared to the median value of the respondents in Lexeiba, the production and prices are low, and the income per hectare is also 6 times lower.

In regard to cost of inputs, the share of fertilizer (urea) was high in all the three areas. Although 300 kg/ha of urea were applied in Lexeiba and Kaedi, only 200 kg/ha were applied in Foum Gleita. In Foum Gleita, the farmers currently do not pay the water charge, but at Lexeiba, and Kaedi, they pay high costs of fuel for the pump as the major expense.

In regard to labor input for each type of farm work, it was found that protection against birds and animals was a heavy task in Foum Gleita. The median value of total labor input was 191,333 UM at Foum Gleita, which is 2.5 times more than the income, in case of selling the entire production (77,500 UM).

Thus, due to the low incomes and high costs at Foum Gleita, the median of return was 23,783 UM even if they sell their entire production and exclude the labor cost. If the labor cost was included,

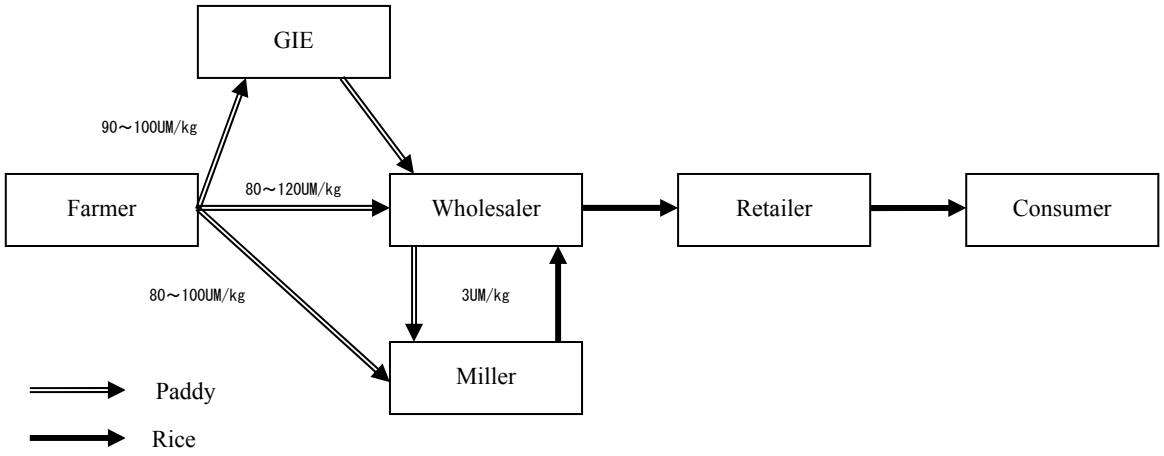
the median of return was -167,314 UM. Since the benefits of rice in a year do not even cover one month's salary of the adult workforce, the rice profitability shall be considered to be low. If the information given by fewer than twenty respondents at Foum Gleita reflected all the farmers engaged in rice growing, it could be concluded that the development of the area will not be possible only by the rehabilitation of irrigation facilities. Therefore, in consideration of various aspects, it is necessary to plan for the improvement to increase profitability.

On the other hand, most respondents who already produce rice regularly said that they would continue rice production and the majority of those who do not produce rice regularly said that they will cultivate if the water is delivered up to their plots after rehabilitation. Rice is an essential staple food of the villagers in Foum Gleita, who are eager to cultivate rice. However, for the sustainable development of this area, it is necessary to overcome every obstacle which results in the low profitability.

3.3.5 Marketing of Agricultural Produces

(1) Marketing of Rice

The marketing of rice is successively guaranteed by the State institution SONIMEX (Société Nationale d'Importation et d'Exportation) and a pool of importers link between imports and local purchase with the SONIMEX as the leading institution. The farmers are organizing GIE :Groupement d'Intérêt Économique (Economic Interest Group) receiving funds from the Credit Agricole, and this GIEs purchase the rice from farmers at a fixed price, and then sell them to SONIMEX. The general flow of marketing of rice in Gorgol region is shown below.



Marketing of Rice in Gorgol Region

The farmers have different options to sell their produce. They can sell it to GIE at a standard price, or they can sell it to a wholesaler or a miller based on the price. Sometimes, the farmers borrow the money from businessman to buy his inputs, and in most cases, they are obliged to sell the produce to the businessmen at the price fixed by the businessman which is called as ‘Thalasse’ system

(2) Marketing of Vegetables

Similar to rice, the vegetables from Gogol region are sold to cities such as Kaedi, Selibabi, Rosso, Nouakchott etc. The vegetables of Foum Gleita are mostly are cultivated by ladies cooperatives and sent to Kaedi, M'bout, Selibabi, and Nouakchott by hiring truck. In Foum Gleita, there is also a GIE to buy the sweet potato at a fixed price.

3.4 Rural Society

3.4.1 Existing conditions of Rural Society

In Mauritania, the percentage of people under poverty line of US$ 1.0 per day is 47% of the country, of which three forth is living in the rural area. Gorgol region is one of the poorest regions in the county.

Gorgol region has a population of around 300,000, 10% of the country, of which 75% are living in the rural areas. Kaedi department and M'Bout department has a population of about 100,000 people respectively.

In terms of population by industry, about 63% of the population in Gorgol region are engaged in agriculture and 10% are engaged in livestock, with a total of 73% which is more than twice of the national average of 35%, and agriculture is considered to be the primary industry of the region. Although people are engaged in agriculture, most of them rely on unstable rainfed agriculture or flood recession agriculture. Therefore, irrigated agriculture is very important so as to have stable agricultural production.

In regard to education, the students entering the elementary school are about 30% below the national average, and not even reached 50%. The literacy rate is 29%, which is not even one-third of the population. The present situation of both the indicators are at the worst level, and left far behind at the country level. During the workshop in Foum Gleita, it was found that even representatives of union could not write their own name.

3.4.2 Agricultural Cooperatives

The cooperatives, the union and Groupement d'Intérêt Économique（GIE）are the important farmers' organization in the Study Area.

These characteristics of farmers'organization are summarized as below.

Table 3.4.1 Characteristics of Each Farmers' Cooperatives

Item	Union	Cooperative	GIE
Objective	Alliance of local cooperatives. External activity to protect members' benefit	Cooperating organization to increase agricultural productivity and to improve farmers economic and social status	Organization for buying agricultural products by farmers, which were produced by farmers, and sell them to outside
Scale	Composed of a few dozen of representatives from member cooperatives (3 for each), represent several hundred - thousand people	Composed of a few-200 people, all relatives or locally related	Generally, GIE is placed in Union. Composed of some of union members.
Officers	7 - a few dozen of people including president, vice president, secretary, accountant	3-7 people including president, vice president, secretary	3-7people including president, vice president, secretary

Generally, the fee system for the famers in the irrigated area includes two types: fixed fee and variable fee which are both targets of agricultural finance.

3.4.3 Roles of Women

Traditionally, the literacy and education rate of women are low, and often their participation in social activities is limited. They must manage the household, children, fields, livestock and fetching of water which takes a lot of time. The status of women is different depending on the community such as Arab or African, since the former women are usually confined inside the house while the man working outside, the later women actively participate in outdoor activities and are apparently very strong.

The ladies cooperatives are expanding various activities of livelihood improvement. In Foum Gleita, 49 ladies cooperatives with 2,700 members have formed 2 unions and cultivate 86 ha of vegetables. The land area per cooperative is 1.7 ha which is very small, but there are at least 55 ladies farmers who work there. Although it is not more than 0.03 ha of land per person, they practice intensive cultivation and marketing. Most of the cooperatives are very active and some groups are engaged in vegetable cultivation for over 20 years.

3.4.4 Results of Rural Society Survey

The farmers in Foum Gleita were classified into six categories based on the conditions of the village as shown below; (a) Persons whose home village were submerged by the dam, (b) Persons whose home village was located near the dam, but were submerged, (c) Persons whose home village become a settlement village, (d) Persons who were settled from around Foum Gleita irrigation area but whose home village still exists., (e) Persons from far away areas (around M'bout) but the home village still exist., (f) Persons who refused to be displaced. These respondents of various situations responded based on various kinds of expectations.

(1) Maintenance and Management of Irrigation Facilities

Since the payment of the water charges were low and the collected water charges were not managed properly, there was no maintenance fund for irrigation facilities. Though the main facilities with the declined capacity were operated by SONADER, the operation and maintenance was not carried out properly.

(2) Procurement of Agricultural Inputs

In the first year of migration SONADER distributed the inputs freely, and after the second year, they were provided at a relatively lower price. When the procurement system was changed to UCAF to UNCACEM route, the prices of inputs also increased. In addition, when the functions of the irrigation facilities were declined, the yield also decreased gradually, and it became difficult to repay the input loan.

(3) Obstructive Factor of Motivation to Production

In regard to lack of motivation, some farmers responded that they would be motivated, if they receive the ownership for their cultivated lands. The farmers who were cultivating in the same project area, and received cultivation rights later are interested to have land ownership rights.

Low motivation to production of farmers was caused by the flood damage and the loss or declining of yields, making it impossible for the farmers to pay the water charges and refund the loans.

(4) Distrust of SONADER and Union(UCAF)

The dysfunctional organization occurred at upper level of agricultural cooperatives such as union, and SONADER was understood from the hearing survey of the farmers.

SONADER gained the confidence of many farmers through the activities at the starting of the project. However, the distrust among the farmers started to appear due to unclear decision-making process in each period. Moreover, at the important periods when the repairs were needed the most, improper fund management was exposed, which caused the distrust on SONADER.

In regard to UCAF, the meaning and purpose of its establishment was not clearly explained by SONADER. Therefore from the beginning, they distrust UCAF. Additionally, the suspicion grew because its most influential members were selected by SONADER and have not been changed for a long time.

3.5 Agriculture Supporting System

3.5.1 Farmers supporting organization

The authorities providing assistance to the farmers are MDR and SONADER. In January 2009, National Society of Agricultural development and Works (Société Nationale des Aménagements

Agricoles et de Travaux - SNAAT） was officially launched as a public corporation for management and provision of agricultural machinery. Although its capabilities are not yet known, it is expected to work well since there is a high demand for agricultural machinery in the country.

(1) Ministry of Rural Development

Ministry of Rural Development consists of six divisions (Administration and Finance, Policy, Cooperation and Monitoring, Agriculture, Livestock, Research, Training and Extension and Rural Development) and there are local offices in the regional and department level. SONADER and CNRADA are functioning under MDR.

(2) SONADER

SONADER was established in 1975 mainly to implement and manage agricultural water projects. Initially, it mainly implemented irrigation projects and worked on various fields such as agricultural credit, supply and mechanization, extension, training and organizing of farmers. After the implementation of the national plan of readjustment in 1988, its duties were limited to studies and implementation of irrigation projects, and maintenance of project areas, extension to farmers and organizing of cooperatives.

At the central level of SONADER, it consists of four departments (Research and Facilities, Extension, Planning and Monitoring, and Administration and Finance). At the local level, it consists of five local offices (Brakna, Guidimakha, Gorgol, Tagant, and Trarza) and two project offices (Foum Gleita, Rkiz).

The main role of SONADER work is implementation of projects. Except for the ongoing projects, it has virtually no budget for maintenance costs, vehicles and fuel, purchase of office supplies, and the distribution at the regional level is irregular. When the study of irrigated agricultural development program in Senegal river (completed in 1997) was conducted, the SONADER had 323 staff, but today it has only 197 staff. At the Foum Gleita office, no staff has transportation facility except the chief, which is the main obstacle for the extension activities, and maintenance and monitoring of the dam.

(3) SNAAT

SNAAT is an agency dealing with the agricultural machinery and heavy machinery. It was sets up for agricultural development and food security as its mission and has 4 major sectors such as 1. Agriculture (general), 2. Irrigated agriculture, 3. Land improvement projects, 4. Survey. It was established in January 2009.

It is a public corporation, but is registered as an enterprise and participates in the bidding of public works and succeeded. The contract program with government is available similar to SONADER, but basically the income is attained though projects. It also deals with the requests from

agricultural cooperatives for providing agricultural machineries.

All the equipments were provided by the government and their major donor was Japanese 2KR program in 2006, and the government's purchase of equipments in 2009. The government provided was 8 billion UM including 2 crop dusting planes, but they have not yet arrived. The machinery is stored temporarily in a yard in Rosso, and a new warehouse is planned with 40,000 m^2 where the storage and maintenance will be done in the future.

Presently, the major operations are only in the headquarters of Rosso (office + garage) and a mobile office in Boghe, but an additional local office is considered in the future. If there are requests in the future, it is also possible to allocate permanent mechanical staffs in Foum Gleita.

3.5.2 Agricultural Extension

Agricultural extension is managed by SONADER which implemented irrigation development project and the other areas are under the control of MDR. The resources of the two agencies for the travel purpose are very limited, and hence the extension work is not implemented fully and only minimum administrative work is carried out as the main activities of extension service.

SONADER also has an extension department at the central level, and extension service in its regional office. In the Gorgol extension office, there are four extension officers in addition to a manager, who are responsible for technical extension, and there is a person-in-charge in the administration department, who is responsible for the activities related to farmers' organization. The Foum Gleita office has an extension manager, training officer and four extension officers. The extension activities are also quite limited, and mainly it is focusing on supervision of loan applications from the farmers' groups and monitoring of the activities.

3.5.3 Agricultural Finance

Initially SONADER was responsible to provide the agricultural finance, but the inefficiency and the negative effects became so obvious that the Government set up the agricultural credit for farmers groups represented by UNCACEM, which was formed as a Governmental bank in 1992. There are branch offices in Rosso and Kaedi.

The loans are offered only for rice producing farmers and farmers' group. This organization has a primary role in financing for agricultural inputs, and offers three types of loans such as short term (one crop season) in the medium term (5 years) and long term (7 years) loan. The credit rate is 14%. The short-term loans is for the purchase of fertilizers, seeds, fuel and other farm inputs and must be repaid at the end of the harvest. The medium and the long-term loans are for the purchase of farm equipment, maintenance of facilities for medium and large size. For the small scale farmers in rural area, UNCACEM plays an important role, because they don't have a choice except using a high interest loan by the business men.

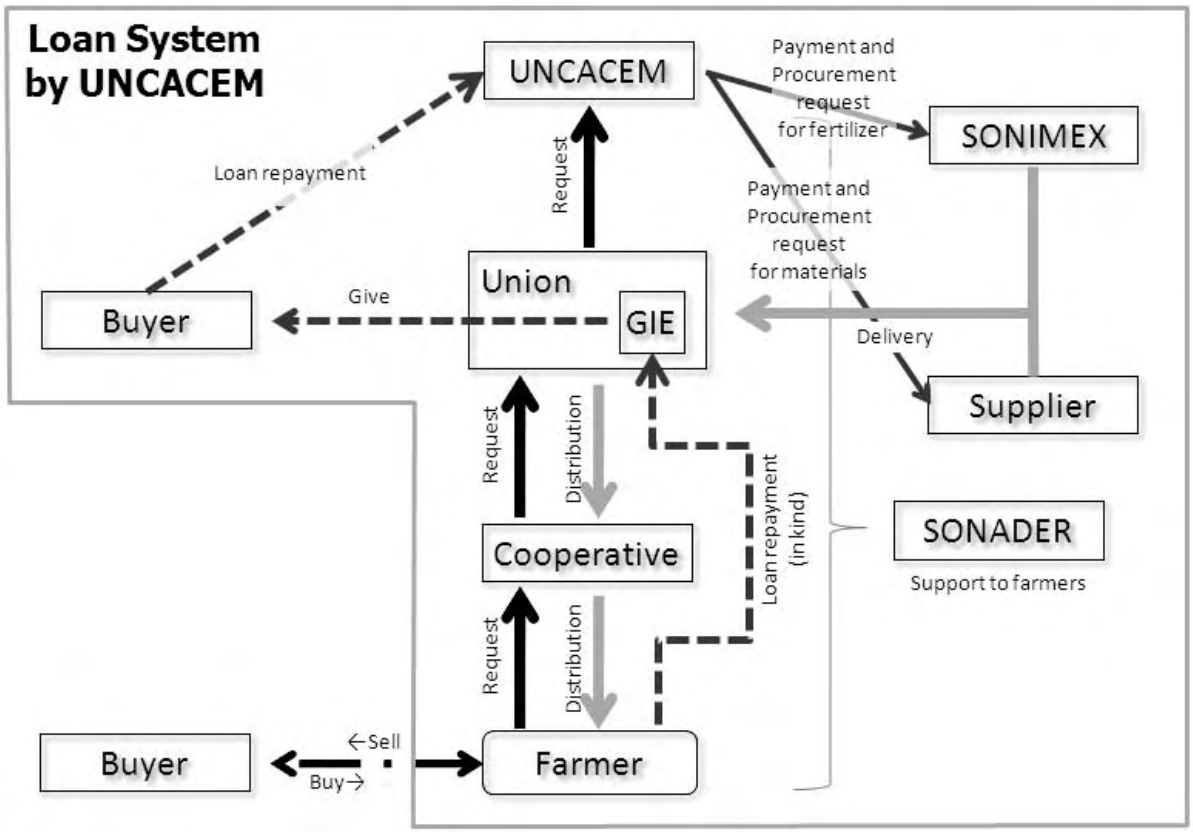


Figure 3.5.1 Flow of Loan Procurement in the Study Area

Among the 3 loans, the short term loan is the most important one, and the major bottleneck which affects the cropping plan is the short-term UNCACEM loan procedure, which takes time for every cropping season. Moreover, especially in the case of FG, the loan could not be used for a long period because of past debt. However, presently, the government changed the policy such that the loan of 2008/09 would be available even for the farmers group having debt. In 2010, it would be less burden for small scale farmers because the government decided 1. to reduce half of the debt from UNCACEM, 2. to extend the repayment period for paying the half of the previous loans.

3.6 Irrigation and Drainage

3.6.1 Existing Irrigated Agriculture Development Plan

(1) Foum Gleita Irrigated Agriculture Development Plan

Foum Gleita irrigated agriculture development plan was prepared in the mid 1970s to fight against the poverty, and to settle the down the nomads including people living in submerged land area. In 1984, irrigated agriculture was started at the same time as the completion of the dam (Stage I). Although the area initially planned was 3,600 ha, and the objective area of the Study is 1,950 ha.

Stage I 550ha	Started in 1984
Stage II 1,400ha	Started in 1989
Stage III1,670ha	not yet started in 2008

(2) Study by PADIUM

In PDIAIM, the revival of irrigated area of Foum Gleita was an important component and made a Study twice supporting by World Bank in July 2006(APD I) and June 2007(APD II). Since the result of Study is important as basic of this development study, its adequacy should be verified in this Study.

In this study, it is proposed the analysis of dysfunctions of the facilities, current situation of the facilities, concrete lining for the principal canal. As the results of reviewed, analysis of current situation and work planning was determined as reasonable and rehabilitation of irrigation facility plan in this study almost follows the contents.

3.6.2 Outline of Foum Gleita Dam

Foum Gleita dam is a Concrete arch dam with a height of 45m. The Foum Gleita dam was built to irrigate 25,000 ha of dry farmland between the dam and Kaédi, stretched over a distance of 100 km downstream from the dam. Its characteristics are as follows:

River： Black Gorgol valley on the northern mountain chain Wa-Wa
Dam area： 8,950km^2
Gross storage of normal water level (33.80m)： 500MCM (Effective Storage：400MCM)
Reservoir area of normal water level(33.80m)： 159.2km^2
Period of construction： 1981-1984

3.6.3 Irrigation and Drainage Facilities of Foum Gleita project

(1) Principal Canal

The irrigation water conveyance to the irrigated area is taken from tunnel of left bank of the dam, and the flow is controlled by a radial gate (hydraulic gear broken). After the gate, the water is conveyed by gravity through the principal canal. From the gate, the water is conveyed by the earthen canal until the round diversion facility located at 3.5 km downstream at the junction of the right and left bank. At this point, OA is divided into principal canal AD (for irrigated area of the right bank) and the principal canal AG (for left bank).

Principal	Area(ha)	Q(m3/s)	L (km)	Lf (m)	Lc (m)	H (m)	Canal gradient
OA (main)	3614	10.73	3,781	8.0	2.5	2.99	0.000074
AD (right)	1144	3.12	1,821	3.5	2.5	2.56-2.54	0.0000286-345
AG (left)	2470	7.33	3,005	6.0	2.5	3.22-3.20	0.000024

(2) Primary Canal

P1 primary canal distributes water to secondary canals S1 to S10 which irrigates on the right bank of Black Gorgol. P2 primary canal distributes water to the secondary canal S16 to S27 which irrigates the left bank. The characteristics of primary canal are mentioned below.

Primary	Area 1 (ha)	Area 2 (ha)	Q (m3/s)	L (km)	Lf (m)	Lc (m)	H (m)	Gradient
P1 (right)	810	1,144	3.0 0.9	8.180	3.50 1.50	2.50 1.50	2.54 1.02	0.0001
P2 (left)	1,134	2,470	7.13 3.5	11.805	6.0 4.0	2.50 2.50	3.21 2.50	0.00003

(3) Secondary Canal

Secondary canal is also an earthen canal. These canals are directly divided from the primary canal P1 (right bank) and the primary canal P2 (left bank), and there are 10 canals in P1 and 12 canals in P2. There are also 10 tertiary canals which are divided from the secondary canals. Irrigated water of secondary canal is supplied to the field through tertiary canal.

(4) Primary Drain

Primary Drain is 13m to 25 m wide and the total length of canal is 5.8km. The secondary drainage canals are 0.5 to 6.0 m wide and its total length of the canal is 30.7km.

(5) Main Water Structures

The principal canal and the primary canal crosses tributaries flown from outside the area to Gorgol at the siphon (3 places) and aqueducts (2 places). They are all made of reinforced concrete.

(6) Farm Road and Additional facilities

The farm road was constructed by the soil drilled from drainage canals along almost all the drain and secondary canals with a width of 3m. Currently they are partly covered with low shrubs and are partly usable. There are about 80 km of length in total and fertilizers and agricultural products are transported by donkey.

3.6.4 Situation of Irrigation and Drainage

The canals serve drinking water for livestock which caused damage on the inner slope of the canals. The soils were piling up at the bottom of canals, which reduced the cross section area of flow. Furthermore, typha growth caused decreasing of water flow and the fallow lands were invaded and covered with bush which was worse than other project area.

However, the concrete structures were obviously constructed stronger, and the water supply facilities are secure. It is necessary large rehabilitation for the upper Siphon of the principal canal, the gate of downstream structure (separation of drains), and it should be installed the fence for preventing animals, the watering for animals and laundry places.

Along the primary canal, there were several vulnerable places which has possibility of enormous damage on larger area if maintenance is not taken immediately. Extremely highly urgency is confirmed in the field. Therefore, this Study tries to take measurement on many of these places

through farmers' participatory approach, direct management of SONADER and reconsignment and currently risk from the damage is reduced.

3.7 Operation, Maintenance and Water Management of Irrigation and Drainage Facilities

3.7.1 Existing Conditions of Operation and Maintenance

In case of small and medium scale irrigation project (less than 200 ha), the farmers are responsible for operating and managing the facilities. In case of large scale irrigation project (over 200 ha), operation and maintenance of terminal facility is responsible for the farmers' groups and SONADER is for basic facility. In fact, in Lexeiba where small scale irrigation areas are accumulating, the irrigation facility is managed by farmers autonomously and in PPG where is big scale irrigation area, it is managed appropriately supported by engineers of SONADER. Except, in Foum Gleita, maintenance and management of basic facility by SONADER and terminal facility by farmers are insufficient. The crop acreage are decreasing up to one fifth by declining in function.

Table 3.7.1 Maintenance Situation in Each Irrigated Area

Area	Maintenance Situation
PPG I	Initially the farmers paid a fee of 16,500 UM / ha / year of which 10,000 UM were paid to union, the rest was used to provide labors. Repair of the main structures are done with the hired labors. The two operators are permanent employees to maintain the pumps with the help of engineers and technicians of SONADER. Since the site opened in 1975, only the embankment was repaired, but from 2009, a part of the rehabilitation is provided with OMVS in Programme de Gestion Intégré de l'Agriculture Irriguée en Mauritainie (PGIRE).
PPG II	Farmers paid a fixed fee of 16,500 UM/ha/year to the union. The regular maintenance and repairs of the main structures are done with the hired labor. A pump technician is a permanent employee to maintain the pumps with the help engineers and technicians of SONADER. The embankment was repaired in 2008 which was damaged by the flood of 2007. Except that, since the project area was opened in 1997, no special rehabilitation has been made.
Lexeiba	Between 1993 and 1996, the farmers paid a maintenance fee of 3,000 UM/ha/year to SONADER, but currently the cooperative members operate and maintain the structures by themselves, and some cooperatives established fund assessment system. Since the facility was constructed by them, the minimum function has been maintained. The pumps are evacuated during the floods. Applications from many irrigated areas have been sent to PDIAIM rehabilitation project (70% - government, 20% - long-term loan and 10% - the expense of farmers) 10 years ago, but only one was fulfilled the requirement and selected.
Foum Gleita	When the facilities of Foum Gleita were completed, SONADER's position was weakened because of restructuring, and hence, the operating and maintenance system have been at a very low level. Until the early 1990, the farmers used to pay 16,500 UM/ha/year to SONADER, but then the charge was reduced and the share of labor charge increased. Until 1999, the management fees were provided, but in 2000, after the extensive damage and loss of crops, the government exempted the farmers from this charge and therefore the money has no longer been collected. Until 2002, SONADER made rounds to inspect the facilities, but after the loss of the vehicle, they were interrupted. Currently, the farmers groups are involved in the management of the canals at the downstream of the network, and the primary canals are supported by the labors hired by SONADER within its budget, which simply cut the grass or repair the earthen canals. Only in case of massive damage, the government conducts emergency treatment, but it is not fast enough and gives enormous impact on harvest. From the workshop, it was found that level of possible maintenance for farmers are grass cutting until the primary canal and dredging until tertiary canal. The dam facility is assigned to SONADER, but in fact, it has only one engineer in Foum Gleita with no vehicle and almost no budget and the access is difficult in rainy season. The engineer strives for the minimum functions of superannuated facilities, but it is far from proper maintenance and operating system of the dam and its facilities.

3.7.2 Existing Conditions of Water Management

The main water resources of Gorgol basin is Foum Gleita dam on black Gorgol river. Foum Gleita project area takes water directly from the reservoir, while the water of black Gorgol river is pumped in Lexeiba and PPG at the downstream side. SONADER is responsible for the water management, outflow of the dam and the intake of water in each area. There is no rule of operation, but when the water run short in the downstream side, more water is released from the dam in consideration of water use efficiency.

Table 3.7.2 Water Management Situation

Area	Water Management Situation
PPG I	According to an irrigation plan, the water supply is managed by the vice president of the union for the entire area. In each cooperative, there is an irrigation manager named 'Aigadie' to manage the distribution of irrigation water.
PPG II	The water management is supervised by a SONADER engineer for the entire project area. In each cooperative, there is an irrigation manager named 'Aigadie' to manage the distribution of irrigation water.
Lexeiba	In principle, there is a cooperative and a set of pumps for an irrigation area and each cooperative plans its program of intake and distribution of water independently.
Foum Gleita	Until 2000, SONADER operated the sluice operation based on the request of the farmers until the tertiary canal, but since then, as there was no vehicle, SONADER had to limit the management of intake water from the dam. To improve the situation, SONADER has trained water police who are in charge for distribution of water and was hired by farmers group on each secondary canal. The water police was selected and trained by SONADER. This system was abandoned as farmers' groups refused to pay the charge to them. The damages in P1 and P2 prevented the normal flow of water that is narrowed down to 1.2 m3 /s. Nothing is done by the union or the cooperatives, and there are not even rotations at the primary canal. Yet, the farmers recognize the importance of management when the functions of facility are restored, and they plan to comply with appropriate irrigation plan.

3.8 Basic Rural Infrastructure Facilities

3.8.1 Rural road

There is a paved road for a traveling distance of 400 km linking from the capital Nouakchott to the city Kaedi, located in the southeastern part of the country and the center of the Study. Between Kaedi and Foum Gleita, the road is under construction between Kaedi and M'bout. At a distance of 80 km east from Kaedi, it is bifurcated at Siliwa, and Base-vie which is the center of the project area is located at about 15 km from Siliwa.

Presently, the road between Kaedi to M'bout is under construction. Additionally, a road line connecting to Foum Gleita dam was already started, and it shall take 2-3 years to complete the construction of paved road. When it will be completed, it shall take only 1 hour from Kaedi to Foum Gleita throughout the year.

3.8.2 Rural Water Supply

(1) Existing Condition of Rural Water Supply

Although there is no water supply facility which covers whole Foum Gleita, there are 5 foot pump wells. In the center Base vie, the water supply network in the center Base vie was established with irrigation water in the nearby primary canal by ANEPA including a pump station, water facility and water supply tower, but after 2009, the maintenance has not been made continuously because of facility trouble.

Almost all the farmers in the irrigated area rely on irrigation canals for their living needs. However, turbidity level (less than 5NTU) and opacity (342 NTU) of the water is beyond the WHO standards, which is quite detrimental to health.

(2) Rural Water Supply Plan

The Ministry of Water Resource and Planning (Ministere de l'Hydraulique et de l'Amenagement) is responsible for planning and carrying out water supply work in rural areas targeting Gorgol region including the irrigated area with resource from the Foum Gleita dam.

In the discussion with Department of Hydraulics & Dams, it is understood that there is a plan to supply water to the villages of high-priority along the canal P2 such as Base vie and Bachatt. The villages along the primary canal P1 are also included in the plan.

3.9 Environmental Consideration

In the Initial Environment Examination, through reviewing With & Without program/project, it was defined that "in case of not implemented", poverty of farmers is more serious, and "in case of implemented", the poverty could be dramatically reduced. Since the objective of rehabilitation of irrigation & drainage is to recover the functions of existing facilities, no negative impact is expected on the environment/society such as land acquisition or forced transfer. Besides, comparatively smaller impact such as environmental prolusion and traffic accidents etc during woks will be lessened. The environmental study of the Ministry of Environment was not conducted for PDIAIM progressing project in Gorgol basin, PPG I and II. According to SONADER, environmental consideration studies are usually not made for the rehabilitation project, since its objective is to repair the original facilities.

4. VERIFICATION TRIALS

Based on the results of analysis of various problems of Foum Gleita irrigated area which were identified from this Study, it was found that the priority issues towards the revitalization of irrigated agriculture of the project area include rehabilitation of irrigation facilities, improvement of agricultural productivity, and strengthening of management of farmers' group. The verification trials were conducted in order to find out the concrete measures towards solving these issues. The outline of the

results of verification trial is summarized in the table shown below.

Table 4.1.1 Outline of Results of Verification Trial

Activity	Results	Apply for A/P
1. Participatory Management of Irrigation and Drainage Facilities	Although there was a prospective achievement for a part of the individual techniques, it could not be verified as a system because of the limitation on time and condition. If the environment is supportive enough, it is possible that the farmers' groups could operate and maintain the irrigation facilities except the basic facilities (dam, principal canal and primary canal) appropriately.	Under the right conditions such as recovering of functions of irrigation facilities, revitalization of organization and restarting of cultivation, it is necessary to strengthen the capability of SONADER and the union and renew the division of their roles in terms of operation and maintenance.
1.1 Strengthening of canals by sandbags	The local materials and techniques were utilized, and therefore, it was understood that the farmers could construct canals with the guidance of local engineers. Regarding the effect of the trials, the livestock drank water in the drinking water troughs, and was prevented from invading the canal. The embankment of the canal could be strengthened by the sandbags. Also, it was seen that the farmers volunteered to repair canal using sandbags. It means that if suitable materials such as sand bags and necessary equipment are available, the farmers will do the operation and maintenance by themselves.	It is necessary to provide the farmers about the details of the way of operation and maintenance and to construct the system of irrigation facilities for independent operation and maintenance. In this time, the trials were made only in a small area. To prevent the invasion of livestock in a wider area, it is important to build consensus of the livestock breeders and fencing of the entire area should be done by rehabilitation work.
1.2 Protection against invasion of livestock		
1.3 Removing of accumulated sands in the canals	It was verified that the farmers could do weeding and dredging at the secondary canal level. Farmers realized the increase of amount of passing water and continued to work on voluntary basis. In order to improve the work efficiency, emptying of the canal is necessary. However, systematic implementation is needed in consideration with the cropping period.	Strengthening of capacity of farmers' cooperatives is needed to plan canal cleaning and to prepare a suitable implementation system.
1.4 Clearing of typha in the canals	At the primary canal level, it was verified that the typha could be removed in both dry and in water conditions. Typha grows stronger and needs to be removed twice in a year. The water management during the typha cutting period is important, because the growth can be restricted by keeping the remaining part of typha under water.	In the O&M of beneficiaries, it is necessary to include typha removal at least once a year, or if possible, twice a year, dropping of canal water, supply of water, and right time of implementation. It is necessary to make efforts on utilizing typha.
1.5 Collection of water charge	Even though the farmers admitted the necessity of collection of water charge, it was found out that the organizational aspect needs to be improved, because UCAF is not working and SONADER is not trusted by the farmers.	Recovery of trust of SONADER and revitalization of UCAF is necessary. Besides, it is necessary to explain the farmers and to build a transparent accounting system for collecting and utilizing water charge.
1.6 Formulation of appropriate operation and maintenance plan	The water charges were not collected, cropping area was only one fifth of the total area, and the organization is not functional. It was clarified that the operation and maintenance condition was not right, and was found out that O&M system was totally absent in the project area.	It is necessary to formulate and implement appropriate operation and maintenance plan at the right time including recovery of function of irrigation facilities, revitalization of organization and restarting of agriculture cultivation.

1.7 Improving the support system of operation and maintenance by SONADER	As a result of instruction of OJT, it was verified that the staffs became actively involved, and they could instruct the farmers more efficiently on operation and maintenance. However, the limitation of transportation is the obstruction of efficient operation and maintenance for the entire area.	Ensuring the transportation of the staffs and more improvement of the ability are needed.
2. Extension Activities Based on Experimental Trials	The availability of recommended techniques to improve the yield of different crops was verified. Especially, there is a possibility for a great improvement in vegetable cultivation. Extension of these techniques will be needed in the future.	It is necessary to extend the cultivation techniques among farmers in the area. It is also important to strengthen extension structure of SONADER.
2.1 Implementation of extension activities based on experimental trials	**＜Rice＞**As a result of applying various recommended techniques while extending to the farmers, it was verified on the improvement of yield by optimum use of fertilizer, shortening of nursery period, and improvement of work efficiency by using farm machinery.	It is necessary to improve productivity with extension of various suggested techniques.
	＜Fruits Trees＞ It was confirmed that the fruits trees grow well with appropriate cultivation management. However, comparatively a high cost and labor input shall be required in the initial stage.	There is a potential in the medium and long term, and it is also expected to provide additional effects such as providing shade of tree which is valuable in the area and improvement of nutrition. Therefore, there is a possibility to introduce fruits trees in the area.
	＜Vegetables＞It was verified that the yield can be increased by 3-4 times by using the various suggested techniques. Mainly, it was a valuable income resource, and it was found out that more economic impact could be expected by the extension of techniques.	Extension of various recommended techniques shall be carried out, which shall improve the productivity and living conditions of the area. Strengthening of marketing is also expected.
	＜Multipurpose Shed＞It was verified that the multipurpose shed could be utilized by the farmers' meeting, rest, and storage; Onion was stored to delay the selling period in order to sell them at a high price.	Various diversified functions including marketing is expected. Maintenance of facility should be done properly.
2.2 Visiting advanced Area	FG farmers have very limited opportunity to visit the farms of other area. By verification trials, it was confirmed that positive exchange of opinions could be made, which is an efficient way to strengthen their knowledge and information.	It should be enforced for improvement of production techniques and to strengthen the ability of organization.
3. Strengthening of Farmers Organizations	Regarding strengthening of support system for SONADER and revitalization of UCAF, self-reliant operation could not be achieved because of time limitation. However, it was found out that there is a need to ensure the transportation of SONADER staff, and they should improve the relationship with the farmers.	Continuous improvement of ability of SONADER FG staffs and strengthening of office and organization of UCAF are expected.
3.1 Strengthening of SONADER	As a result of instruction of OJT, it was verified that staffs became active, and provided support for farmers' organization more efficiently. However, limited transportation is a major obstacle on efficient support for organization in entire area.	It is expected to ensure transportation of staffs and improve their ability.
3.2 Training of Farmers Leaders	It was verified that the organizational ability of leaders of 5 cooperatives who were engaged in the farm management of the verification trials was improved and their activities became more intensive.	Training of leaders of other cooperatives is needed in a similar way.

3.3 Strengthening of UCAF	Although the discussion of revitalization of UCAF was active, forming of a new organization could not be achieved. The main reasons were not only the time limitation, but also the deep-seated distrust of officers in UCAF and speculation of each group after reformation.	It is necessary that they achieve a self-reliant organization management and take time for discussion among the farmers for mutual understanding. Strengthening of UCAF shall be continued.

5. Formulation of Action Plan (Draft) and Model (Draft) for Gorgol Region

5.1 Issues of the Foum Gleita Project Area

5.1.1 Analysis of the History of the Project

Until the completion of facilities in 1990, the farmers in Foum Gleita were satisfied with the many inputs provided by the government and the external agencies. Therefore, the farmers relied on these support and they didn't attain sufficient self independence. The farmers who lost their land submerged by construction of the reservoir or those who lost their right of land use by the construction of irrigation facilities, received the irrigated areas as a compensation, but the basic infrastructure facilities were not constructed and they were forced to move without being adequately explained about their obligation and the future vision of the irrigated agriculture. Therefore, the dependency on the government became very strong.

After the completion, the project entered the maintenance phase. SONADER staff and the materials were downsized, and the project (Agricultural Sector Adjustment and Investment Project, Programme d'ajustement du secteur agricole, PASA) has started the reduction of government support to the farmers. While the support of strengthening of farmers' organization was provided, the dependence of farmers was still strong. Since there was not enough impact of the program, they could not establish an independent management system.

After 2000, the water charges were not collected, and SONADER also reduced its activities leading to many problems in the functioning of irrigation facilities, and finally the farmers and SONADER could not manage to solve the problems completely.

Moreover, regarding loans by UNCACEM to UCAF, repayment rate before 2002 when the loans available were very low, and only 37% of the total loan was repaid. During the period between 2002 and 2007, the loans were not available because of past debt. In 2008, the farmers were provided with loans for the agricultural year 2008-2009, which was also not repaid, and it become difficult to practice sustainable farm management without a proper farm management.

5.1.2 Problems and Countermeasures

(1) Outline

Based on the analysis of the history of the Foum Gleita project, problems and countermeasures identified from the past studies were organized in the 2 figures shown below.

As the background of malfunctioning of farmers organization, three types of problems have been identified including reduction of cultivated land, low productivity, and low price. Low productivity and low prices are the result of difficulty in access to remote Foum Gleita. The reduced supply of irrigation water led to the abandonment of farmland that was resulting in the reduction of cultivated area. Hence, the function of irrigation which was fundamental condition of irrigated agriculture was not fulfilled. Moreover, the "low productivity and low price" became impediment for the farmers who barely continue to produce and led to reduce their income and decline their irrigated agriculture in the area. Besides, there are risks of flood damage which is difficult to control.

The figure of measures is almost the opposite of with the figure of problems with recovery functions of irrigation facilities, high productivity and high price as the principal axis. It was considered that the recovery of organizational functions is the premises of these measures.

The rehabilitation for revitalization of irrigation facilities by the external assistance was mentioned additionally. These methods promote the return of the farmers and recovery of the cultivated area. At a middle term, these would improve productivity, selling prices and stabilize the incomes of farmers to active irrigated agriculture in this area.

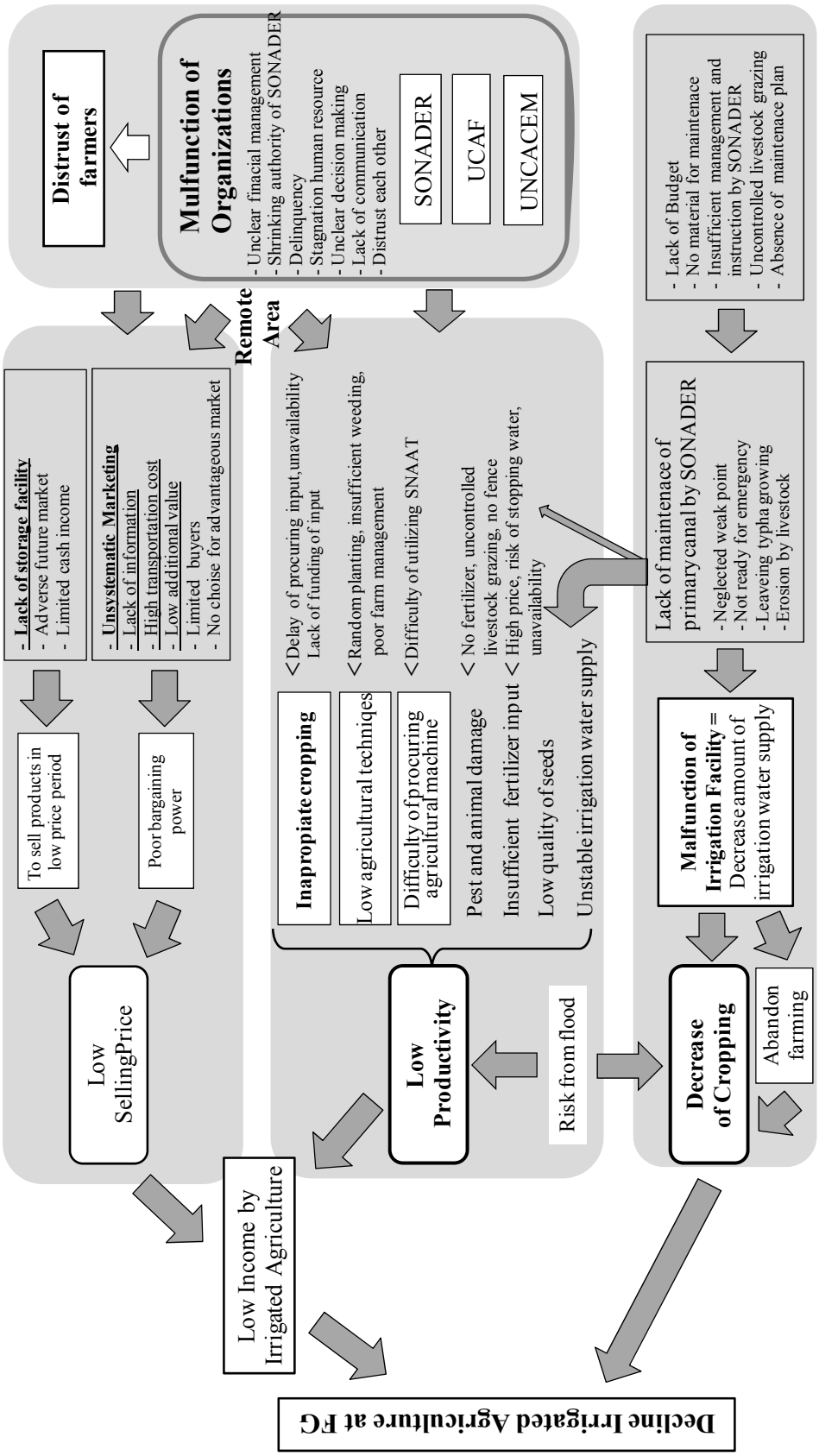


Figure 5.1.1 Associate chart of problems of Foum Gleita

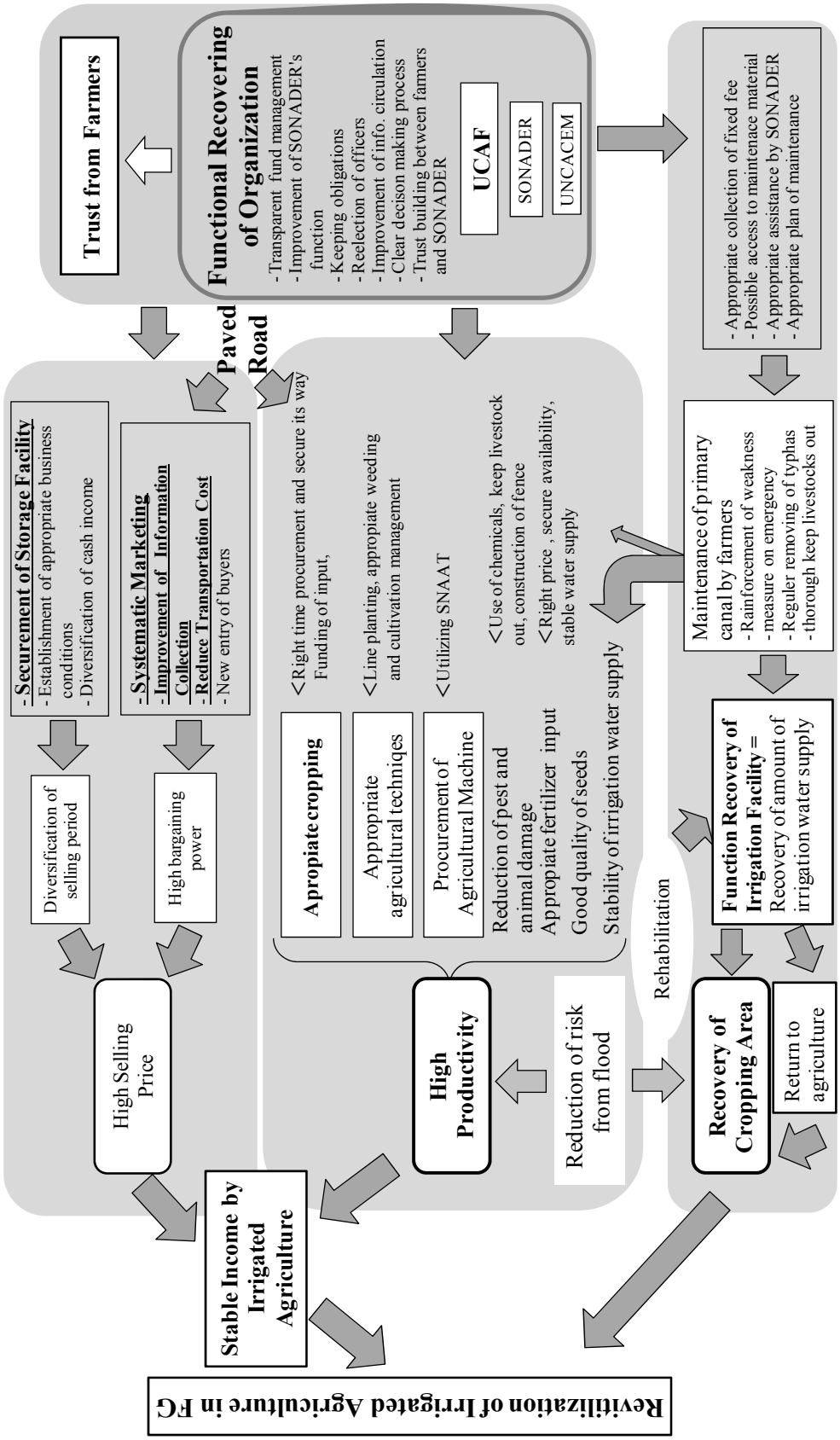


Figure 5.1.2 Relation figure of measures of Foum Gleita

5.2 Framework for A/P

Rehabilitation of cooperatives and irrigation facilities including strengthening of farmers' cooperatives and SONADER is an essential issue to development of the project area. It is necessary to attain a high productivity by appropriate agricultural techniques, and then securing of high selling price through marketing support also is important. It is explained the above from the high priority.

5.2.1 Strengthening of Farmers' Cooperatives

Strengthening of farmers who are the beneficiaries, are responsible for irrigated agriculture in Foum Gleita. Initially, since the living environment of the farmers was changed by the construction of dam and irrigated area, they have received massive aid and compensation from the government and overprotective measures were provided. However, the financial constraints of the government and the transition to a policy that demanded more independence of the farmers led to the reduction of government assistance. As beneficiaries, the farmers have not fulfilled their obligations and responsibility and had neglected the worsening of conditions. Therefore, irrigated agriculture in Foum Gleita fell became less active. To improve this situation, it is required that the farmers should have the ownership sense as beneficiaries, change their mind to gain more autonomy and to form organizations which could be rationally managed and the decisions are made democratically.

There are two kinds of farmers' organization, agricultural cooperatives and the unions (UCAF). The strengthening of these organizations was promoted through verification trial. The cooperatives are small units, and there are many units in the area. Therefore, it is difficult to know the actual condition which has low function with unclear rules. During the verification study (pilot projects), assistances were provided such as strengthening training of organization, and revising of internal regulations of the cooperatives through consensus, and a general meeting was held for the five cooperatives related to the verification trials. As a result, the cooperatives became active. Based on this condition, it is necessary to indicate the strengthening of cooperatives for further strengthening and carry on assistance.

The UCAF was dormant for a long time. However, it was influenced by different activities of the Study team, and it resumed its activities, and started the preparations for the repayments on loans. The UCAF previously managed the loans, equipments (e.g. tractors), and the collection of irrigation charges. In recent years, it is not functioning practically because of stoppage of payment of irrigation charges, frozen loans because of past debt, reduction of cultivated area and thus decreasing of the farmers in the area. During the verification trials, the Study team helped the UCAF to review its internal regulations, organize the meetings to explain to cooperatives, and to prepare for the pre-general meetings. The future has become clearer, because it needs innovative changes though awareness, and assistance of SONADER is also necessary.

5.2.2 Strengthening of SONADER

According to the information obtained in the history of SONADER the Foum Gleita SONADER office had nearly 150 staff in the project area. In 1990, after starting of the project, SONADER became responsible for the operation and maintenance of facilities, and it became a relatively smaller office, both in its structure and its activities. Furthermore, with the decline of the functions of irrigation facilities, the cultivation area was reduced to one-fifth of the total area (400 ha). Besides, the irrigation charges have not been collected, and the UCAF cannot pay back the loans, and therefore the services to be provided by SONADER Foum Gleita have become limited. While monitoring and management of Foum Gleita dam and control of water discharge quantity of the dam is one of the major tasks of SONADER, the provision of extension services to the farmers is also another major task of SONADER in which, it provides only the minimum support to the farmers.

In order to activate the project area, the support services need to be provided including the expansion of extension services, marketing and administration activities of farmers' organizations. Presently, only one full time technician is managing the Foum Gleita dam, but in consideration of the importance of the dam, it is necessary to increase the number of employees. Besides, the possibility of assigning staff to assist them in their task should also be considered. There is also a need to provide the facilities for mobility to facilitate their work and to discuss further with SONADER.

5.2.3 Requirement of the Functional Restoration of the Irrigation Facilities

As mentioned the above, for revitalization of the irrigated area in Foum Gleita, it is essential to restart the activities of the organizations, and it is essential to recover the function of the irrigation facilities in order to revitalize the whole area (1,950ha).

The government didn't provide enough self-support to farmer's organizations, and their support is also downscaled. As a result, there was malfunctioning of organizations malfunctioned, and the maintenance of the facilities was not carried out. Therefore the embankment of canals was deteriorated and the canals were invaded by typha, and the ability of conveyance of water fell down dramatically. Presently, the decrease of volume of water conveyed is equivalent to 1/5th of the planned water provided for irrigation. There is also a risk to collapsing of canal at any time. Neither the SONADER nor the farmers have the means to intervene, and there is a constant risk of losing the harvests. In 2000 and 2008 the main canal collapsed partly, and the government intervened, but more time is necessary to reestablish the passage of water, and the harvests have been decreased significantly.

Even for the farmers who are not cultivating currently, the biggest reason for giving up the cultivation in the past was shortage of irrigation water and almost all the interviewed farmers answered that they would cultivate again if irrigation water is supplied appropriately. Irrigated agriculture is valuable asset on economics and food security. The former farmers are strongly claiming

for their land ownership. For beneficiaries, recovering of functioning of irrigation facilities is an issue of critical importance and needs of rehabilitation works are very high.

It is necessary to consider the responsibility or charge that the farmers will be asked to pay in case of realization. Until now they rely entirely on the government, and their responsibility is never considered seriously, and hence the project did not have a lasting impact. It is the reason that the plan of rehabilitation will include some arrangements such that the farmers will be entirely responsible for the management of the project area from the level of the tertiary canals.

The typha also invaded the reservoir area of the dam, and it is difficult to eradicate the roots after the rehabilitation. Even if it is cut, typha grows again to a height of about 3.5 m in 6 months. It is necessary to include the cutting of the typha in the plan of operation maintenance works. Besides, it is essential to line the part of the main canal with concrete so to minimize the maintenance work in the medium and long term of the canal, since the canals are located in the extreme upstream area away from the land of cultivation.

5.2.4 Improvement of Farm Management Technology

In order to focus to removal constraints on farm management It is desirable to give priority in order of 1) delaying of cropping schedule, 2) extension of farming techniques 3) utilization of agricultural machine.

It is caused the decreasing of yield at present situation, because of out of the schedule. The problem of procedure of the loan procurement and delaying of input supplying is caused of delaying of the cropping schedule. The delaying of the cropping is limited the possible cultivated areas to affect the next season cropping. To decrease cultivated rate is occurred low yield. If the financial problems of the cooperatives are solved, and the farmers become eligible to borrow the loan from UNCACEM, the farmers can buy the inputs on time, and carry out the rice farming as per the farming schedule. SONADER should properly guide the farmers union so that 200% of cropping pattern can be achieved regularly in the Foum Gleita project area.

Foum Gleita farmers are practicing sub-optimal farm management practices such as using of poor quality of seeds, minimal land preparation, non application of phosphate fertilizer, poor fertilizer management, poor transplanting, no drainage after maturity and delayed harvest, and these practices ultimately result in poor yields. In verification trials of the Study, new cultivation technologies have been experimented for both rice, and vegetable cultivation instead of the existing methods followed in the Foum Gleita project area. These kinds of new cultivation methods should be verified, and should also be extended to the farmers.

Because of the non availability of machinery, all the farm operations including ploughing, transplanting, harvesting etc. are carried out manually in Foum Gleita area. These activities not only require heavy labor, but also consume time. Besides, child labor is also used for some works such as

transplanting, which results in poor yields. Therefore, farm machinery should be made available for the farmers.

5.2.5 Marketing Support

In the marketing support, first it is necessary to construct the storage facilities so that the selling time can be adjusted and the farmers can sell the products with a high price. Secondly, it is desirable to introduce the marketing information network established at the union to collect the marketing information of each city.

In addition, it is important to decrease the cost of transportation and marketing, and to improve the bargaining power of price negotiation through implementation of a joint sale, improvement of transporting by union, and also by adding value to the agricultural products.

5.3 Details of Action Plan

5.3.1 Overall outline

It is necessary to undertake the works of urgent rehabilitation on the network of irrigation, in order to assure the water need which is the basis of the production. During the construction work, the farmers will not have access to water, and therefore countermeasure will be necessary to provide food help similar to the support which was provided in the beginning of the development of the project area. Besides, manures, seeds and the farm equipment shall be provided for the first agricultural season that follows the rehabilitation work. As a technical support, it is important to strengthen the organization of SONADER and the UCAF, when this study will be completed. After the rehabilitation, it will be easier for SONADER to lead the extension and maintenance of the irrigation facilities by the farmers' groups, and irrigated agriculture of the project area will become autonomous. Based on these considerations, the Action Plan prepared for the rehabilitation of irrigated agriculture is shown below.

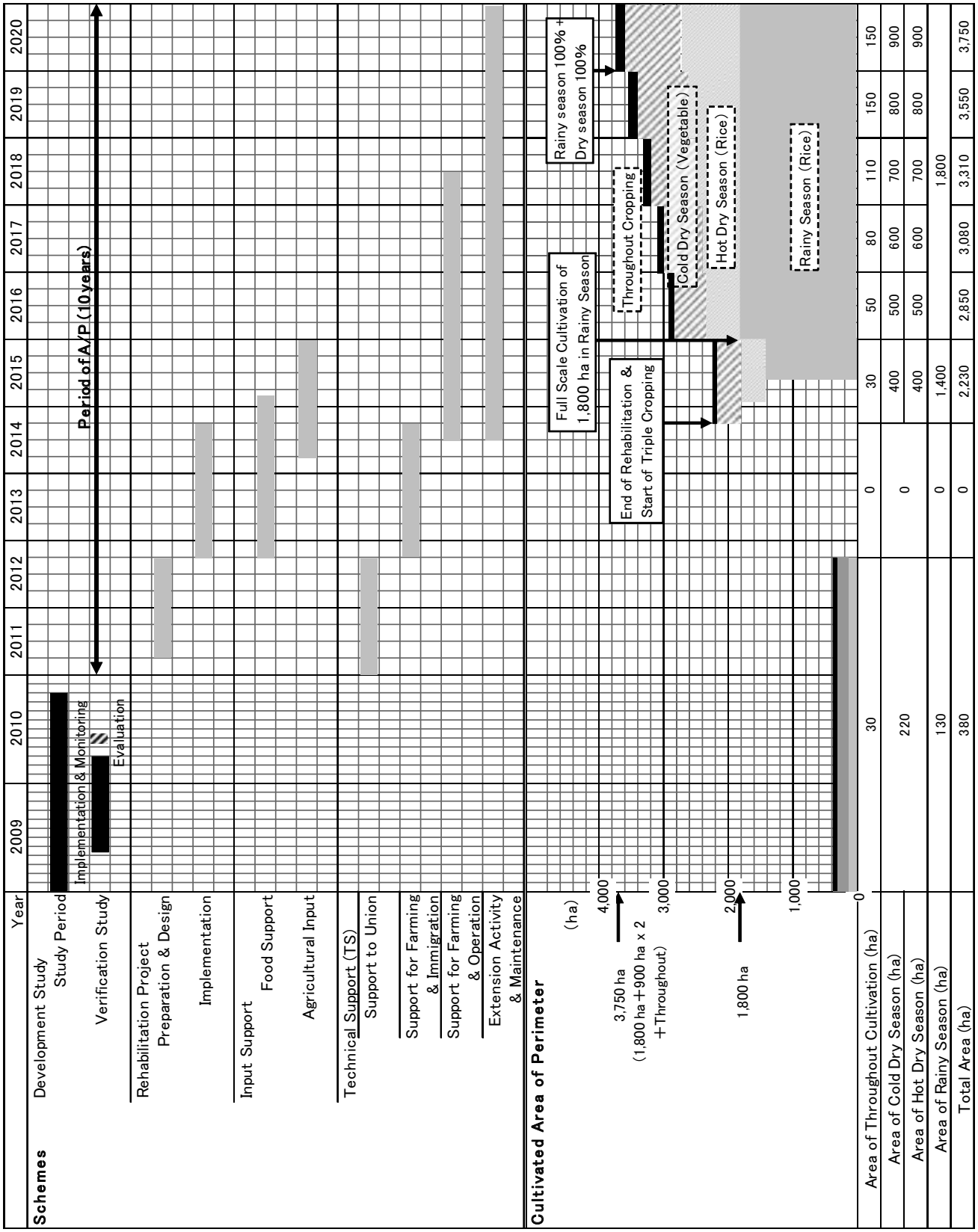


Figure 5.3.1 Action plan (A/P) for Rehabilitation of Foum Gleita Irrigation area

As shown above, the A/P is carried out for 10 years from 2011 with the objective to reach 100% planting of rainy season and in dry season at the final year. In order to achieve the target, first of all, it is important to implement the rehabilitation of the irrigation facilities as early as possible. In the project, a soft component shall be provided to support for appropriate maintenance with development of circumstances. In addition, food support to farmers, who cultivate currently, is planned. Moreover, the farmers who have not cultivated for a long time will be able to restart agricultural activities in an independent way by the input support at the end of the rehabilitation of the irrigation facilities.

5.3.2 Rehabilitation Plan of the Irrigation and Drainage Facilities

(1) Basic Policy of the rehabilitation of Irrigation and Drainage Facilities

The program of rehabilitation of Foum Gleita irrigated area was formulated based on of stage 1 and stage 2 of the detailed project (APDI and APDII) elaborated by the WB and the SONADER in 2006 and 2007, and our survey, and according to the following principles:

- To revitalize irrigated agriculture on the 1,950 ha in order to effectively use abundant storage capacity of 400 million m^3 of the dam reservoir.
- To recover canal capacity in order to satisfy the water requirement for double cropping of rice in a year through rehabilitation of principal and primary canals for 3,600 ha and secondary and tertiary canal for 1,950 ha based on the original design concept used in 1983-89.
- To retrieve the hydraulic parameter of the canals to the original conditions through rehabilitation work.
- To apply maximum farmer's participatory approach so as to realize as much as possible maintenance works including the same for principal and primary canals by the farmer's cooperatives in future.

(2) Rehabilitation Plan of the Irrigation and Drainage Facilities

In regard to repairing the dike, removal of sediment deposits in the canal and re-embankment of the canal dike is required. Steel wire net and barbed wire fence for a total length of 45 km along the periphery of the irrigation area shall be installed. In addition, it is essential to construct drinking places such as water tank (25 places around each diversion gate) and communal laundry（12 places around each village).

Proliferation of typha and bush (mainly toufelhenne) can be effectively protected by reinforced concrete lining on the inside of the canal and protection sheet under the concrete joint. However, the lining is planned only for the OA, AD and AG principal canals. The concrete lining improves the roughness coefficient of canal and flow velocity which is enable to reduce the required canal section to economic size.

The rehabilitation of the principal canal dike consists of clearing of typha and bushes, stripping, bench cutting and re-embankment with compaction. The dike crest width of the principal canal was proposed to widen from the 2.5 m of original dimension to 4.0 m considering the advantages of adopting larger equipment in number of equipment, rehabilitation period, economy, etc.

The bottom widths of secondary canal are 0.6 to 1.2 m, and the tertiary canals are 0.4 m. The concrete structures of these small canals are in good enough condition. Therefore the target of rehabilitation is mainly the earthen canal, and the scope of the project covers until the tertiary canal.

The farm roads are in relatively good conditions except that some sections are filled with bushes. They will be cut under the farmers' participatory approach. At the site of the siphons and the aqueducts, concrete causeway (submersible bridge or radier) were installed but they were invaded by marsh or sediments, and hence they are not functioning properly. The sands will be removed at the time of works on the drains to make all of them functional again.

The removal of sediment deposits from the drainage canals is required, in particular at the downstream of cross structures with major irrigation canals. This removal work shall be required once in every 3-5 years as regular maintenance in order to control the sedimentation.

The proposed schedule reveals that the rehabilitation works for 3 principal canals need 9 months for completion. The rehabilitation works for P1 & P2 primary canals are planned to start at 10 months after commencement of substantial work and the water supply from the dam to resume irrigation shall be started at 15 months from the commencement of the substantial works.

(3) Cost estimate for Rehabilitation Work of Irrigation and Drainage System

The construction cost estimated at the beginning of 2010 is shown below.

Table 5.3.2 Financial Price of Full Rehabilitation Cost

No.	Major Works	Cost (mUM)
1	Preparatory work (preparation, temporary construction, management)	241.2
2	Rehabilitation of the irrigation canals	3,147.1
3	Rehabilitation of the related structures	123.8
4	Farm roads, plots	84.4
5	Rehabilitation of the drains	151.0
6	Miscellaneous works	177.9
7	Additional urgent works	294.5
	Total	4,219.9
	Fund of reserve (+10%)	

Source: SONADER、2007

(4) Operation & Maintenance and Monitoring & Evaluation

The operation & maintenance cost consists mainly of removal of sediment deposit of canals, clearing of typha and bushes, maintenance of related structures, farm roads, drainage, terminal facilities and plots, and other O & M costs. An annual O & M cost was estimated to be UM 57 million for 1,950 ha (29,000 UM/ha) for financial price and added to the cost of A/P implementation. It is expected that SONADER will promote self-reliance of famers step by step, to increase the ratio of maintenance by famer's cooperatives and Union, then to focus on the support of the technical and management sectors.

During the implementation of A/P, monitoring and evaluation shall be carried out periodically to check whether its contents and schedule are appropriate. This is an indispensable process to achieve an efficient progress of the implemented project. The following tasks should be considered to conduct such monitoring and evaluation:

- Preparing a manual for monitoring and evaluation;
- Identifying information needed to conduct monitoring and evaluation;
- Establishing a system and allocating staff to guarantee a good quality of monitoring and evaluation;
- Surveying the situation of the project area on the issues such as the quantity of agricultural production and the use as well as the degree of spread of agricultural techniques;
- Developing the capacity of staff in charge of and organizing seminars on monitoring and evaluation.

To include expected costs of these tasks in the cost of implementing the project, a value that is equivalent to 3% of the estimated cost of rehabilitation work was assumed to cover such costs. This value was divided into several portions and added to the cost of A/P during its implementation.

5.3.3 Technical Cooperation project

(1) Outline of needs of Technical Cooperation Project

In this environment, even though the rehabilitation is conducted and the function of water supply is recovered, and the rural area is temporarily activated, there is a possibility that the declining of the area may happen again. Before reestablishing the functions of the water supply by rehabilitation, the supervising ability of SONADER should be improved, and it is necessary to restore the farmers' trust in this area to restore the function of union and achieving the purpose of establishment of union. Moreover, to manage their vital faming smoothly after rehabilitation, the farmers should practice the improved farming technologies related to farm management.

(2) Contents of Technical Cooperation

The main elements and terms of the technical support are proposed as shown below

- Supporting period of the follow up: Continuation of reform or re-establishment of new union
- Period during the rehabilitation works: Support for the UCAF and extension services of SONADER and resettlement plan
- Period for after rehabilitation; Support for farm management (cooperative management by each organization, financing and repayment for farming, water fee management system, operation, maintenance and management of irrigation facilities)

5.3.4 Input Support

After the rehabilitation of the project, when the farmers once again start the cultivation in the rehabilitated area, they would need the support of inputs including seeds and fertilizers especially for the first cropping season. Presently, the farmers do not have enough financial resources to arrange the inputs by themselves. Besides, at the present situation, the farmers are not eligible to borrow money from UNCACEM to buy the inputs. Therefore, an input support project is planned to be executed in corresponding to the starting of cultivation.

5.3.5 Agricultural Machinery Support Project

In Foum Gleita, all the farming operations including ploughing, transplanting, harvesting, threshing etc., are carried out manually. These operations require has heavy labor, and sometimes some of the farm operations such as transplanting are done by young children, and when the transplanting works are not done properly with optimum spacing and depth, the yields will be also relatively low. In some area, the farming operations are not carried out in time, which also result in low production. During the field survey, the farmers showed their deep interest in using farm machinery. It is proposed that the agricultural machinery support project shall be implemented so that all the farming operations shall be carried out strictly according to the farming schedule.

The requirement farm machinery in this area are tractors (6), combines (6), tillers (15), thresher (15), and trucks(4).

Representing a difficulty of the condition to procure farm machinery at private company, it is thought the effective means that SNAAT under MDR is presently responsible for the management of farm machinery and equipment and it is proposed that SNAAT can establish a permanent antenna office in Foum Gleita to operate, maintain, and rent the farm machinery to farmers. SONADER can function as year intermediary organization in between the SNAAT, and the lease agency.

5.3.6 Extension Activities Support Project

Presently, the farmers in Foum Gleita are attaining rice yield of one third of Lexeiba. The reasons for the reduction in yield are mainly due to series of sub - optimal farm management practices including poor quality of seeds, minimal land preparation, non application of phosphate fertilizer, poor

fertilizer management, poor transplanting, no drainage after maturity and delayed harvest. To improve this situation, extension support is needed. Presently, the extension support provided by SONADER is limited due to limited number of staff, and the limited facilities to carry out the extension services such as transportation of extension staff to the farmers' area. Therefore, after the rehabilitation of the project area, the extension services shall also be improved.

From results of interview to SONADER, it was informed that about 200 ha can be covered by one extension agent in consideration of the coverage area. Therefore, 4 extension agents, and 6 extension agents shall be required for P1 and P2 area respectively, apart from 1 manager, and the total extension staff shall be 11 persons.

5.3.7 Operation and Maintenance of the Irrigation Facilities

In the medium and long term perspective, it should have necessarily an autonomous maintenance system for the network of irrigation. Since the government transferred the operation and maintenance to the organizations of farmers and the important point of view of the increasing the ownership sense of the farmers, the most realistic improvement plan will be to give the main responsibility of the operation and maintenance to the organizations of farmers after the rehabilitation, and to keep SONADER for the technical assistance. The water taxes that will be collected will serve for the financing of the maintenance works. Currently, they are not collected, but once the union will be re-established, it will be necessary to institute a perfect transparent management system.

The operation and maintenance works of the irrigation network are divided into three categories including the current maintenance works, the specific works and the works to be done by contracting. Immediately after the rehabilitation, the network will need only that current maintenance, but after some years it must be planned that there will be the specific works or the works to be done by the contractor. In future, it would be necessary to pay the water tax of 29,000 UM/ha which is almost equivalent to two times of the existing water tax of 16,500 UM/ha, but the water tax is expected to be increased gradually.

The external aid can not be expected for the operation and maintenance works after the rehabilitation. The fee for O&M shall be funded by the farmers themselves, they will manage the funds and will decide on the use of such funds. For the management of the funds and their utilization, the farmers will be assisted and controlled by SONADER to avoid abnormalities. Therefore, an absolute transparent system of management of the funds must be established.

5.4 Evaluation of A/P

(1) Financial Analysis of A/P

In order to evaluate the impact of the implementation of the A/P on the farm economy of Foum Gleita and economy of Mauritania, cost-benefit analysis was conducted based on the collected

data. Concerning the state of average farmers in Foum Gleita, it was assumed that the number of family members is seven, and they practice rice and vegetable faming in the project area of 0.5ha, and maize and sorghum outside the project area with the family labor.

It is expected that the profits of paddy and vegetables will abundantly be increased by the implementation of A/P. Especially, although the vegetables cultivation area per year is small compared to paddy, it is expected that the income of vegetables will be contributed to the family budget.

On the other hand, if the food expenses per family per day is 1,000UM, and the Engel's coefficient is assumed as 0.6, the estimated living expense per family per year became 1,000×365 / 0.6 = 608,333UM. However, this income is well over the estimated profit（204,094UM）in case that all harvested paddy is sold. Therefore, it cannot be assumed that the farmers of Foum Gleita maintain living expenses with only rice farming.

It is concluded that even if the profitability of rice farming is increased, and as long as farming area is limited to 0.5ha, there is a little possibility that the basic living conditions can be realized only based on rice farming, and the production of vegetables is indispensable to the development of farm economy.

(2) Economic Analysis of A/P

In order to analyze the impact of A/P on the economy of Mauritania, cost-benefit analysis was conducted. In case that A/P is implemented, the negative net benefit would continue from the first year until third year, and then will be converted to positive in the fourth year, and would continue to increase till the cultivated area reaches the maximum in the eighth year. It is calculated that the Internal Rate of Return (IRR) is 0.15, and the cost-benefit ratio (B/C) is 1.18.

In rice farming, a considerable amount of time is spent for watching the birds and animals in Foum Gleita. Therefore, the labor cost is high and the net benefit is negative. In case that the A/P is implemented, it is assumed that the net benefit is converted to positive after the fifth year with the increase of yield by improvement of farming techniques and rise of selling price by the increase of the marketing ability of the farmers.

The result of economic analysis suggests that it is essential to improve the yield of paddy and vegetables through technical support to secure the benefit of A/P

5.5 Formulation of Model for Gorgol Region

5.5.1 Study Area of the Model for Revitalization of Irrigated Agriculture

The study areas of the model for revitalization of irrigated agriculture (hereinafter called the Model) are PPG1, PPG2, and Lexeiba which are using pumped of water from Gorgol river, and Foum Gleita project area which use the gravity irrigation network. The common aspects of these project

areas are the large scale of the projects, rice production, and the management by the cooperatives and union, although they have different features, such as irrigation types, geographical conditions, sizes and farmers' characters.. Their problems are also similar in relation to government support, farming system, mechanization, farmer's organization, etc. It is expected that the productivity and farmer's livelihood conditions will be improved by the formulation of model of revitalization of irrigated agriculture.

5.5.2 Problems and Countermeasures of Irrigated Agriculture in the Region

Problems of irrigated agriculture in the area are reviewed here. In order to do that, some problems observed in Foum Gleita, whose conditions are the worst in the region, are extracted to apply to all the other irrigation areas and countermeasures for those are also drawn in a figure below. The basic structure consists of the low selling price and the low productivity of 2 axes, and the insufficient institutional capacity lies behind them.

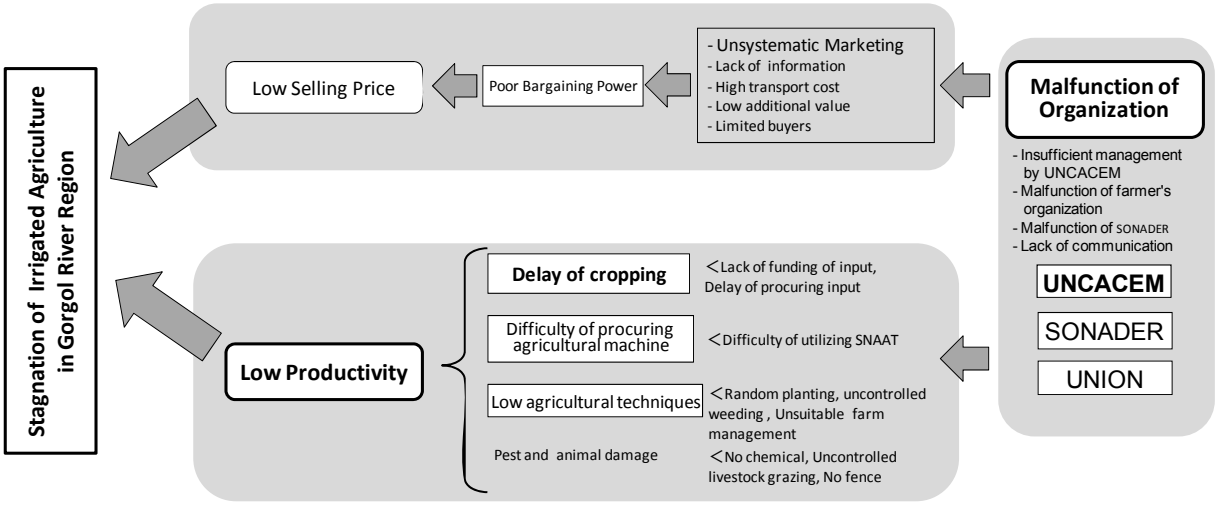


Figure 5.5.1 Problems Hindering Revitalization of Irrigated Agriculture

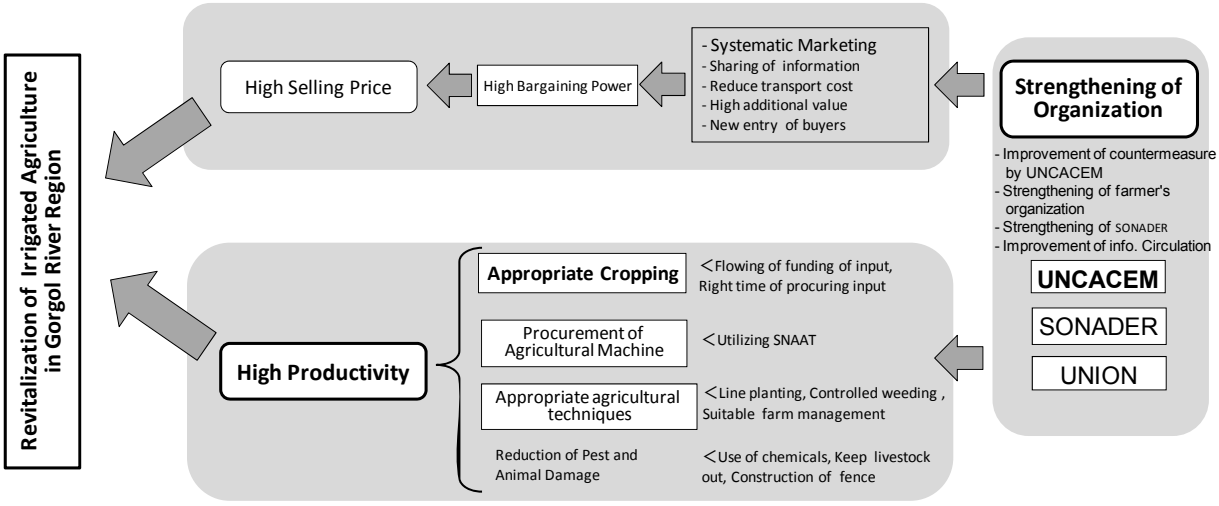


Figure 5.5.2 Countermeasure of Revitalization of Irrigated Agriculture

5.5.3 Important Issues for Revitalization of Irrigated Agriculture

As the major issues, capacity building of organization and high productivity are raised. In the former, 3 important issues are addressed; 1. Improvement of UNCACEM, 2. Strengthening of farmer's organization and 3. Strengthening of SONADER. In the latter, 2 important issues are included; 1. Suitable cropping season and 2. Procurement of farm machinery. The contents of each important issue are explained as below, according to the order of priority.

(1) Capacity Building of the Organization

a) Improvement of UNCASEM

On the project area of Foum Gleita agriculture can not least because it is impossible to obtain financing for the purchase of the inputs. Unless UNCACEM is not repaid their loans during harvest time, even if farmers need loans for next cropping season, they can't get new loans in advance. That is the problems on the financing system. Because of this, input isn't provided to next season's loans in proper time, cause of low yield, delaying their payment. It is expected that improving of the loan system, easing loan condition, making procedure easy, and also being fulfilling loan found for UNCACEM.

b) Strengthening of Farmer's Organization

This is an essential element to improve productivity and marketing with appropriate and vitalization of the farmer's organization. Lexeiba has been practicing farming steadily. It is like a good model around project area. One of the particularities in the area comes from the leader of the union who is reliable as well as knowledgeable. Even without the technical support of SONADER, they maintain the activities of production and arrange the necessary inputs. Farmers should target independent and sustainable farming by themselves. Therefore capable and reliable leaders of farmers' organizations are essential.

c) Strengthening of SONADER

This is a necessary measure for preserving the functions of the irrigation network in order to re-establish, maintain and increase the irrigated areas. At the same time, this is for increasing the production with the improvement of the farming techniques. SONADER is in charge on behalf of the government, of the maintenance of the main facilities, but it is not functioning properly, since its budget and technical staff were reduced. In the long run, a sustainable and independent farming and maintenance should be established by farmers, but it is difficult to materialize in a short term. So SONADER should supervise them with enough time to ensure technological transfer. SONADER should be strengthened in capacities for planning, techniques and supervision, and in personnel.

(2) High Productivity

a) Suitable Cropping Season

This is a countermeasure to follow the suitable cropping season and to improve the productivity through improvement of timing of input supply and farm techniques. Cultivation in a suitable period for each crop is important element to increase the productivity due to the limitation of the climate condition. Hence, it is necessary to follow the cropping season. Even without development of new agricultural field or irrigation system, cropping area increase is expected with double cropping. It is necessary to improve timing of cropping season and farmers' farming techniques such as proper timing of inputs supply, suitable varieties, suitable cropping schedule, and farming practices.

b) Procurement of the Farm Machinery

This is a counter measure to undertake the high productivity through the use of farm machinery. But the project area being far and poor, the machines tend to arrive too late or not provided most of the time. Because of it, the cultivation schedule and the harvests are delayed, as a result, the harvest decreases. Considering the difficulties of financing, the situation of the maintenance organisation and their present capacity would not permit to take care of it. On the other hand, lately (in 2008), the SNAAT has been established and it was possible to rent the farm machinery in rural area. In case farmers of Foum Gleita can procure machineries, it would be possible for the SNAAT to displace or to transfer its technicians there.

5.5.4 Related Organizations

To implement the countermeasures of each issue, the organizations related are summarized below.

Table 5.5.3 Related Organizations of the Project

Major Issues	Important Issues	Farmer's organization			Administrative organization							
		Farmer	Cooperative	Union	SONADER	CNRADA	SNAAT	UCASEM	MDR	DconMIN	Int MIN	Local gvt
Capacity Building of Organization												
	Improvement of UNCACEM	○	○	○	○			◎	◎	◎		
	Strengthening of farmer's organization	○	◎	◎	◎				◎			
	Strengthening of SONADER	○	○	○	◎	○		○	◎	○		
High Productivity												
	Suitable Cropping Season	○	○	○	◎	○	○	○	◎			
	Procurement of Farm Machinery	○	○	○	○		◎		◎			

note ; symbol ◎ shows related organization or C/P organization at the supported by outside , symbol ○is related organization

5.5.5 Implementation Schedule

Considered to the priority of each important issue, formulation of the project for the solution and temporary implementation schedule are described the below.

The A/P in Foum Gleita is the first priority project for SONADER related to all project. It is assumed that SONADER doesn't have enough time to carry out the other project. However, at the beginning of the project, it is desirable to address the project early as possible to target the existing irrigated area.

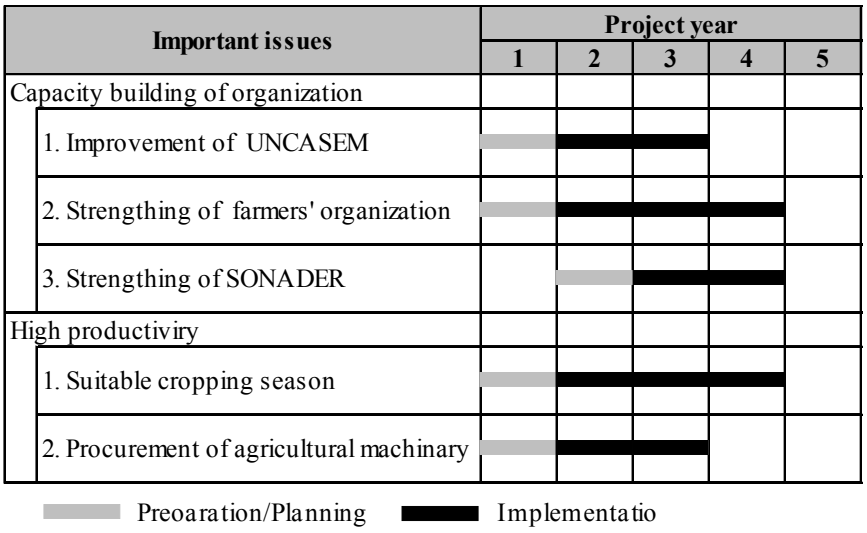


Figure 5.5.3 Implementation Schedule for Revitalization Model of the Irrigated Agriculture

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

(1) The Senegal river basin is the only granary in Mauritania, and a portion of the farmland area is concentrated in the Gorgol river basin, which is a tributary of the Senegal river. In the Foum Gleita project, an area of 1,950ha is developed for irrigated agriculture which is a part of 4,400 ha of the whole area. It is essential to revitalize the area, where now only 500 ha area is cultivated. With the potential expansion of 3,600 ha, the area has the potential to exceed Kaedi as agricultural production center of Gorgol region, and therefore the rehabilitation works are undoubtedly of paramount importance for the region.

(2) The plan to revitalize agriculture in this project area was prepared based on the estimation of the rehabilitation of the irrigation and drainage facilities, development of protection fence, cultivation area, and formulation of operation and maintenance plan. Further, the economic evaluation of the plan was prepared based on the benefits and costs of the work. The plan provides for the reactivation of the 1,950 ha area in 10 years to restore agricultural production,

and economic evaluation shows that the economic rate of return exceeds 15%. The commonly practiced rehabilitation works are planned, and no particular technical or sophisticated efforts are needed. The project will have a positive environmental and social impact, and its rapid implementation is justified because it helps to fight against poverty among the farmers and to ensure stability for country's food security.

(3) In order to promote the rehabilitation works as a national project without delay, it is also essential to reform the appropriate union of cooperatives and farmers who use these facilities. While implementing the rehabilitation as agricultural infrastructures reform, it is also important to carry out improvement measures totally including the strengthening of SONADER, the union and the cooperatives, and the improvement of the farming techniques in order to practice and manage sustainable and effective farming.

(4) For the reinforcement of the farmer's organization and improvement of farming, the active training and management of SONADER is essential to obtain the appropriate involvement of the union of cooperatives and farmers. The strengthening of the Foum Gleita antenna office is particularly necessary. To avoid the decline of agriculture activities that has occurred in the past, the present cooperative union will be essential for the maintenance of the irrigation system facilities and therefore transparent administrative reforms of this organization that reflects the intentions of the farmers must be completed as quickly as possible. If all the improvement measures are not carried out properly, the past mistakes would be repeated once again, even if the facilities will be rehabilitated. Therefore, a continuous support to support to the organization similar to the practices carried out in the Study is desired even after the completion of the Study.

(5) To promote the resettlement of the farmers, it is necessary to distribute drinking water in the villages. According to information from Ministry of Water Resource and Planning, the regional water supply covering the entire population of Foum Gleita is under process. Hence it is not necessary to include this activity in the works of the revitalization of agriculture. SONADER shall hold discussion and exchange information with the concerned department to establish emergency facilities in the Foum Gleita area.

(6) One of the main factors for the declining of the functions of the irrigation facility is due to the damages of the canals by the invasion of the animals. It is necessary to prevent the animals entering the irrigated area so as to preserve the function of facilities on a medium and long term. The rehabilitation work includes the priority components, the installation of protective fence of the main canals and provision of drinking water for the farm animals. At the same time, SONADER and the union shall intensify the discussion with the livestock producers and a strong instruction from local government will be needed.

6.2 Recommendations

(1) The farmers must return back to resume the farming activities. To select the return of the interested farmers, the motivated professionals who would work there must show clear and transparent methodologies. It is recommended that SONADER, which is primarily responsible, shall prepare a resettlement plan for the quick return of the farmers. While selecting the farmers for resettlement, the applicants who wish to return just to receive the right to use the land, and those who do not practice farming but claim a right of residence should be carefully excluded, and the farmers who will practice farming permanently should be selected. Besides, it is also necessary to include the environmental and social considerations during the process of preparing resettlement plan.

(2) In order to avoid the declining of agriculture to happen again, it is necessary to strengthen SONADER, the main management body of the project. It is recommended to determine quickly the reform of SONADER and increasing of number of technical staffs including the necessary budget for the reorganization in Foum Gleita antenna office.

(3) For sustainable agriculture of the large irrigation project, it is essential to form a transparent union, and it is recommended to reform the current cooperative union. The support and cooperation of SONADER are necessary in order to carry out the reform of the union, and to make it sustainable without failure. It is recommended to provide continuous investment and equipment for this purpose.

(4) In order to maintain sustainable agriculture, the farmers need to fulfill the part of their obligations which include payment of water charges, repayment of loans and maintaining the irrigation network. It is recommended that SONADER shall conduct awareness of ownership among the farmers through the meeting with cooperatives and the union so that they understand that the irrigation facility is their property and they should carry out their duties and responsibilities.

(5) The implementation of the project shall be carried out by SONADER and also be supported with the legal and financial assistance from the Ministry of Economic Development, and Ministry of Agriculture, which are the organizations related to the project. If the stakeholders meeting is held in regard to implementation of future study to carry out the project, it is desirable to include the environmental and social considerations and improvement measures in the agenda.

(6) After the rehabilitation of the project, monitoring and evaluation shall be carried out, and based on its result, the system of improvement of methods of cultivation and maintenance of the facilities should be established. It is recommended that a system shall be established allowing the autonomy of farmer organizations, cooperatives and union in the long-term.

(7) Foum Gleita reservoir has an effective capacity of 400 million m^3 of usable volume. If the storage height of the water in the reservoir is increased by one meter, then the reservoir volume can be increased by 100 million m^3. Besides, it can protect the project areas at the downstream from the dam to the Senegal river, which are normally damaged extensively by the frequent floods that occur every year by the overflow of the Gorgol river. In this case, it is necessary to make some improvements in the structure of the dam including the spillway crest of the dam. It is proposed that discussion shall be made with the Ministry of Water Resources and Planning to verify the technical and administrative feasibility of such improvements.

THE DEVELOPMENT STUDY FOR THE PROJECT ON REVITALIZATION OF IRRIGATED AGRICULTURE IN THE IRRIGATED ZONE OF FOUM GLEITA IN THE ISLAMIC REPUBLIC OF MAURITANIA

FINAL REPORT

TABLE OF CONTENTS

ANNEXES

List of Tables

List of Figures

Page

Units and Currency

kg	**kilogram**
t, MT	**Metric tons = 1,000 kg**
h	**hour**
mm	**millimeter**
cm	**meter**
km	**kilometer**
ha	**hectare**
HP	**Horsepower**
km^2, sq.km	**square kilometer**
m^3	**cubic meter**
MCM	**million cubic meter**
MSL	**Mean Sea Level**
MW	**mega Watt**
LPS, l/s	**litters per second**
mm/mon	**millimeter per month**
mm/d	**millimeter per day**
m/s	**meter per second**
m^3/s	**meter per second**
℃	**degrees centigrade**
%	**percent**
US$	**United States of America Dollar**
UM	**Ouguiya Mauritanien**
EUR	**EURO**

Exchange rates

	UM	US$	EURO	¥
UM		0.003768	0.002792	0.3448
US$	265.4		0.7409	91.53
EURO	358.2	1.350		123.5
¥	2.900	0.01093	0.008097	

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Islamic Republic of Mauritania (Mauritania) has a population of 3.1million with a per capita income of US$ 581, and 23.7% of the national GDP is occupied by the agricultural sector. According to the Human Development Index (HDI) (World Bank, Human Development Report 2007), it is placed at the 137th place out of 171 countries. It occupies an area of 1.03 million km^2, which is 3 times the area of Japan, having 90% of the area as desert area. The development of agriculture around the Senegal River is absolutely essential to ensure the national food supply.

Therefore, a Program of Integrated Development of Irrigated Agriculture in Mauritania (PDIAIM) is implemented for the period of 2000-2015, with funding from WB, ADB and IDB, with the aim of increasing the income and employment through the promotion of irrigated agriculture in the Senegal River valley. Presently, the Phase-2 of the program is on-going (2005-2010). One of the main cornerstones of the PDIAIM is the revitalization of operation and management of irrigation facilities, and as a part of this program a Master Plan (M/P) was prepared for the irrigation facilities in the Gorgol river valley (a tributary of the Senegal river) where the big irrigation schemes exist. Based on this M/P, the Government of Mauritania sent a request for the cooperation to the Government of Japan, for a grant as a part of the "Program of Integrated Development of Gorgol river basin". The purpose of this request was to assist in the irrigated agriculture of the Gorgol river basin and to rehabilitate the irrigation facilities in the irrigated zone of Foum Gleita, where only 400 ha is presently cultivated out of the 1950 ha, which was initially developed in 1980.

In February and April 2005, JICA dispatched a study mission from the Middle Western Africa Assistance Office to check the validity of the project site and to meet with the government officials of Mauritania. These missions have revealed that the irrigated zone of Foum Gleita has great potential for irrigated agriculture, but the water supply to the agricultural lands is insufficient because of reduction of the irrigation water flow by the water weeds in canals, and poor conditions of drainage canals. Therefore, the mission proposed that priority should be given to the management and maintenance of irrigation works by the participation of farmers, rather than the rehabilitation works. Then the Mauritanian government revised its application in January 2006 for a "Project on Integrated Development of Irrigated Zone of Foum Gleita", more focused on a development study of the management and maintenance of irrigation works and integrated development of agriculture in the surrounding areas.

Based on the request, the Japanese government sent a baseline survey mission in April 2008, and agreed and signed the Scope of Works and Minutes of Discussions on 8th and 9th April, 2008 respectively.

Besides, in August 2006, the government of Mauritania submitted a request for grant aid on

"Project of Integrated Development of the Irrigated Zone of Foum Gleita" whose main objective is to maintain the irrigation facilities in the irrigated zone of Foum Gleita. In regard to this request, the possibility of implementation of grant aid shall be verified through this study by analyzing the ability of management and maintenance works of the irrigation facilities.

1.2 Objectives of the Study

The objectives of the Study are as follows:

1. To formulate a model for the revitalization of irrigated agriculture in the Gorgol river basin so to improve the food security of the area;
2. To formulate an action plan (A/P) for revitalization of irrigated agriculture in the irrigated zone of Foum Gleita, which has a high agricultural potential.
3. To strengthen the capacity of the counterpart (C/P) organization National Society for Rural Development of Mauritania (SONADER), other relevant agencies of the project area, and the farmers organizations through the technical transfer of the Study.

1.3 Study area

The model of revitalization of irrigated agriculture in this Study focuses on the Gorgol river basin of 25,000 ha area, and 400,000 inhabitants. The action plan (A/P) focuses on the Foum Gleita project area of 1,950 ha, and 9,000 inhabitants. Refer to Location Map of the Study Area.

1.4 Study period

This Study will be carried out in three years period in accordance with the S/W agreed, signed and exchanged with the Ministry of Economy and Finance of Mauritania on April 8, 2008, and the M/M agreed, signed and exchanged with the SONADER on April 9, 2008. The main components of the Study undertaken in each year are mentioned in the following table.

Table 1.4.1 Contents of the Study in Each Year

Fiscal Year (April to March)	Contents of the Study
First Year (November2008 to March2009)	Implementation of "Preparatory Work in Japan", "First Field Survey" and "First Home office Work in Japan". Formulation of a model plan (draft) and an action plan (draft). Preparation of the Progress Report 1 in Mauritania and the Interim Report in Japan.
Second year (April2009 to March2010)	Implementation of the "Second Field Survey". Implementation and monitoring of Verification Study, and Preparation of Progress Report 2 and 3 in Mauritania.
Third year (April to October2010)	Implementation of the "Third Field Survey" and "Second Home office Work in Japan". Presentation and discussion on the Progress Report and assessment of the Verification study in Mauritania. Preparation of Draft Final Report in Japan. Implementation of "Fourth Field Survey" and "Third Home office Work in Japan". Presentation and discussion on the Draft Final Report, sharing information and discussion with each donors. Preparation of the Final report in Japan and sending it to Mauritania.

The members of the Study Team are shown in the Assignment Schedule of Appendix1.

1.5 Counterpart Organization

The main counterpart organization of this Study is SONADER. The counterparts include the officers from the Department of Study and Development (Direction Etudes et Aménagements) of the Head office, SONADER Gorgol branch office (Direction Régionale du Gorgol) and Foum Gleita branch office (Antenne de Foum Gleita) (See Table 1.5.1). The technical support was also provided by the other staffs of SONADER and the National Centre for Agronomic Research and Agricultural Development (CNRADA). In addition, the representatives of the Ministry of Economic Development, Ministry of Rural Development, local elected officials and the farmers in Foum Gleita also provided support for the Study.

Table 1.5.1 Members of the Study Team and their Counterpart

JICA Study Team	Assignment	Counterpart	Title
MENJO Michimasa	Project Manager / Irrigated Agriculture	Guisset Alassane Chérif Abdellahi ould Baba Abdellahi ould Guèye	Director of Studies and Development (Nouakchott) Regional Director of Gorgol (Kaédi) Manager of Foum Gleita (FG)
SUZUKI Takafumi	Irrigation Plan/ Evaluation of environmental impact	Mody Samba Ndiaye Mohameden Habiboullah	Head of Works (Kaédi) Head of Works (FG)
MURUGABOOPATHI Chellasamy	Farm Management/ Market Distribution 1	N'Thidy Mangassouba Kane Djibril Ousmane Mohamed Fall ould Wery Idoumou ould Ethmane Ba Alassane Abdoul	Head of Extension Service (Kaédi) Head of Extension Service (FG) Instructor (FG) AVB (FG) AVB (FG)
KUWAHARA Tsuneo	Participatory Water Management 1	Mody Samba Ndiaye Kane Djibril Ousmane Jaavar ould El Hossein Samba Yené	Head of Works (Kaédi) Head of Extension Service (FG) AVB (FG) AVB (FG)
TAKIGAWA Eiichi	Participatory Water Management 2	Mody Samba Ndiaye Kane Djibril Ousmane Jaavar ould El Hossein Samba Yené	Head of works (Kaédi) Head of Extension Service (FG) AVB (FG) AVB (FG)
NAKAMURA Maiko	Farm Management 2	N'Thidy Mangassouba Kane Djibril Ousmane Mohamed Fall ould Wery Idoumou ould Ethmane Ba Alassane Abdoul	Head of Extension Service (Kaédi) Head of Extension Service (FG) Instructor (FG) AVB (FG) AVB (FG)
NAGAI Tomokazu	Market distribution 2/ Coordination	N'Thidy Mangassouba Kane Djibril Ousmane Mohamed Fall ould Wery Idoumou ould Ethmane Ba Alassane Abdoul	Head of Extension Service (Kaédi) Head of Extension Service (FG) Instructor (FG) AVB (FG) AVB (FG)
TSUCHIYA Toshihiro	Rural water Supply Planning	Mody Samba Ndiaye Mohameden Habiboullah	Head of Works (Kaédi) Head of Works (FG)

CHAPTER 2 BACKGROUND OF THE SOCIOECONOMY AND AGRICULTURAL DEVELOPMENT

2.1 Socioeconomic Background

Mauritania, which gained its independence in November 1960, covers an area of 1.03 million km^2, equivalent to three times that of Japan, and is located between 15°and 27°northern latitude, and 5° and 17° western longitude. It is bordered with the Western Sahara at the north, Algeria at the east, Mali at the southeast, Senegal at the southwest, and Atlantic Ocean at the west. Except the southern area, 90% of the country is located in the arid regions with rainfall ranging between 100 mm at the northern part of Sahara region, and 450 mm at the southern part along the Senegal River.

The population of Mauritania is composed of different ethnic groups, mainly Moors, Pulaar, Soninke, Wolof, and other small groups. Arabic is the official language, but in the actual works, French language is widely used. Besides, the language of the tribe such as Hassaniya, Pulaar, Soninke, and Wolof is used within the same ethnic group.

Regarding administration, the country is divided into 13 regions or wilayas, consisting of 53 prefectures (Departments /Moughataa), which is further divided into districts (Arrondissement), communes and villages. The Mayors and Chief of the villages are elected by the people, but the governor of regions (Wali), prefectures (Hakem) and districts are appointed by the Ministry of Interior.

After attaining the independence in 1960, the economic development of the country has focused towards the development of mining, agriculture, fisheries and livestock and the effective use of the products from these developmental activities. Currently, the two main industries of agriculture (sorghum, millet, rice) and livestock (cattle, sheep) contribute 23.7% of GDP (2005) and employ 52.9% of the work force (624 000 in 2000), and make it as a major socio-economic sector. The revenues from the foreign trade are generated by the export of fishery products (octopus and squid) and iron ore. The petroleum and natural gas were found in Nouakchott and oil production began at Chinguetti oil field in February 2006. The income from fishery accounted for 45% of total exports, of which 70% are exported to Japan. The export of iron ore from the town of Zouerate in the north accounts for 20% of the total export revenues. Besides, copper and phosphate are also exported. In 2006, the GDP was 2.3 billion (740USD per capita), which ranks the Mauritania amongst the poorest countries in the World.

Table 2.1.1 Economy of Mauritania

1. Major industries	Agriculture and Livestock (sorghum, millet, rice, cattle, sheep)
2. GDP	2.3 billion dollars (2006, WB)
3. GDP per capita	560USD in 2005, 740USD in 2006 (WB)
4. Economic growth rate	11.7%（2006, WB）
5. Inflation	29.8%（2006, WB）
6. Gross Trade Balance	Exports $ 1.343 billion (2007) Imports $ 1.192 billion (2007)
7. Main trade	Exports - Petroleum, iron ore, fish products (2006） Imports - Oilfield equipment, petroleum products (2006）
8. Main trading partners	Exports - China, Italy, France, Belgium (2006） Imports - France, China, USA, Belgium (2006）
9. Currency	Mauritanian Ouguiya（UM）
10. Exchange rate	1 USD＝268 Ouguiya (Average of 2006, EIU)）
11. Amount of external debt	2.281 billion dollars (2005, EIU)
12. Major donors (2005, Million USD)	1. France (47.53) 2. USA (21.50) 3. Spain(15.74) 4. Japan (14.72) 5. Germany (12:48)

Source: Ministry of Foreign Affairs of Japan, reports

2.2 National Development Plan

After the independence, Mauritania tried to form a democratic society for the people in poverty and to improve the standard of living by the improvement of the socio-economic indices of the country. However, the country is sparsely inhabited on this vast area with a limited access to education, severe climatic conditions, limited natural resources and operational capacity, and a weak financial capacity. Because of these constraints, the developmental programs could not reach the success level, and the country is still stagnating as one of the poorest countries. Therefore, it is absolutely necessary to prepare a strategy to revive the economy through efficient social, industrial, and commercial development based on review of the social and structural policy for the selection of priorities. It is difficult to cope up alone and independently because of the lack the economic capacity, financial and human resources for implementing such a strategy and the country cannot pay the foreign debt. Because of these reasons, Poverty Reduction Strategy Paper (PRSP) was prepared in cooperation with IMF and foreign countries in order to adapt a strategic framework to fight against poverty. The country's agriculture is recognized as a potential source of development, since it is the main sector in which most of the population is engaged. Self-sufficiency is still far from being achieved and the country still depends on imports to meet its needs for agricultural products. For this import, a large amount of resource is utilized which is one of the major factors hindering the revitalization of the economy. In the PRSP programs, promoting of agricultural development and increasing of food production are emphasized.

The Senegal River Basin located at the southern part of Mauritania is covered with large areas of flood plains suitable for agriculture. This is an important area for its agricultural potential with a

rainy season and water supply from the Senegal river and its tributary the Gorgol river. The program of Integrated Development of Irrigated Agriculture in Mauritania (PDIAIM) is implemented since the year 2000. This program is planned to revive the economy and to reduce the poverty through agricultural development and renovations of facilities across the country, mainly focusing on agricultural activities, especially irrigated agriculture.

2.2.1 Poverty Reduction Strategy Paper（PRSP）

The Mauritanian government has established the first full PRSP in December 2000 with development goals in the medium and long-term for the period 2001 to 2015. Its goals are (1) economic growth and poverty reduction, (2) the quantitative and qualitative improvement of basic social services, and (3) the abolition of regional and gender disparities for access to economic infrastructure. In particular, it is necessary to improve the rate of poverty, literacy rate, access to education, health care and water access, all of which are the striking problems in rural areas.

In November 2006, the PRSP II was prepared based on the analysis of data which were collected until that time. In this paper, the priorities to fight against poverty are:

- The formulation of an integrated rural development strategy shall focuses on agriculture and livestock,
- The review of the profitability of irrigated agriculture in the Senegal basin
- Verification of rural finance
- Developing the structure of successful example of community-driven development (Community Driven Development Approach).

This study is placed as a high priority project to rehabilitate Foum Gleita in the Gorgol river basin and to boost the rural areas in the basin of Gorgol river, which is a tributary of the Senegal river.

2.2.2 Program for Integrated Development of Irrigated Agriculture in Mauritania（PDIAIM）

PDIAM is a Program implemented with the assistance of the World Bank (WB), the African Development Bank (ADB) and Islamic Development Bank (IDB). The Ministry of Agriculture and Livestock, National Society for Rural Development of Mauritania (SONADER), and the National Union of Agricultural Cooperatives of Credit and Savings Mauritania (UNCACEM) are the implementing agency of the program. It consists of three phases that are implemented between 2000 and 2015 (projected), and currently the program is in its phase II. The program aims at revitalization of irrigated agriculture to increase productivity, to generate income, to provide access to credit institutions and to bring a range of employment opportunities for the residents of the Senegal basin. For this purpose, irrigation facilities will be rehabilitated in 25,000 ha area in the Senegal river valley. In this program, the rehabilitation APD study (Avant Projet Détaillé) was carried out for the large scale irrigation areas in the irrigated zone of Foum Gleita. Currently, the strategy implemented in the

program is undergone in the project areas of PPGI, PPGII near Kaedi and rehabilitation of agricultural facilities in Gorgol river at Lexeiba. The plan is also made for the diagnosis and the rehabilitation of agricultural facilities Foum Gleita, which constitutes a fundamental reference for the Study (see below).

Table 2.2.1 PDIAIM Related to Foum Gleita

Year	Code	Project and Studies	Type	Doc. Type	Area	Note
1999	**PDIAIM Phase I**: approved					
		PDIAIM PAD (Project Appraisal Document)	plan	PAD	National	WB
2000		**PDIAIM PID** (Project Information Document)	Info	PID	-	WB
2001	I.a.1	Etudes des **schemas directeurs** de la Gestion de l'Eau et d'Amenagement de la Vallee du **Gorgol, Rapport Principal**, Version Provisore	M/P	M/P	Gorgol	Lahmeyer International, SCET RIM
	I.a.2	Etudes des **schemas directeurs** de la Gestion de l'Eau et d'Amenagement de la Vallee du **Gorgol, Rapport Principal**, Version Definitive	M/P	M/P	Gorgol	ditto
2004	I.b.1	Etudes d'**APD** et DCE d'un Programme d' Amenagement Hydro-agricole dans la Vallee du **Gorgol**, Etude d'Avant Projet Detaille, Memoire **Descriptif et Justificatif**, Version Definitive	B/D	APD, main report?	Gorgol	Engineering and Development (CID), SCET-RIM
	I.b.2	ditto, Etude **Environnemtale**, Version Definitive	ditto	APD, separate volume	ditto	ditto
	I.b.3	ditto, Etude **Geotechnique**, Version Definitive	ditto	ditto	ditto	ditto
	I.b.4	ditto, D'Etude **Agro-Socio-Economique** et sur la Constitution d'une Association des Usagers, Version Definitive	ditto	ditto	ditto	ditto
	I.b.5	ditto, Etude **Geophysiqque**, Version Definitive	ditto	ditto	ditto	ditto
	I.b.6	ditto, Curage du **Gorgol**, Cahier des **Profils en Travers**, Version Definitive	ditto	ditto, drawing	ditto	ditto
	I.b.7	ditto, **Piste Lexeiba-Monguel**, Cahier des **Profils en Travers**, Version Definitive	ditto	ditto, drawing	ditto	ditto
	I.c	Expertise pour l'Auscultation du **Barrage** et le Suivi de l'Envasement de la Retenue de **Foum Gleita**, Rapport Final - Provisoire	Func. survey	Rapport (Part 1 - 4)	Foum Gleita	Lahmeyer International, SCET RIM
2005 2		Document d'**Evaluation** du Projet de la **Phase II** du **PDIAIM**	Info	Report	National	WB
3	**PDIAIM Phase II**: approved					
3		PDIAIM Phase II **PID** (Appraisal Stage)	Info	Report	National	WB
12		Implementation **Completion** Report for PDIAIM **Phase I**	Info	Report	National	WB
	PDIAIM Phase I: completed					
2006	II.a	Etudes **APD** de **rehabilitaion** des grands perimetres irrigues collectifs; Perimetre de **Foum Gleita**, **Phase1**: **Diagnostic** et Proposition de Solutions	B/D	Rapport	Foum Gleita	ERA, Safi, SCET RIM
2007	II.b	Etudes **APD** de **rehabilitaion** des grands perimetres irrigues collectifs; Perimetre de **Foum Gleita**, **Phase2**: Etude d'**A**vant **P**rojet **D**etaille et **DCE**	B/D	Rapport	Foum Gleita	ditto

2.3 Outline of Mauritania Agriculture

2.3.1 Classification of Cropping Systems in Mauritania

There are 4 agro-ecological zones in Mauritania which are classified in terms of agricultural production.

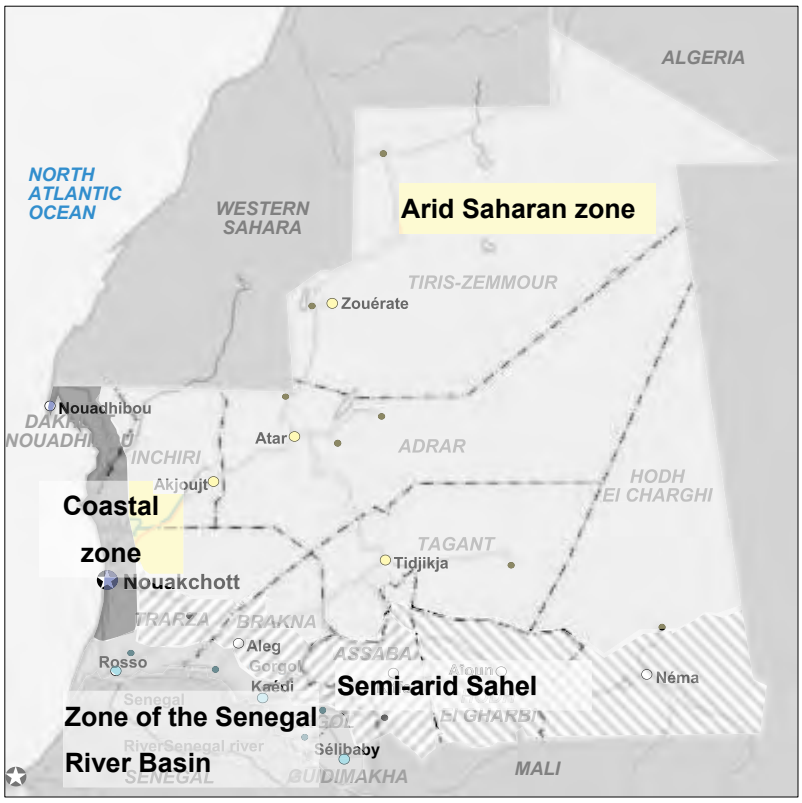


Figure 2.3.1 Agro-Ecological Zone Map

1) Arid Saharan zone

Dry Zone which occupies 78% of the area of the country, with a precipitation of less than 150 mm per year, except the coastal area. Nearly 300,000 people live in this area having the oases for living.

2) Semi-arid Sahel

The livestock rearing which is one of the major economic sector is practiced in the semi-arid area which has a population of about 90,000 people, and covers about 17 % of the national area. It is divided into two regions, consisting of the western regions including Assaba, Tarzi, Brakna, Gorgol and parts of the Guidimakha, and eastern regions of Hodh El Gharbi and part of the region Hodh El Chargui.

3) The Area of the Senegal river basin

This area is located on the right bank of the Senegal river, with a population of 450,000, containing most of the development potential of irrigated agriculture in Mauritania on 2 % of its land. Apart from the irrigated agriculture in rainy and dry seasons, animal husbandry and fisheries are also practiced in the area. This zone consists of regions Trarza, Brak n a, Gorgol and a part of the region Guidimakha.

4) Coastal zone

This is a 50 km wide region along the Atlantic Ocean of 670 km length. It occupies about 3 % of the land on which 1,400,000 people live in the two major urban centers of Nouakchott and

Nouadhibou.

2.3.2 Agricultural Land Use

Based on the natural conditions and the characteristics of the region, the agriculture lands of Mauritania can be classified as follows.

1) The Rainfed Area (Dieri)

This area has a narrow strip of land along the border of Mali and along the Senegal river, where the rainfed agriculture is possible. Sorghum, millet and maize are grown. Planting is normally made at the time of the arrival of rains in the early June; the harvest is at the end of the rainy season in November. The potential of the rainfed area is 220,000 ha, of which 138,652 ha are already exploited (2007).

2) Recession Area (Flood recession, Lowland and Controlled recession)

In this area that was over-flowed by the high waters of the Senegal river and its tributaries in the rainy season, sorghum, maize, and wheat are cultivated, after the water subsides the area leaving the soil saturated with water. The recession area consists of flood plains area submerged by the rising waters of river and submerged upstream of the dam or in depressions. The largest floodplain (Maghama) development along the Senegal river is controlled by SONADER. There is a potential of recession area of 139,100 ha, of which 83,996 ha are already exploited (34,961 ha of flood area, 39,535 ha of lowland, and 9,500 ha of controlled recession by SONADER) (2007).

3) Irrigated Area

This area of the Senegal basin and tributary consists of private farms irrigated by pumps and the farms which were established by national project. Some lands are administered by unions and cooperatives, and growing rice during the rainy season from June to October, and rice and vegetables during the dry and cold season from November to February are commonly practiced.

The potential of irrigated area of Mauritania is 137,400 ha, of which 126,000 ha (90 %) is in the Senegal river basin, with 25,000 ha (17.9 %) area in the Gorgol river basin.

4) Oases Area

In the oases of the arid Sahara, dates and alfalfa for fodder are grown. Besides, wheat, barley, sorghum are cultivated under dates as mixed farming. The Oases agriculture area is 5,500 ha in which 1.8 million dates trees (2000) were planted.

Table 2.3.1 Area of Cultivation in Each Area (2007)

States	Total (ha)	Acreage															
		Controlled farmland by PDRC										Controlled farmland by SONADER					
		Rain-fed				Flood Recession									Irrigated area		Total
						Flood recession			Lowland			Controlled recession					
		sorghum (ha)	maize (ha)	Millet (ha)	Total (ha)	sorghum (ha)	maize (ha)	Total (ha)	sorghum (ha)	maize (ha)	Total (ha)	sorghum (ha)	maize (ha)	Total (ha)	rice (ha)	Total (ha)	(ha)
Hodh Charghi	18,270,000	43,638	0	10,776	54,414	0	0	0	13,108	0	13,108	0	0	0	0	0	67,522
Hodh Gharbi	5,340,000	8,598	0	152	8,750	0	0	0	2,268	288	2,556	0	0	0	0	0	11,306
Assaba	3,660,000	28,717	1,341	63	30,121	0	0	0	3,035	5,882	8,917	0	0	0	0	0	39,038
Gorgol	1,360,000	14,839	1,490	94	16,423	10,776	451	11,227	0	4,070	4,070	4,370	3,158	7,528	1,993	1,993	41,241
Brakna	3,300,000	7,392	0	4,739	12,131	21,610	451	22,061	5,395	2,412	7,807	250	0	250	1,685	1,685	43,934
Trarza	6,780,000	10	0	0	10	1,373	300	1,673	0	0	0	1,100	622	1,722	9,678	9,678	13,083
Adrar	21,530,000	50	0	0	50	0	0	0	789	0	789	0	0	0	0	0	839
Daklet Nouadhibou	1,780,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tagant	9,520,000	3,557	0	0	3,557	0	0	0	1,882	0	1,882	0	0	0	0	0	5,439
Guidimagha	1,030,000	10,052	3,144	0	13,196	0	0	0	172	234	406	0	0	0	184	184	13,786
Tiris Zemmour	25,858,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inchiri	4,630,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nouakchott (District)	12,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	103,070,000	116,853	5,975	15,824	138,652	33,759	1,202	34,961	26,649	12,886	39,535	5,720	3,780	9,500	13,540	13,540	236,188

***** Source: Documents SSSI / DPCSE / MFA. The oasis area was not included, since the data on the area in mixed farming is not available.

2.3.3 Agricultural Production

The main crops in Mauritania are sorghum, maize, millet and rice. The country's total food production is 180,000 tons in 2007. 89,000 tons of them including 82,000 tons of paddy rice (chaff) were produced on the lands controlled by SONADER.

Table 2.3.2 Agricultural Production in Each Area (2007)

States	Controled area by PDRC										Controled area by SONADER					
	Rain-fed				Recession									Irrigated area		Total
					Flood recession			Lowland			Controlled recession					
	sorghum (ton)	Maize (ton)	Millet (ton)	Total (ton)	sorghum (ton)	Maize (ton)	Total (ton)	Sorghum (ton)	Maize (ton)	Total (ton)	Sorghum (ton)	Maize (ton)	Total (ton)	Rice (ton)	Total (ton)	(ton)
Hodh Charghi	17,455	0	1,078	18,533	0	0	0	9,438	0	9,438	0	0	0	0	0	27,971
Hodh Gharbi	2,579	0	30	2,609	0	0	0	726	0	726	0	0	0	0	0	3,335
Assaba	7,179	536	0	7,715	0	0	0	850	4,117	4,967	0	0	0	0	0	12,682
Gorgol	5,787	596	19	6,402	7,004	311	7,315	0	2,849	2,849	3,059	2,369	5,428	4,837	4,837	26,831
Brakna	1,109	0	474	1,583	9,725	406	10,131	3,129	1,689	4,818	150	0	150	8,287	8,287	24,969
Trarza	2	0	0	2	549	240	789	0	0	0	715	498	1,213	68,444	68,444	70,448
Adrar	13	0	0	13	0	0	0	316	0	316	0	0	0	0	0	329
Daklet Nouadhibou	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tagant	1,316	0	0	1,316	0	0	0	376	0	376	0	0	0	0	0	1,692
Guidimagha	8,042	3,144	0	11,186	0	0	0	155	211	366	0	0	0	597	597	12,149
Tiris Zemmour	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inchiri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nouakchott (District)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Produit Brute	43,482	4,276	1,601	49,359	17,278	957	18,235	14,990	8,866	23,856	3,924	2,867	6,791	82,165	82,165	180,406

***** Source: Documents SSSI / DPCSE / MFA. The oasis area was not included, since the data on mixed farming area is not available.

According to FAO estimates, the annual consumption of white rice in Mauritania is 150,000 tons (Programme Spécial d'Intervention, Avril-Septembre 2008). If the rate of polished rice and paddy (unpolished rice) is 0.7, annual consumption of paddy is 150,000 / 0.7 = 214,286 tons. Therefore, self sufficiency can be calculated as 82,165 / 214,286 = 38% in 2007. If the rice production is revitalized in Foum Gleita, the cropping area will be 2,700 ha (1,800 ha of 1,950ha is in rainy season, 900 ha is in hot dry season) and yield is 5 tons/ha, the annual production of paddy is calculated as

2,700alcul13,500 tons, which is16% (13,500 / 82,165) of present production in the entire country, and 6% (13,500 / 214,286) of the consumption of entire country and has a significant impact in the national rice production.

2.4 Development Plan of Gorgol Region

2.4.1 Outline and Objectives

The drought that hit the country in the early 1980s has generated a massive exodus from rural areas to urban, which resulted in the impoverishment of the rural economy. To stop this phenomenon and revitalize the regional economy, it was urgent to invest in agriculture and to provide training, which involved reviewing the basic policies of this sector. The government of Mauritania implemented a program to reduce poverty that included the implementation of Foum Gleita project.

With cooperation of development partners, particularly the World Bank, the government set up a project to Foum Gleita, namely "Black Gorgol Project", whose major objectives were to settle the populations on their land, provide production tools, guarantee the water shortages, and improve their living conditions (Source: Note on the perimeter of Foum Gleita, SONADER, 2008).

The project aimed to provide irrigation water to farmlands in Kaedi by releasing water into the Gorgol river from the largest dam in Mauritania in dry season, and it was completed in 1983 with the facilities capable of supplying irrigation water to the irrigated area located at the downstream side.

The stable water supply from the Senegal river led to develop Gorgol Perimeter Project I&II (PPGI & PPGII) and the perimeter of flood irrigated area are exploited with the PDIAIM support Program in 1997. In the perimeter of Lexeiba, the cooperatives were founded in 1986, and under the leadership of their leaders, and the union of the cooperatives, the area has been expanded every year. The Support plan based on PDIAIM was started and the diversification of agricultural products was strongly desired among farmers with the ambition to supply markets in the urban centers and outside the region.

Furthermore, the final program of the Foum Gleita Irrigation program set the goal of 3,600 ha, of which 550 ha, and 1,400 ha were developed in the first and second period in 1984 and 1989 respectively. At the same time, people immigrated to this area to began agricultural production, mainly rice cultivation. Between the late season of 1980s and the first season of 1992, double cropping was conducted, and the harvest area reached to 2,500 ha.

However, since the farmers were not adequately trained and did not realize the payment for water charges for irrigation, the recovery rate of water charges payment was very low, and hence in 1994, SONADER was obliged to stop the supply of irrigation water to Foum Gleita. Besides, the floods which occurred in this year have reduced the irrigated area, and after the occurrence of another flood in 1999. Meanwhile, the "typha" and other aquatic plants invaded the irrigation canals, which

reduced the water transport capacity of the canals to 12 % of the original plan. In addition, the livestock damages of the canal banks also reduced the stability of the canals.

The main canal was damaged in 2001 due to gradual deterioration of the banks by the watering of livestock. Several places are in dangerous situation, but the rehabilitation of collapsed banks is not easier because of the high embankment. Since then, SONADER has been supplying a fixed volume of water limited to 1.2 m^3/s (20 % of 6 m^3, maximum water flow at the peak period). Many villages use impure canal water as drinking water, and hence it is essential to ensure maintenance once a year, but the repairs to provide drinking water are not undertaken.

Though Foum Gleita has a modern irrigation system with abundance of water, it is one of the poorest regions of the country, and urgent measures are needed for the rehabilitation of the project.

2.4.2 Planning of Agricultural Water Use Facilities

The Mauritanian government currently imports 50 % of its rice needs and plans to improve the self-sufficiency rate of rice which is the staple food of the population by increasing the irrigated area and the self reliance of finance of poor farmers. During the 9 years period of 1999 to 2007, the maximum irrigated area in the rainy season were up to 22,000 ha (average 15,900 ha), including a maximum of 3,675 ha in Gorgol basin (average 2,780 ha) having the rice production on the right bank of the Senegal river.

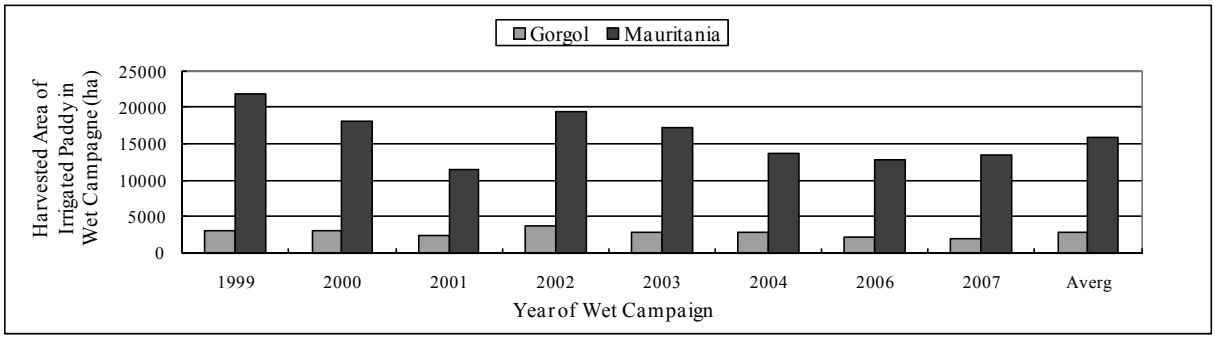


Figure 2.4.1 Harvested area of Irrigated Rice in Wet Season in Gorgol and Mauritania (ha)
Source: Agriculture Statistics Series, MDR, 2008

Gorgol is a major tributary of the Senegal river bordering Senegal with 21,000 km^2 of basin area. It meets Kaedi at 320 km upstream of St.Louis, at the right bank of the Senegal river

At the junction of the Gorgol river and Senegal river, a gate valve is set up at Kaedi to prevent of flooding in Senegal and at the same time, when the valve is closed for Senegal river, it serves to keep the water level high and supply water to the PPG area by flood recession. The gate valve is 4m high, and 5 m width with 3gates and an elevation of 3.50 m.

The white and black Gorgol rivers join at 17 km east of Lexceiba, located 40 km east of Kaedi,

and further downstream, it becomes Gorgol river. There are small irrigated areas by pumping (up to 130 ha) around the confluence of the black and white Gorgol river are dotted with a total area of about 650 ha. Willaya Assaba and Willaya Tagant are located at the north of the white Gorgol river.

The Gorgol river crosses the Kaedi to Mbout road at 1 km east of Lexceiba. It goes back east to become the black Gorgol, and reach the Project area at 40 km east of Lexceiba. The Foum Gleita dam is located at 10 km east of the project area. The Assaba State is located at the further upstream of the dam of the black Gorgol river.

The dam of Foum Gleita was completed in 1983. It is the largest in Mauritania with a maximum storage capacity of 400 million m^3. While the dam can provide water for irrigation development of over 20,000 ha area, only 4,500 ha of irrigated area has been developed until now.

The Senegal basin is 1800 km long with a basin area of 290,000 km^2. In 1988, Manantali dam was built at the upstream side in Mali, with the assistance of international financial organizations and Western countries and is managed by OMVS. The dam is expected to supply the cities such as Dakar and Nouakchott (in progress) and to irrigate 375,000 ha. The irrigation water rights are 9,000 ha for Mali, 240,000 ha for Senegal and 126,000 ha for Mauritania. In 2000, 200 MW hydroelectric plant was completed which provides electricity to Dakar and Nouakchott. Kaedi city relies on this plant for 100% of its power. In 1986, OMVS completed the Diama dam (storage capacity of 250 million m^3), which helps to prevent the saline water moving back upstream (up to 200 km upstream) and use the dam water to the cities and as a source of irrigation.

2.4.3 Irrigation Development of Gorgol Region

In Gorgol river, 5 irrigated areas were developed; (1) PPG I (700 ha, since1977), located at the end of the Gorgol river, and is largely pumping from the Senegal river, (2) PPG II, which is an extension of PPG I, having pumped irrigation and recession area, then (3) an area extended from PPG II and irrigated only by recession, (4) Lexceiba area, which includes small pumping irrigated area between the Foum Gleita Project area and Kaedi city, and finally (5) Foum Gleita project area established for the surrounding nomads and the population who were displaced by the construction of dam. The outline of PDIAIM is mentioned below.

Table 2.4.1 Outline of PDIAIM Projects in Gorgol river

	PPG I	PPG II	Decrue	Lexeiba	Foum Gleita
Development	1977	1997	1997	1986	1983-1989
Perimeter (ha)	700	1200	700	650	1950
Irrigation Method	Pump - 4sets 1m dia. & canals	Pump 6sets 1m dia., Canals & decrue	Decrue with 3 sets of sluice gates, no canal	Many small pumps (about 0.2 m dia. & canals	Gravity irrigation with complete system (silted and deteriorated)
Recent major rehabilitation	2009-10, pump, dike & canal	2009-10, dike	2008, dike	2008-09, river training. 2009, system of 2 large cooperatives	2008, dike 10 m, provisional repair
Water source	Senegal R.	Gorgol R.	Gorgol R.	Gorgol R.	Gorgol R.
Cooperatives	Active	Active	Active	Active	Not Active

Source: APD Vallee du Gorgol,SONADER, CID, SCET-RIM, 2004

These areas were studied and planned in the PDIAIM. and additional repair work is ongoing in 3 areas of Maghama in Senegal river basin, and repair work is planned in PPG and Bellara of Trarza region. The rehabilitation works in PPG II and beralla are planned in the Integrated Water Resources Management and Development Program for Multiple Use in the Senegal Basin (PGIRE: Programme de Gestion Intégrée des Ressources en Eau et de Développement des Usages à Buts Multiples dans le Bassin du Fleuve Sénégal, WB funds for OMVS, and SONADER supervises the irrigation facility in Mauritania). APD study is implemented to rehabilitate irrigated facilities of PPG II decrue area and Kaedi Pont Vanne. Additionally, the Lexeiba irrigated area was included in the rehabilitation program in the PDIAIM.

The main canals were originally planned for a capacity of 10 m^3/s, but now the danger spots are multiplying and their capacity is only 1.2 m^3/s. The most urgent repairs are made, but it is desirable to restore very quickly, since they are extremely deteriorated.

Irrigation water distribution is not the subject of consultative committee, but the union of cooperatives in the area and SONADER contact every day. Current situation of PDIAM project in Gorgol river basin irrigation area is mentioned below.

Table 2.4.2 Current situation of PDIAM in Gorgol river Basin Irrigation Area

Phase I (2000-05)	Phase II (2006-10)	PhaseIII (2011-15)
Studies: • Gorgol valley master plan, 2001 • APD Gorgol valley, 2004	Studies: • APD Foum Gleita (I), 2006 • APD Foum Gleita (II), 2007 • JICA Study, 2008-10	Suspension at this stage
Implementation: • Small scale pump irrigation (1 project in Gorgol R. & 2 project in Senegal R.)	Implementation: • River training of Gorgol R. in Lexeiba • 2-Ground sills in Lexeiba • 1-Ground sills in Kaedi • Redevelopment pump, dike, canals in PPG I & dike in PPG II • Drinking water extension in Lexeiba	Implementation: Foum Gleita • Redevelopment • Bridges and structures in the network • Bridges in the Gorgol
	Implementation: 1,857 million UM	Implementation: 2,434 million UM

Source: APD Vallee du Gorgol,SONADER, CID, SCET-RIM, 2004

The plan of Foum Gleita in PDIAIM is repairing of irrigation system of Foum Gleita (1,950ha) including the related facilities such as bridges for vehicles (2 bridges at Gorgol, 5 canals), 5 troughs for livestock, and 4 washing locations.

CHAPTER 3 EXISTING CONDITIONS OF THE STUDY AREA

3.1 Administrative Divisions

The Study area is located at the southern part of the Gorgol region (capital: Kaedi) at the lowland of Gorgol river basin. The Gorgol region has a relatively better access to the precious water resources in the Country with the Gorgol river at the north, and Senegal river running along the southwest of the region. Gorgol river stretches to the east to Assaba region and then to the north to Brakna region. The Study is focused on the irrigated agriculture which is carried out in Foum Gleita, Lexeiba, and the areas near Kaedi. The 4 departments of the region are briefly outlined below.

Department	Commune	Summary
Kaedi	7	It is the capital of the Gorgol region with the largest city Kaedi. PPG is located in Kaedi commune, and Lexeiba irrigated areas are mostly located in Lexeiba commune.
M'bout	9	In this department, Foum Gleita commune consisting of project area, dam and reservoir are located, and is extended at the upstream of the black Gorgol river.
Maghama	8	In this department, there are several small-scale pumping of irrigated areas along the Senegal river, and it contains the large-scale recession irrigated area.
Monguel	5	This department is located at the upstream of the White Gorgol river, but it has poor water resource. There are also flood-recession, rainfed, and undeveloped areas along the river.

Source: http://www.le-gorgol.org/gorgolphp

Figure 3.1.1 Summary of 4 Departments in the Gorgol Region

The map of the Gorgol region including the border areas is shown below.

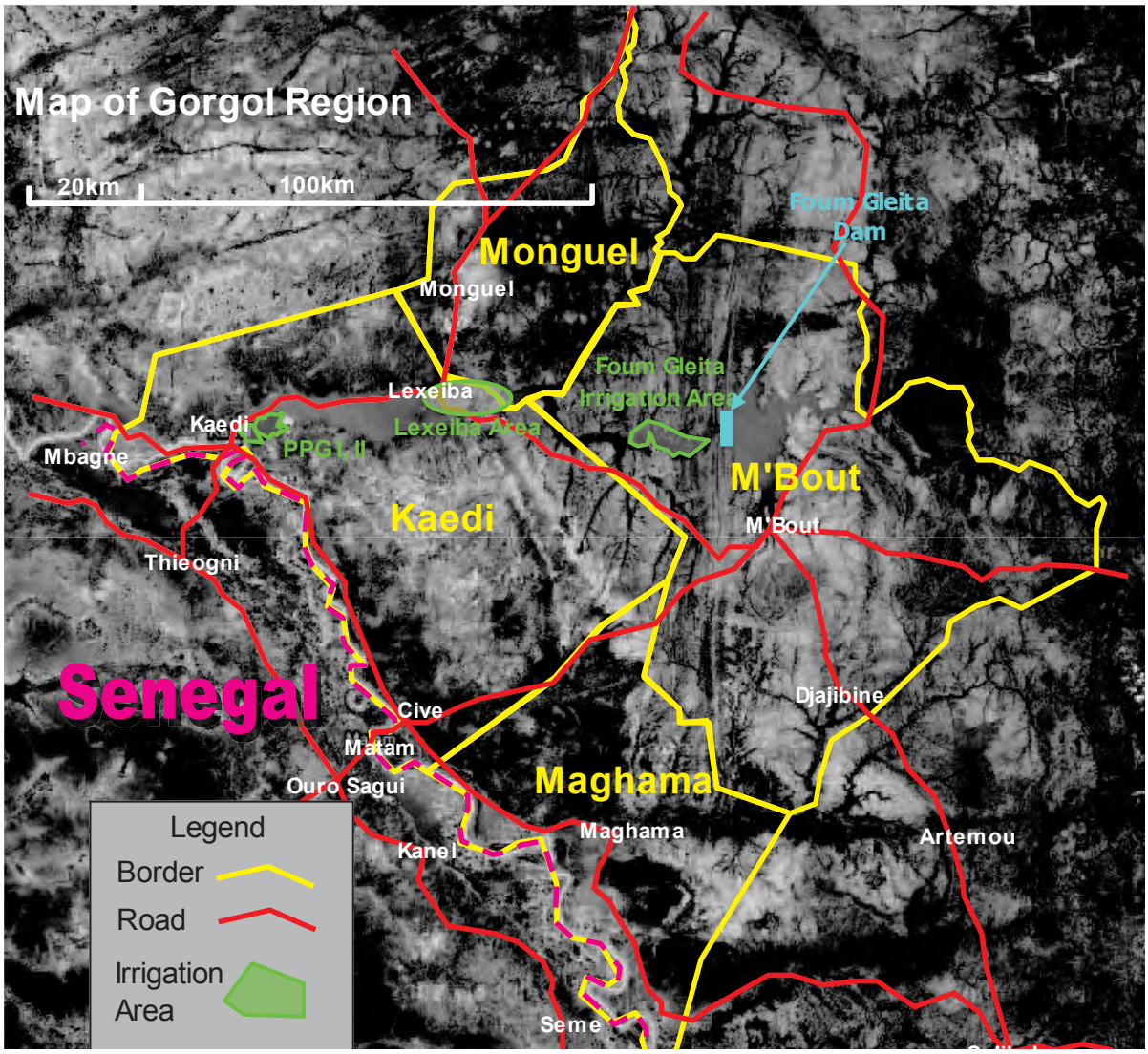


Figure 3.1.2 Map of Gorgol Region

3.2 Natural Conditions

3.2.1 Climate

In Mauritania, there are 13 weather stations and 69 precipitation stations (1997). In the Study area, there is a weather station (rain gauging started from 1963) at the Central Agricultural Research Institute (CNRADA). In Foum Gleita, there are weather stations at the dam site, Foum Gleita town and Dakhla village. Since 1994, the data has been missing for most of the years except for the rainfall record.

According to data of Kaedi precipitation station, the monthly mean of maximum temperature is 41.6℃ in May and the minimum temperature is 17.2℃ in January. The maximum temperature of 40℃ lasts from May to July. The annual mean precipitation is 255.6mm concentrated between July to

September in the rainy season. There is almost no rain from November to May. The monthly mean maximum humidity is 81.8% in August, and the minimum humidity is 11.9% in April. The monthly average wind velocity is high as 3.7m/s from May to July, and 2.0m/s in October.

Table 3.2.1 Weather Data

Mois	J	F	M	A	M	J	Jt	A	S	O	N	D	Années
Pluviométries (mm)	0,1	0,9	0	0	1,5	11,9	56,5	89,7	77,2	14,1	0,7	2,9	255,6
Température min (°C)	17,2	19,6	22,1	25,3	27,0	27,2	25,9	25,5	25,2	24,9	21,6	18,1	23,3
Température max (°C)	31,8	34,6	37,4	40,4	41,6	39,8	37,0	35,6	36,1	38,8	36,1	32,1	36,8
Température moy (°C)	24,5	27,1	29,8	32,8	34,3	33,5	31,4	30,5	30,6	31,9	28,8	25,1	30,0
ETP (mm)	449,9	451,8	562,6	603,0	632,9	477,0	372,0	260,3	225,0	330,4	383,4	401,3	5149,7
HR max (%)	37,9	28,7	28,7	32,0	38,0	56,3	73,7	81,8	81,5	65,5	42,1	37,0	50,3
HR min (%)	17,9	12,3	12,4	11,9	15,9	22,8	35,8	44,7	41,8	28,1	17,4	18,0	23,2
HR moy (%)	27,9	20,5	20,6	22,0	27,0	39,5	54,8	63,3	61,7	46,8	29,8	27,5	36,8
V (m/s)	2,6	2,9	3,2	3,4	3,7	3,6	3,7	3,3	3,0	2,0	2,2	2,8	3,0
Ensoleillement (h/j)	6,4	7,2	7,0	7,0	6,7	6,5	6,6	6,6	7,1	7,9	7,4	5,3	6,8

Source: APD: Avant Projet Detaille; Perimetre de Foum Gleita, Phase II, 2007

The maximum rainfall is usually 30-50mm/day, and based on a 10 year probability, it is estimated as 100 mm/day, and a continuous spell of heavy rainfall is rare. Annual mean rainfall is 290mm in the past decade (2000-09). The 'Harmattan' heat wave occurs from Sudan climatic zone in May, which is one of the important characteristics of this region.

3.2.2 Hydrology

(1) Hydrographic Basin

The area of Gorgol river basin is 21,000 sq.km, which is extended to 185km in length. The sources of tributaries of the main white and black Gorgol river are located at the Assaba State with a low mountainous area (600m high). The black Gorgol river traverses along Wa-Wa hills (100-170m high) where the Foum Gleita dam is located. From the starting point, the black Gorgol river runs to the eastern side to the dam, where as the white Gorgol river flows to the south and western side, and finally both the rivers meet at the confluence. At the confluence, the basin area of black Gorgol river is a little larger than white Gorgol river, but the average basin area of each river is 8,000 km^2. The annual mean discharge of black Gorgol river is 343 million m^3, where as that of white Gorgol river is 87 million m^3.

Table 3.2.2 Monthly Mean Discharge of Gorgol River

Month	Black Gorgol (Foum Gleita dam) (S=8950 km^2)		White Gorgol (Agueilllat) (S=8370 km^2)		Foum Gleita Dam (S=21,000 km^2)		Discharge
	m^3/s	MCM	m^3/s	MCM	m^3/s	MCM	MCM
Jan. - Apr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.1	0.3	0.0	0.1	0.0	0.0	0.4
June	1.8	4.6	0.5	1.2	0.4	0.9	6.7
July	23.6	63.3	6.1	16.4	3.9	10.1	89.8
August	55.5	148.5	14.1	37.8	8.8	22.9	209.2
September	46.1	119.4	11.1	28.7	7.3	19.0	167.1
October	2.5	6.7	0.8	2.2	0.4	1.1	10.0
November	0.2	0.5	0.1	0.2	0.0	0.1	0.8
December	0.1	0.1	0.0	0.1	0.0	0.0	0.2
Annual	10.8	343.4	2.7	86.7	1.7	54.1	484.2

Source: Directeures de la gestion de leau et damenagement de la vallee du Gorgol, SONADER, 2001

In comparison with this calculation, it was estimated that the annual storage of the reservoir is about 880 million m^3 based on the measured water level of the reservoir in the past 10 years.

The upstream area of the white and black Gorgol river have many desert area with sand gravel. There is no water flow in the dry season and there is no large scale irrigation facility. Recently, irrigation has been started at 2 sites using the water harvest dam (Ba Fond) made of soil and concrete of 4-5 m high, which were constructed by the Ministry of rural development. Maize is grown in the irrigated area of 10 ha area. The upstream of black Gorgol river reservoir is also a desert area, and there is no water flow in the dry season. Sorghum is cultivated for self consumption in less than 1 ha area by rainfall. Pump irrigation by solar electric power has just started at one site in an area of 1 ha.

(2) Water Level of the River

Water level indicator was set at 2 sites including Foum Gleita, and the confluence of Gorgol and Senegal river at Kaedi and the water levels are recorded by SONADER. At the Kaedi floodgate, OMVS is recording the water level from the other side of the Senegal river. As mentioned before, the irrigation water for the PPG II and flood recession area at the upstream of Kaedi floodgate is supplied by closing of the floodgate of the Senegal river and keeping the water level high in the recession period. The water levels of both Senegal and Gorgol rivers having no floods in 2004 are shown below.

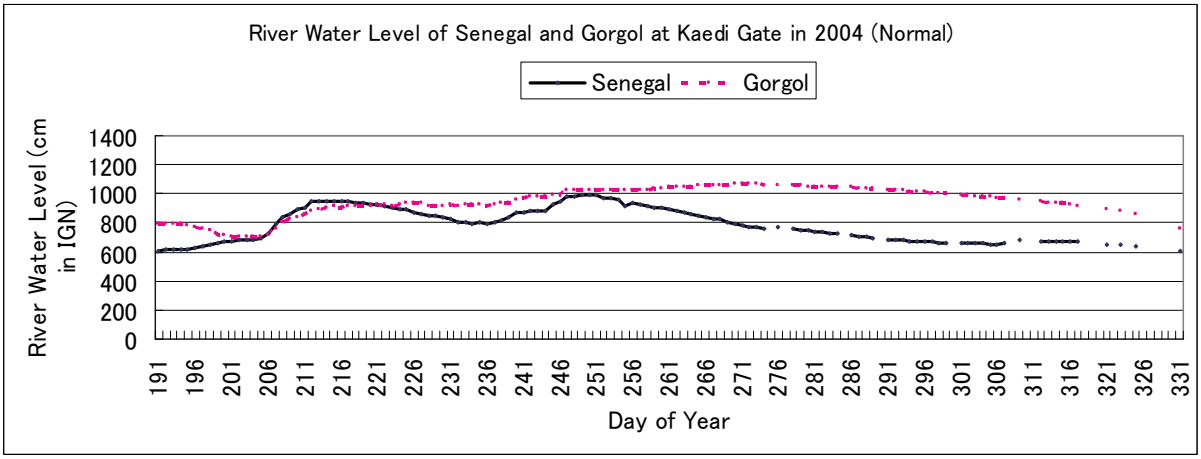


Figure 3.2.1 Water Levels of Senegal and Gorgol river at the Kaedi Floodgate (2004)

Source: SONADER, Kaedi

In 2004, this maximum water level was EL.9.96m (September, 5) at the Senegal river and EL.10.69（September, 29）at the Gorgol river. As usual, there was no obstacle for irrigation in the recession season. In the above figure, the horizontal axis denotes the day of the year starting from January 1. The altitude IGN denotes the average elevation above the sea-level surface. (2.96m is added to OMVS elevation value). The water level in rainy season was collected for nine years from 1998 to 2007, except for 2002. Water level of Senegal and Gorgol river at Kaedi floodgate in each year is shown below.

Table 3.2.3 Water Levels of Senegal and Gorgol river at the Kaedi floodgate（EL.m）

Year	Senegal river		Gorgol river	
	Date	EL.m	Date	EL.m
1998	Sep.12	11.52	Sep.27	11.06
1999	Sep.17	12.00	Sep.23	12.50
2000	Sep.15	11.01	Oct.06	11.18
2001	Sep.07	10.90	Oct.14	10.83
2003	Oct.01	11.98	Oct.01	12.20
2004	Sep.05	9.96	Sep.29	10.69
2005	Oct.04	10.34	Oct.09	11.20
2006	Oct.04	11.04	Oct.09	11.24
2007	Sep.13	12.02	Sep.21	12.52
2008	No data			

Source: SONADER, Kaedi

(3) Flood

Although the flood condition was improved after the construction of dam in 1983, there were extensive floods in 2007 and 2009. Especially in 2007, the water level of Senegal river reached to EL.12.02 (September, 13, 14,IGN point of OMVS). After it recorded EL.12.52 (September, 21) a week later in Gorgol river, recession started. However, one of the three floodgates was damaged. Besides, the bank at the upstream recession area was broken on September, 27 which influenced on breakage of dike in PPG II, and finally resulted in one month of long flooding. That area was avoided

the flood in 2009, so that the bank was rehabilitated and the gate was repaired.

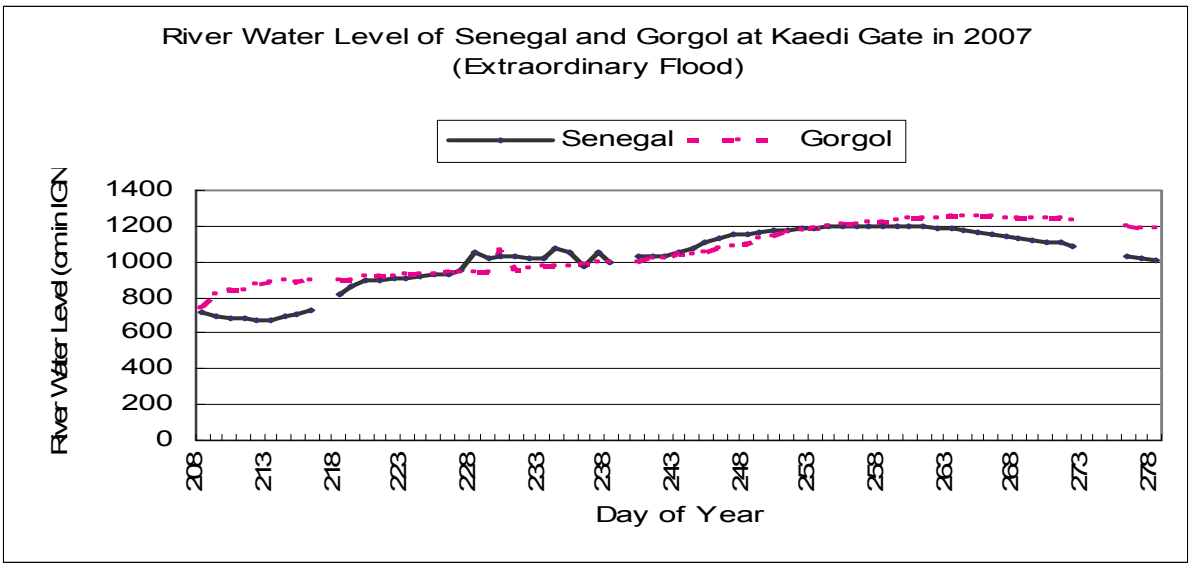


Figure 3.2.2 Water Level of Kaedi Floodgate (2007)

Source: SONADER, Kaedi

A part of Lexeiba and Foum Gleita were flooded in 2007. Regrading and reinforcement were carried out for the bank of recession irrigated area in 2008 with SONADER's supervision using national budget. Also, SONADER started rehabilitation work of PPG I (including reinforcement part of PPG II area) since 2009 in 15 months within World Bank-funded PGIRE for OMVS. Currently, in Lexeiba, dredging and groundsill work of Black Gorgol river were implemented by PDIAM and SONADER, which was completed in 2010.

After the completion of the dam in 1983, the main floods in Foum Gleita were recorded in 1994, 1999 including the 2 floods mentioned above. The largest flood, which usually occurs on seven years probability, occurred in 2007 and 2009, and damaged the low part of the area, and almost all the area was flooded with the flood lasting for one month period. However, even though the area is usually flooded, the damage is not so serious because of the recession of flood waters within a few days. In consideration of the frequency of flood, no plan is included in this Study for the construction of any measures which might influence the downstream side. The flood control action shall be improved by saving with revitalization of irrigated agriculture.

(4) Kaedi Floodgate and Foum Gleita

Kaedi Floodgate is the facility which operates water in Gorgol river basin. It is possible to carry out proper water resource development in the Gorgol river basin by properly operating Kaedi Floodgate and Foum Gleita dam. Such kinds of development include the following: 1) Irrigated farming can be done through a year, 2) Flooding can be controlled, and the flood recession irrigated

agriculture is possible in the proper cropping season. 3) The fishery and daily farming farmers can use abundance of water. At the same time, Kaedi Floodgate acts as the drainage facility in eastern area.

3.2.3 Topography and Geology

The rocks in the surroundings of the Study area consist of micaceous schist, and quartz which were subjected to metamorphism during the Cambrian-Ordovician period of Paleozoic era. The younger rocks are extremely hard. The rocks extend mainly at the high angle in the direction of N-S, 60～80°W. These rocks can be markedly observed on both the sides of Foum Gleita dam. It forms a continuous mountain so that it looks like a sharp cliff standing on a flatland. In principle, they are huge serpentine rocks, but they are arranged as polydeformed isoclinal-type fold rocks. The stratification was made by metamorphism, and therefore, the weathered rocks were detached and became flaky rocks. The seepage in the rock is impervious in the stratification. However, there is a high fluidity in the parallel direction to stratification. Hence, they have high anisotropic characteristics.

On both the sides of the black Gorgol river at the downstream of the dam site, the conditions are extremely different with no fresh rocks out-cropping. In general, it is formed by gentle sloppy area all around and covered with fine sands, silt or clay-rich alluvial formation for a few meters thickness which were transported by black Gorgol river. The alluvial area on both the sides of the black Gorgol river has a slope of 1/400～1/600 which are used as agricultural lands.

In a part of the area along the river, there is a reddish brown monogranular accumulation. The origin of this sand seems to be sable eolien coming from the desert area. This fine-grained sand flowed from mountainous slope of the dam site into main watercourse at Foum Gleita and also caused siltation.

There are still moderate low hills around Foum Gleita farming lands. They are the monadnock formed by high angled decayed rocks running in N-S direction. The sediments are composed of quartz and hence it is not suitable for farming.

Black Gorgol river is flowing down the center of the irrigated Foum Gleita from east to west direction. The riverbed around Foum Gleita has a low inclination of 1/4000. The inclination at further downstream is the same or lower and hence, the flood near to Kaedi Lexeiba often affects Foum Gleita.

3.2.4 Groundwater

The Study area consists of schist and quartz, and hence, there is anisotropy on seepage in the rock. For instance, on both the sides of dam site, cavities by erosion of groundwater in parallel direction to high angled stratification are observed, but along the direction of stratification, the permeability is low. Since anisotropy and stratification on these strata permeability are high, vertical boring exploration for groundwater, capturing shallow groundwater is not easier. Therefore, Foum

Gleita villages have only a few wells which are actually used among the wells which were dug for appraising groundwater. In this area, only 5 wells are available with good quality groundwater and are used as drinking water for villagers. One of them is in D'Dakhla village located in the downstream edge of P-2 main watercourse. Two wells are in El Wihda and another two wells are in El Adala located at the downstream edge of P-2 main watercourse. There is one well in the right side at the downstream of Foum Gleita, but it is not used.

The sediments are deposited horizontally in the alluvial formation close to the Gorgol river which is used as farmlands. Hence, it is expected that the groundwater level is the same as the Black Gorgol river forming the groundwater surface parallel to the ground. However, since the river course and the farmland area have a height difference of more than 2-3m, agricultural products is not affected by the infiltration, except during the flood periods.

3.2.5 Water Quality

Simple water quality tests for well water around Foum Gleita village were carried out, and the results are indicated in the table shown below. Although only a few parameters were analyzed, and BOD analysis which is important for drinking water was not done, the concentrations of NH_4, NO_2, NO_3, and PO_4 which indicate the pollution due to farm fertilizer, decomposed animal and plants and manures, were below the acceptable standard values, and hence the groundwater was not polluted. The pH values of the water are close to neutral, and it would be drinkable which was found by tasting the water.

Table 3.2.4 Results of Water Quality Analysis

Parameters	Unit	Village					Values of WHO Guidelines (Standard)
		El Wihda		D'Dakhla	El Adala		
		Well 1	Well 2	Well	Well 1	Well 2	
pH		7.0		7.5	7.0		6.5～9.5
COD	(Meq/l)	5.0		0	5.0		
NH_4	(Meq/l)			0.2	0.2		<0.5
NO_2	(Meq/l)	0.05		0.05	0.01		<0.1
	(Meq/l)			5	5		<50
PO_4	(Meq/l)			0.1	0.5		
Fe	(Meq/l)	0.05					
Taste and odor		Normal	Normal	Normal	Normal	Normal	
Color		Normal	Normal	Normal	Normal	Normal	

The results of water quality analysis of reservoir water and the main watercourse which receives its water from the reservoir at Foum Gleita dam (Table 3.2.5) are shown below.

Based on the water quality analysis of this Study (31/12/2008), it was clarified that the NO_3

content of water of the watercourse is close to the marginal tolerance level and the NO_2 content of the water is not at the satisfactory level. It was informed that most of the people who drink this water newly would be affected. Moreover, the water contains lots of finer-grained suspended solids materials which are not settled under the natural conditions, and it was confirmed that the suspended particles are highly visible.

Since the flood occurrence in the area about 4 months have passed when this study was conducted, but the reservoir water was still muddy because of large amounts of clay and silt content. One of the characteristics of reservoir water is that it has widely green-color plankton in the lake near to M'bout at the upstream of the dam site. Even at a glance from a distance, it is visible as green fresh water. When the water was observed after taking it back in the plastic bottle and putting it outside, it separated into green-color plankton. After a few days, it smelled and a week later, it had a strong foul smell. From this observation, it was shown that organic pollution is becoming more serious in the area.

Table 3.2.5 Results of Water Quality Analysis of Water at Dam Reservoir

Parameters	Symbol	Unit	OMS	Base-vie robinet	FG Dam Canal	FG Dam Canal	FG Dam d=9m	FG Dam d=6m	FG Dam d=3m
Temperature		℃							
pH			6.5-9.5	7.21	8.64	7.5	8.06	8.06	8.06
Conductivity		µonduc<2100	129.6	118.5		118	123	124	
TDS		mg/l	<1000	77	70				
Turbidity		FTU	<5	**425**	**481**				
Residual		mg/l					**400**	**367**	**385**
Salinity		%/10	<1.2	0	0				
Potassium	K	mg/l	<12	8	7.4		2	2	2
Sodium	Na	mg/l	<150	11.3	10.7		13	12	13
Calcium	$Ca2^+$	mg/l	<270	18.43	7.77		8.02	8.02	8.02
Magnesium	Mg	mg/l	<50	12.82	6.804		1.94	1.94	1.94
Nitrates	NO_3^-	mg/l	<50	47.5	35	1(4.3)	0.00	0.00	0.00
Nitrites	NO_2^-	mg/l	<0.1	0.49	0.451	0.01(0.033)	<0.01	<0.01	<0.01
Sulfates	SO_4	mg/l	<250	33	40		22	20	24
Chlorine	Cl	mg/l	<250	14.2	21.3		12	12	11
COD						>8			
Ammonium nitrogen	NH_4^+	mg/l				0.2(0.25)	0.00	0.00	0.00
Phosphate	PO_4^{3-}	mg/l				0.05(0.15)	<0.02		
Iron							<0.05	<0.05	<0.05
Total hardness									
Manganese							0.04	0.04	0.04
Odor						normal	normal	normal	normal
Taste							normal	normal	normal
				31/12/08	31/12/08	25/12/08	29/10/01	29/10/01	29/10/01
				SNDE Analysis		Simple analysis	CNH Analysis		

3.2.6 Soils

The soil survey (soil map of 1/50,000) for the project area was carried out in 1977 (Soil map of the Project Area is shown in Annex 2). The main soils in the project area are as follows:

- The soils of vertisols developed on alluvium with a minimum drainage capacity:
  These soils are distributed at the downstream area of the project area. They are fine textured deep soils with a low permeability.
- The humic soils developed under the climate of high temperature in rainy season:
  These soils are distributed in the base slope of the terraces and plateaus on both the sides of the valley and tributaries. They are characterized by fine to medium texture and the presence of a shallow stony horizon (quartzite, schist).

The aptitude of the soils of the Study area is classified into the following 3 categories:

1. The soils located along the alluvial valley, which are deep and having a fine texture (20-25% clay) and an average permeability are suitable for all crops including rice.
2. The soils located on the left bank with the same characteristics of the first group but are shallower are suitable for mixed farming.
3. The deep soils in the floodplain, with a finer texture (25-35% clay) are suitable for rice cultivation.

According to WARDA research in Foum Gleita in 1999-2001 (WARDA annual report, 2001-02), alkalinization had been detected in shallow soils (<1.2m soil depth), as a result of carbonate release from the schist bedrock. However, the analysis of past 30 years data revealed that there has been no secondary increase in alkalinity or salinity as a result of irrigation activities, because most soils in Foum Gleita have a strong buffering capacity against alkalinization processes. Irrigated rice cropping and incorporation of organic matter into the soil both contribute to decreasing or preventing further alkalinization. Therefore, improved crop management resulted in significant increases in rice yields, and poor farming practices including non application of phosphate fertilizer was the main reason for the reduction in yields.

3.3 Agriculture

3.3.1 Agricultural Land Use

(1) Land Use and Ownership in Gorgol Region

The Gorgol region has an area of 13,891 sq. km including 88,000 ha (6%) of cultivable area of which 41,000 ha (3%) is actually cultivated. The farm land use in Gorgol region by each farm type is shown in the right-side Table (Cultivated in 2007/08). The shares of SONADER's management area including controlled recession area, flood recession area, and irrigated area occupy 80%, 30%, 15% respectively, and occupy a high productivity area in the country. Although 4,500 ha of irrigated area was developed already in the Gorgol region, only 2,000 ha, which is equivalent to less than half of the developed area was cultivated. It is because of the fact that the two major irrigated areas, PPG II had a serious damage by flood and the Foum Gleita irrigated project suffered from a drastic reduction of function in irrigated areas. In regard to land use of each irrigated zone, rice monoculture is cultivated in PPG I and II in the rainy season. In Lexeiba, rice cultivation in rainy season, and vegetable cultivation in cold dry season are practiced. In Foum Gleita, rice cultivation in rainy season and vegetable cultivation in cold dry season are practiced in different farms (first cropping).

Table 3.3.1 Farm Land Use in Gorgol Region

Unit: ha

Type	Crop	Gorgol	Nation	% to Nation
Rainfed		16,423	138,652	12
	Sorghum	14,839	116,853	13
	Millet	94	15,824	1
	Maize	1,490	5,975	25
Water Harvest		4,070	39,535	10
	Sorghum	0	26,649	0
	Maize	4,070	12,886	32
Flood Recession (FR)		11,227	34,961	32
	Sorghum	10,776	33,759	32
	Maize	451	1,202	38
Irrigation		1,993	13,540	15
	Sorghum	-	-	-
	Maize	-	-	-
	Rice	1,993	13,540	15
FR controled by SONADER		7,528	9,500	79
	Sorghum	4,370	5,720	76
	Maize	3,158	3,780	84
General Total		41,251	240,035	17

Source : Ministry of Rural Development (2009)

In regard to land ownership, after the enacting of land legislation law in 1983, it is stated that the land ownership in genera belongs to the country. However, if the land is developed and used through a certain procedure, the user can maintain the land ownership by law. In order to standardize the land ownership, the Government recommends registration and approval of land ownership. However, generally, land is used in the habitual practice without doing a legal procedure, except for the land areas which are developed by the government. For example, people who used to manage and use the land from generation to generation are using the land without any proper legal process. It also includes the areas, which were certified by the French colonial government. In the areas which are developed by the government, the land-use rights are given as a grant to farmers along with the official documents. Both PPG and Foum Gleita are the typical examples, where such procedure was followed.

In Lexeiba, where the land has been developed by the residents, the land ownership registration has not yet progressed, but the land use rights are approved.

The background of land legislation and the conflict between Mauritania and Senegal in 1989 are described below. The land legislation was established because of long-term drought damage on grazing land ecosystem, smooth settlement of liberated residents by antislavery movement in 1981, food security and needs of management of government developed farm. At the same time, nomadic settlement was also planned. The conflict between Mauritania and Senegal begun with struggle among the community residents on land use issue especially along the border of Mauritania and Senegal, and it caused deportation of some citizens of both the nations. Although it was officially controlled in 1991, most of the African residents who were displaced from Mauritania to Senegal could not return back from the refugee camps. However, in 2007, Mauritania government approached UNHCR and after that, they return back to Mauritania, and a few of the returnees are settled in Foum Gleita.

Land ownership and land use rights in Gorgol irrigated area are totally different from each other, and the actual situation is summarized as shown below.

Table 3.3.2 Actual Situation of Land Ownership and Land Use Rights in Each Irrigated Area

Area	Situation
Foum Gleita	In 1989, SONADER distributed the land use rights of 0.5 ha per person to the farmers. The report of the WB[1] and JICA indicate that the traditional owners are taking a tenancy even today, which was also reported by some people during the Study Team's interview. However, the head of the union claims that the statements are not true.
Lexeiba	The inputs of irrigation development were covered by the long term loan from UNCACEM for the pump facility and canal construction was made by the farmers labor. Since it was carried out by community participation, land-use rights are approved.
PPG I	In 1975 at the beginning of service, SONADER provided the land use rights of 0.5 ha per person to the farmers. Today, the registration of land ownership is progressing, and land ownership rights are approved for 82% of the farmers.
PPG II	In 1997 at the beginning of service, SONADER provided the land use rights of 1.0 ha per person to the farmers. The registration of land ownership is also progressing, but it has been 13% so far.

(2) Land Use in Foum Gleita3

The developed area in Foum Gleita is 1,944 ha, but the actual cultivated area is decreasing after reaching the peak cultivation area in the beginning of 1990s.

During this study, it was shown the result of the survey of the cultivated are 2007/2008 to 009/2010 by SONADER extension staffs. In 2009-10, the total cultivated area is 692.5 ha of which 610.0 ha are cultivated inside the project area, and 82.5 ha are cultivated outside the project area. The

[1] Etudes APD de réhabilitaion des grands périmètres irrigués collectifs; Périmètre de Foum Gleita, Phase2: Etude d'Avant Projet Detaillé et DCE

rice cultivated area in the rainy season and hot dry season varies between years to year. In 2009-10, 150 ha rice was cultivated in rainy season including 120 ha inside the project area and 30 ha outside the project area, and 226.5 ha of rice was cultivated in hot dry season including 197 ha inside the project area, and 29.5 ha outside the project area. Apart from rice, vegetables are also cultivated, and vegetables cultivated area in 2009-10 is 74.8 ha, and sweet potato is cultivated in an area of 117.5 ha in cold dry season and 85.5 ha in hot dry season.

Table 3.3.3 Cultivated Area in Foum Gleita Project Area（2007/08 to 2009/10）

Year	Area	Area by cropping season (ha)								
		Rainy (June to Oct)				Cold dry (Oct.-Feb)		Hot dry (Feb.-June)		Total Area
		Rice	Sorghum	Maize	Sweet Potato	Vegetables	Sweet Potato	Rice	Sweet Potato	
2007-2008	P1 (Inside)	15.5	0.0	0.0	0.0	22.0	0.0	0.0	0.0	37.5
	P1 (Outside)	8.0	1.0	1.5	0.0	47.3	7.5	0.0	1.0	66.3
	P2 (Inside)	67.0	11.5	8.0	8.0	74.0	25.5	6.5	30.7	231.2
	P2 (Outside)	0.0	0.0	0.0	0.0	38.3	1.5	0.0	0.8	40.6
	Project Area	82.5	11.5	8.0	8.0	96.0	25.5	6.5	30.7	268.7
	Outside Area	8.0	1.0	1.5	0.0	85.5	9.0	0.0	1.8	106.8
	Total	**90.5**	**12.5**	**9.5**	**8.0**	**181.5**	**34.5**	**6.5**	**32.5**	**375.5**
2008-2009	P1 (Inside)	43.5	0.0	10.0	0.0	27.6	0.0	0.0	0.0	81.1
	P1 (Outside)	10.0	0.0	0.0	0.0	30.8	12.0	7.0	0.0	59.8
	P2 (Inside)	190.3	4.0	6.0	28.0	57.5	47.5	34.5	4.2	371.9
	P2 (Outside)	0.0	0.0	0.0	0.0	27.0	4.0	0.0	0.0	31.0
	Project Area	233.8	4.0	16.0	28.0	85.1	47.5	34.5	4.2	453.0
	Outside Area	10.0	0.0	0.0	0.0	57.8	16.0	7.0	0.0	90.8
	Total	**243.8**	**4.0**	**16.0**	**28.0**	**142.8**	**63.5**	**41.5**	**4.2**	**543.7**
2009-2010	P1 (Inside)	25.0	0.0	0.0	0.3	11.8	26.0	40.0	7.5	110.5
	P1 (Outside)	24.0	0.0	0.0	0.0	3.5	0.0	12.0	3.0	42.5
	P2 (Inside)	95.0	0.5	0.0	33.0	47.5	91.5	157.0	75.0	499.5
	P2 (Outside)	6.0	0.0	0.0	4.5	12.0	0.0	17.5	0.0	40.0
	Project Area	120.0	0.5	0.0	33.3	59.3	117.5	197.0	82.5	610.0
	Outside Area	30.0	0.0	0.0	4.5	15.5	0.0	29.5	3.0	82.5
	Total	**150.0**	**0.5**	**0.0**	**37.8**	**74.8**	**117.5**	**226.5**	**85.5**	**692.5**

Source : SONADER , Foum Gleita

The area outside the project area was at first called as illegal intake area, but in consideration of the fact that most of the cases are the people who have cultivation rights in the project area, and their relatives, and they moved their cultivation area close to the main canal where it is easy to obtain water due to declining of water in the main canal. Most of the farmers and SONADER do not consider it as a major problem since the cultivators are relatives, and some area of rice production in rainy season and vegetable production is practiced, and SONADER also encourages vegetable farming. According to personnel related to the project, there was no outside area when the facility was working well. It was recognized absolutely as a temporary provision and the problems would be resolved after

rehabilitation.

3.3.2 Agricultural Production

(1) Gorgol Region

In Gorgol region, agricultural practices are characterized by different systems based on the agro-ecological zones:

- Rainfed agriculture on the arable lands known as 'Diéri
- Flood-recession agriculture in the flood-prone areas of the valley known as 'Walo'
- Controlled recession agriculture where 'walo' is enhanced by the presence of dike to broaden the flooded area and retain water longer.
- Agriculture in lowland areas, known as 'Bas fond'
- Irrigated agriculture along the Gorgol and Senegal river

Traditionally, rainfed (Diéri) cultivation is the most practiced for a long time. However, because of the changes in the rainfall pattern, the area under rainfed cultivation has reduced. The major crops grown under rainfed condition are sorghum, millet and maize along with cowpea, water-melon and peanuts.

'Walo' (Flood recession) cultivation is the dominant type of cultivation in the Gorgol region. The cultivated area varies from year to year, but flood recession cultivation is always practiced. Generally they grow millet, sorghum, and maize. The areas covered by different agricultural practices are shown below.

Table 3.3.4 Agricultural Area under different Systems in Gorgol Region

Agricultural Season (2004 – 2005)				Agricultural Season (2005 – 2006)		
System	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)
Rainfed	20,400	0.2	4,080	17,580	0.6	10,548
Walo	50,00	0.4	2,100	12,000	-	-
Controlled Recession	6,500	0.8	5,200	8,000	-	-
Bas-fond	1,600	0.7	1,120	3,000	-	-

Source: Gorgol En Chiffres, Office National de la Statistique, 2008

In Gorgol region, the introduction of irrigated agriculture started from middle of 1970s. PPGI (Pilot Perimeter of Gorgol 1) was among the first irrigated agriculture projects in Mauritania. The rest of the irrigated agriculture projects started after 1980 after the construction of Foum Gleita Dam.

The general information of the major irrigation projects in Gorgol region is shown below.

Table 3.3.5 General Information on Major Irrigation Projects in Gorgol Region

Item	PPG I	PPG II	Lexeiba	Foum Gleita
Construction Year	1975-77	1992-97	1986	1982-89
Irrigation Area (ha)	700	1188	1183	1940
Presently Cultivated Area (ha)	650.0	662.0	600.0	500
Major Crops	Rice in rainy season, and fruits in a small area	Rice only in rainy season	Rice, vegetables, fruits	Rice and vegetables

Source: JICA Study Team, 2008

The major part of irrigated agriculture areas is shared between Kaedi, where the two of the projects PPG I and PPG II are located, and, Foum Gleita where the Foum Gleita project was developed by the water from Foum Gleita dam. These major irrigation projects were developed, and are supervised by SONADER. In PPG I and II, only rice is cultivated in rainy season. In 1999-2000 hot dry season, they have tried on experimental basis to cultivate rice in PPG II in 450 ha, but the yield was not so high because of shortage of irrigation water due to low water level, and ever since rice is cultivated for only one season in PPG I and II. However, some farmers whose areas are located close to the Gorgol river are cultivating some vegetables in small areas using their private pumps.

Apart from these major projects, there are some small irrigated areas by individual farmers along the Gorgol river. Currently, the cultivated area of one farm household varies from 0.5ha to 6 ha. The conditions of the small irrigation projects which are supervised by SONADER, Gorgol Region are shown below.

Table 3.3.6 Conditions of Small-Scale Irrigated Areas Supervised by SONADER, Gorgol Region

Name of the Cooperative	Area (ha)	Land tenure	Situation	Observations
Guiraty	20 ha	No	No activity, damaged	
Loboudou Dial	51 ha	In progress	Active	
Guiraye	56 ha	In progress	No activity, damaged	
M'Bollou	46 ha	Provisional	Active	
Diackré	24 ha	No	Active	
Djéol1	30 ha	No	Active	
Djéol2	30 ha	Provisional	Active	
Djéol3	32.5 ha	Definitive	Active	
Djéol4	32 ha	Registered	Active	
Djéol5	80 ha	No	No activity	
Gahara	20 ha	Registered	Active	
Dindi	20 ha	In progress	No activity	
Bowel	43.5 ha	Definitive	Active	Rehabilitated by PDIAIM I
Koundel1	25 ha	No	No activity	
Koundel2	20 ha	No	No activity	
Koundel3	60 ha	No	No activity	
Civé Bethé bethé	39 ha	Definitive	Active	Rehabilitated by PDIAIM II
Bélinabé	36 ha	Definitive	Active	
Bir el Barka	150 ha	Definitive	No activity	Rehabilitated by PDIAIM II

Name of the Cooperative	Area (ha)	Land tenure	Situation	Observations
Rindiao-Sylla	41 ha	In progress	Active	
Synthiou	22 ha	No	No activity	
Dioké	28 ha	Provisional	Active	
Néré Walo2	65 ha	No	Active	Multicropping
Néré Walo1	20 ha	In progress	Active	
Roufi Awdi	31.75 ha	No	No activity	
Woloum Hatar	40 ha	No	Rehab. in progress	
Fondou	40 ha	In progress	No activity	
Tethiane	20 ha	Definitive	No activity	Study in progress for rehab. By PDIAIMII
Sylla pnud	20 ha	In progress	Active	
Toufoundé Civé	33 ha	Registered	Active	
Privé Anne Kalidou	5 ha	In progress	Active	In Bélinabé
Privé Souleymane Anne	5 ha	No	Active	In Bélinabé
Privé Youssouf Kane	12 ha	No	Active	In Néré Walo
Privé Tall Djiby Samba	6 ha	No	Active	In Synthiou
Privé Sao Moussa	10 ha	No	Active	In Néré Walo
Privé Demba Sillé	50 ha	No	Active	In Néré Walo
Privé Abou Baïdi Dia	4 ha	No	Active	In Roufi Awdi
Civé2 Tondé Hirandé	44.5 ha	Definitive	No activity	Rehabilitated by PDIAIMII
Civé3	37 ha	Definitive	No activity	
Garly1	17 ha	No	No activity	
Garly2	18 ha	In progress	No activity	
Garly3	27 ha	No	Active	Multicropping
Dimichgha	63.5 ha	Definitive	No activity	Rehabilitated by PDIAIMII
YoumaneYiré1	15 ha	In progress	No activity	
YoumaneYiré2	25 ha	No	No activity	
Paliba	20 ha	No	No activity	Multicropping
Fimbo2	20 ha	No	Active	Multicropping
Sinthiane	20 ha	No	No activity	
Bedinky	19.9 ha	In progress	No activity	
Waly1	24 ha	In progress		Included in Maghama irrig.
Waly2	20 ha	In progress		Included in Maghama irrig.
Waly3	36 ha	In progress		Included in Maghama irrig.
Waly4	22 ha	In progress		Included in Maghama irrig.
Waly5	25 ha	In progress		Included in Maghama irrig.
Toulel1 et 2	85 ha	In progress		Included in Maghama irrig.
Toulel3	60 ha	In progress		Included in Maghama irrig.
Sanghé	25 ha	No	No activity	
Privé Alpha Hamidou	5 ha	No	Active	In Djéol
Privé Ibrahima Niang	2 ha	No	No activity	In Djéol
Gourel Gobi	28.5 ha	Registered	Active	Rehabilitated by PDIAIM I
Tokomadji	20 ha	Definitive	Active	Rehabilitated by PDIAIMII
Privé Dia Amad.Youss	2 ha	Provisional	Active	In Djéol
Privé Diarra Mamadou	5 ha	No	Active	In Djéol
Privé Elhadj	7 ha	No	Active	In Djéol
Bogguel Thelli	112 ha	Definitive	Active	Rehabilitated by PDIAIMI
Privé Salif Dème	6 ha	No	Active	In Synthiou
Total	1975.2 ha			

Source : SONADER (2008)

The major crops cultivated in the large scale irrigated projects of Gorgol region are shown below.

Table 3.3.7 Crop Cultivation in Irrigated Projects in Gorgol Region (2006-07)

Project		Cereals		Vegetables					
		Rice	Maize/ Sorghum	Onion	Carrot	Tomato	Sweet Potato	Okra	Cabbage
PPGI	Area (ha)	650.0	-	-	-	-	-	-	-
	Production (t)	2600.0	-	-	-	-	-	-	-
	Yield (t/ha)	4.0	-	-	-	-	-	-	-
PPGII	Area (ha)	662.0	-	-	-	-	-	-	-
	Production (t)	0.0	-	-	-	-	-	-	-
	Yield (t/ha)	0.0	-	-	-	-	-	-	-
Lexeiba	Area (ha)	600.0	-	120.0	30.0	5.0	10.0	5.0	30.0
	Production (t)	2400.0	-	3000.0	450.0	200.0	300.0	75.0	1050.0
	Yield (t/ha)	4.0	-	25.0	15.0	40.0	30.0	15.0	35.0
Foum Gleita (*)	Area (ha)	501.5	117.0	38.2	5.6	5.7	22.2	2.5	8.2
	Production (t)	1583.5	58.5	321.1	12.2	21.4	133.8	20.3	46.7
	Yield (t/ha)	3.2	0.5	8.4	2.2	3.7	6.0	8.3	5.7

Note : (*) The survey covered 11 villages of Foum Gleita
Source : JICA Study Team, 2008

Rice is the major crop cultivated in the irrigated area of Gorgol region and an average yield of 4.0 t/ha is obtained in PPGI and Lexeiba. In Foum Gleita, the average yield is lower because of the sub-optimal farming practices including use of low inputs, improper farming schedule.

Although vegetable cultivation is carried out both in Lexeiba and Foum Gleita, it is not cultivated in PPGI and II. Ever since PPG projects are developed, vegetable cultivation was carried out only once in 1999 on trial basis in 36 ha, and ever since it has not been carried out.

In case of Lexeiba, small pumps are operated by individual cooperatives, and the decisions on the vegetable cultivation can be easily made on cooperative basis, and those cooperatives which are interested are carrying out vegetable cultivation. On the other hand, PPG I and PPG II are operated by big pumping stations covering the entire areas of PPG I and PPG II. In order to operate, these pumping stations, a majority of the cooperatives in the Union should agree for irrigating the area. Besides, the farmers do not complete the harvesting of the rainy season rice crop in time, and sometimes the harvesting prolongs until middle or end of December. Therefore, it becomes difficult to cultivate vegetables in dry season.

Rice before Harvest in PPGI (Dec. 08)

While comparing the vegetable yields of Lexeiba and Foum Gleita, the Lexeiba yields are much better since Lexeiba cooperatives are more organized and strictly follow the recommended farming practices, where as the Foum Gleita farmers are practicing sub-optimal farming practices.

Although the ladies cooperatives of Foum Gleita also have a high interest in vegetable farming, they do not have enough financial support to buy necessary inputs for the vegetable farming.

Apart from cereals and vegetables, fruits are also cultivated in a small area in PPG I and Lexeiba as shown below.

Table 3.3.8 Fruit Cultivation in Irrigated Projects in Gorgol Region (2006-07)

		Banana	Lemon	Guava	Mango
PPGI	Area	-	0.2	0.3	0.5
	Production	-	2.5	1.5	3.2
	Yield	-	12.5	5	6.4
PPGII	Area	-	-	-	-
	Production	-	-	-	-
	Yield	-	-	-	-
Lexeiba	Area	2	1.5	-	1.5
	Production	60	4.95	-	10.5
	Yield	30	3.3	-	7
Foum Gleita	Area	-	-	-	-
	Production	-	-	-	-
	Yield	-	-	-	-

Source : JICA Study Team, 2008

(2) Agricultural Production in Foum Gleita

In Foum Gleita, cropping is normally carried out in three seasons (rainy season, cold dry season and hot dry season) depending on the crop. While irrigated rice is cultivated mainly during rainy season (June to November), it is also cultivated during hot dry season ('Contre Saison Chaude' CSC; February to May) in some areas of the project, where the irrigation water is available. Maize and sorghum are cultivated during cold dry season ('Contre Saison Froide' – CSF; October to February-March), and rainy season either with or without irrigated conditions. Vegetables (onion, sweet potato, cabbage, carrot, tomato, and okra) are cultivated during cold dry season, and sweet potato & okra are cultivated throughout the year under irrigated condition.

The cropping conditions in Foum Gleita during three seasons are shown below.

Table 3.3.9 Season-wise Cropping conditions in Foum Gleita

	Area (ha)				Production (t)			Yield (t/ha)			Cropping Intensity
Year	Rainy	CSC	CSF	Total	Rainy	CSC	CSF	Rainy	CSC	CSF	
1989-90	1,049	350	140	1,539	5,455	1120	168	5.2	3.2	1.2	0.79
1990-91	1,840	820	-	2,660	8,464	1312	-	4.6	1.6	-	1.36
1991-92	1,612	680	500	2,792	7,415	1972	250	4.6	2.9	0.5	1.43
1992-93	1,117	622	530	2,269	3,016	1742	106	2.7	2.8	0.2	1.16
1993-94	1,186	-	307	1,493	5,455	-	236	4.6	-	0.8	0.77
1994-95	303	437	258	998	755	1180	168	2.5	2.7	0.7	0.51
1995-96	1,143	480	700	2,323	4,343	1776	980	3.8	3.7	1.4	1.19
1996-97	1,200	485	700	2,385	5,520	1426	980	4.6	2.9	1.4	1.22

	Area (ha)				Production (t)			Yield (t/ha)			Cropping Intensity
Year	Rainy	CSC	CSF	Total	Rainy	CSC	CSF	Rainy	CSC	CSF	
1997-98	1,162	510	330	2,002	4,648	1887	330	4.0	3.7	1.0	1.03
1998-99	1,235	560	185	1,980	4,322	1904	200	3.5	3.4	1.1	1.02
1999-00	943	500	110	1,553	3,300	0	150	3.5	0.0	1.4	0.80
2000-01	300	-	-	300	540		-	1.8	-	-	0.15
Note : CSC – Hot dry season ;CSF – Cold dry season											

Ref : Etude Des Schemas Directeurs de la Gestion de L'eau et D'amenagement de la Vallee du Gorgol, June 2001

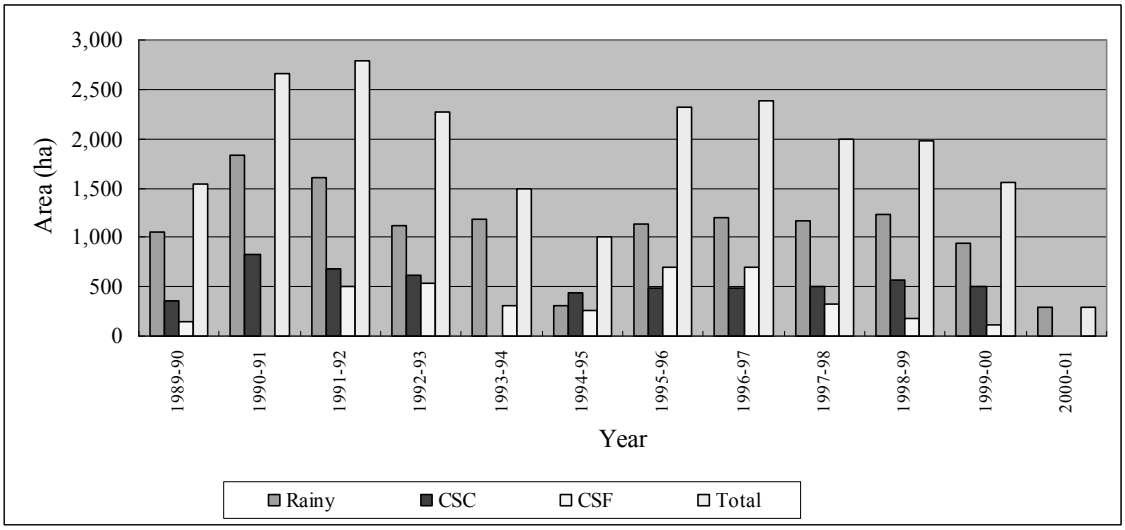


Figure 3.3.1 Variation of Cropping Condition in Foum Gleita

As shown in figure 3.3.1, the area of cultivation was at its peak during the two seasons of 1990-91 and 1991-92. Since there was a flood in 1993-94, the area of cultivation was decreased. The reason for the decreasing is degradation of irrigation canal except flooding.

Cropping conditions of cereals in Foum Gleita since 1985 is shown below.

Table 3.3.10 Crop-wise Cropping Conditions in Foum Gleita

Year	Rice			Sorghum/Maize		
	Area (ha)	Production (t)	Yield (t/ha)	Area (ha)	Production (t)	Yield (t/ha)
1984-85	55	146.9	2.7	110	261.8	2.4
1985-86	707	2,849.2	4.0	71	22.7	0.3
1986-87	815	3,097.0	3.8	25	32.0	1.3
1987-88	460	1,794.0	3.9	30	27.0	0.9
1988-89	707	3,322.9	4.7	167	205.4	1.2
1989-90	1,399	6,617.3	4.7	1,453	1,714.5	1.2
1990-91	2,481	9,179.7	3.7	963	1,569.7	1.6
1991-92	2,532	10,406.5	4.1	490	637.0	1.3
1992-93	1,502	916.2	0.6	329	427.7	1.3
1993-94	1,723	8,339.3	4.8	293	278.4	1.0
1994-95	723	2,545.0	3.5	29	23.2	0.8
1995-96	1,428	5,269.3	3.7	105	156.8	1.5
1996-97	1,220	4,721.4	3.9	300	420.0	1.4
1997-98	1,662	6,648.0	4.0	330	363.0	1.1
1998-99	1,014	3,549.0	3.5	185	185.0	1.0
1999-00	350	1,050.0	3.0	-	-	-
2000-01	900	2,430.0	2.7	12	15.6	1.3
2001-02	579	2,200.2	3.8	60	60.0	1.0
2002-03	709	3,190.5	4.5	252	201.6	0.8
2003-04	611	2,566.2	4.2	249	347.9	1.4
2004-05	755	3,020.0	4.0	140	84.0	0.6

Ref : Etudes APD de réhabilitation de grands périmètres irrigues collectifs, Ministère du Développement Rural et de l'environnement, July 2006.
Note : There is a small variation between the data in Tables 3.16 and 3.17.

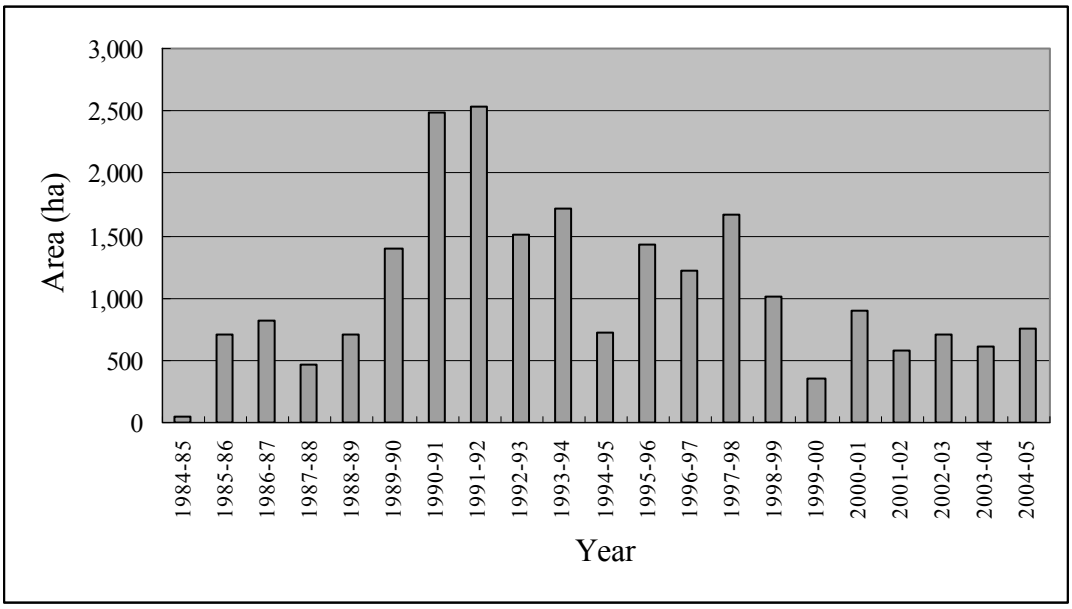


Figure. 3.3.2 Cultivation Area of Rice in Foum Gleita

As shown in Figure.3.3.2, the area of rice cultivation was at its peak during the two seasons of 1990-91 and 1991-92. Since there was a flood in 1993-4, the area of cultivation in 1994-95 was less

than 1,000 ha area, as is after flood in 1999.

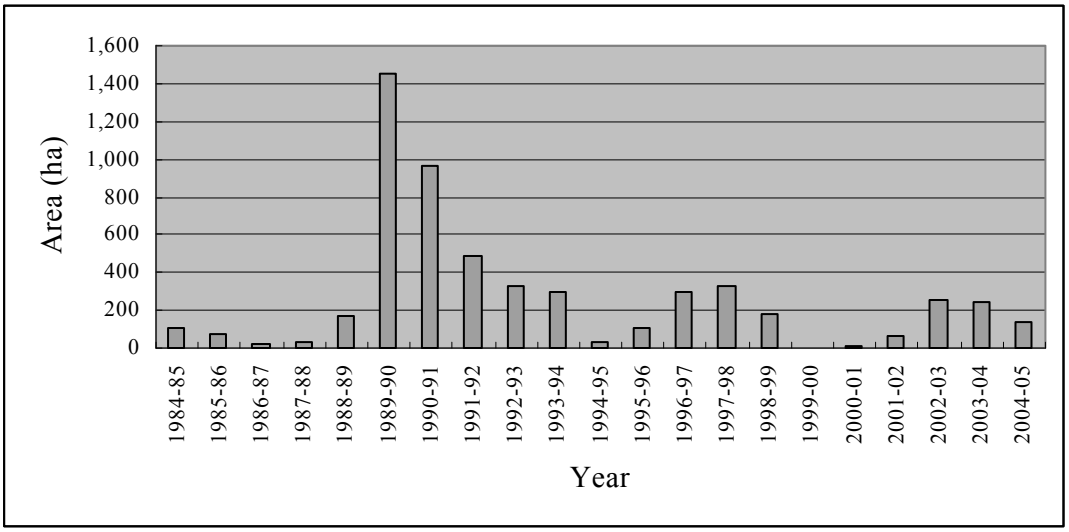


Figure. 3.3.3 Cultivation Area of Maize/ Sorghum in Foum Gleita

Similar to rice, the cropping area of maize and sorghum was at peak during two seasons of 1990-91 and 1991-92. After flood in 1994, maize/sorghum area was reduced to 29 ha. After 1999 flood, there was no cultivation of maize/sorghum. Since 2001, the farmers manage to cultivate an area of 50-350 ha of maize and sorghum.

Except for some conditions such as flood, non-availability of inputs, and delaying farming schedule extremely, the rice yield varies from 3.5 to 4.7 t/ha with an average rice yield of 4.0 t/ha. In case of maize and sorghum, the average yield is about 1.0 to 1.5 t/ha. In case of vegetables, the average yield is about 10-15 t/ha.

Farmers have experience of rice cultivation for 20 years since 1984. They know how to manage farm and techniques and importance of cropping schedule. However, because of delay loan, they could not purchase input at appropriate time. Therefore, their cropping schedule delays and the yield is decreasing as a result.

Discussion with Farmers organizations in Foum Gleita

(3) Cropping Conditions in 2006-07

According the survey of the JICA Study Team (2008), the cropping conditions in 2006-07 is shown in Table 3.11, and the present cropping pattern is shown in figure. 3.3.4.

Table 3.3.11 Cropping Conditions in Foum Gleita in 2006-07

Village	Unit	Rice (1)	Rice (2)	Rice (Total)	Maize	Onion	Carrot	Tomato	S. Potato	Okra	Cabbage
W.Issa	Area (ha)	2.0	2.0	4.0	-	1.5	0.5	0.5	1.0	0.5	1.0
	Production (t)	6.0	6.0	12.0	-	30.0	5.0	15.0	20.0	6.0	30.0
	Yield (t/ha)	3.0	3.0	3.0	-	20.0	10.0	30.0	20.0	12.0	30.0
Sabouhal a	Area (ha)	109.5	-	109.5	-	2.0	0.3	0.3	0.3	0.3	0.3
	Production (t)	328.5	-	328.5	-	7.5	1.3	2.4	1.8	0.0	2.4
	Yield (t/ha)	3.0	-	3.0	-	3.8	4.4	8.1	6.0	0.0	8.1
Lehsei	Area (ha)	-	-	-	-	1.3	0.7	1.3	1.3	0.7	1.3
	Production (t)	-	-	-	-	2.2	1.3	0.7	1.6	0.8	1.3
	Yield (t/ha)	-	-	-	-	1.7	2.0	0.5	1.2	1.3	1.0
Adala	Area (ha)	-	-	-	-	22.4	2.6	2.6	2.6	-	2.6
	Production (t)	-	-	-	-	224.4	2.1	1.3	26.4	-	4.0
	Yield (t/ha)	-	-	-	-	10.0	0.8	0.5	10.0	-	1.5
Kowel hel Jawar	Area (ha)	47.0	47.0	94.0	47.0	3.0	-	-	-	-	-
	Production (t)	164.0	141.0	305.0	23.5	18.0	-	-	-	-	-
	Yield (t/ha)	3.5	3.0	3.2	0.5	6.0	-	-	-	-	-
Dahla	Area (ha)	31.0	15.0	46.0	-	1.0	-	-	-	-	-
	Production (t)	124.0	30.0	154.0	-	2.5	-	-	-	-	-
	Yield (t/ha)	4.0	2.0	3.3	-	2.5	-	-	-	-	-
El Whida	Area (ha)	16.0	8.0	24.0	-	1.0	-	-	-	-	-
	Production (t)	56.0	20.0	76.0	-	2.5	-	-	-	-	-
	Yield (t/ha)	3.5	2.5	3.2	-	2.5	-	-	-	-	-
Base-ve	Area (ha)	17.0	17.0	34.0	-	1.0	-	-	-	-	-
	Production (t)	68.0	59.5	127.5	-	20.0	-	-	-	-	-
	Yield (t/ha)	4.0	3.5	3.8	-	20.0	-	-	-	-	-
Aravat	Area (ha)	40.0	30.0	70.0	10.0	2.0	0.5		15.0	0.5	2.0
	Production (t)	100.0	90.0	190.0	5.0	7.0	2.0		72.0	12.0	6.0
	Yield (t/ha)	2.5	1.5	2.7	0.5	3.5	2.0		2.4	6.0	3.0
Zreigat	Area (ha)	10.0	20.0	30.0	60.0	2.0	1.0	1.0	2.0	0.5	1.0
	Production (t)	30.0	50.0	80.0	30.0	4.0	0.5	2.0	12.0	1.5	3.0
	Yield (t/ha)	3.0	2.5	2.7	0.5	2.0	0.5	2.0	3.0	1.5	3.0
Magta D'iom	Area (ha)	45.0	45.0	90.0	-	1.0	-	-	-	-	-
	Production (t)	135.0	175.5	310.5	-	3.0	-	-	-	-	-
	Yield (t/ha)	3.0	3.9	3.5	-	3.0	-	-	-	-	-
Total	Area (ha)	317.5	184.0	501.5	117.0	38.2	5.6	5.7	22.2	2.5	8.2
	Production (t)	1011.5	572.0	1583.5	58.5	321.1	12.2	21.4	133.8	20.3	46.7
	Yield (t/ha)	3.2	3.1	3.2	0.5	8.4	2.2	3.7	6.0	8.3	5.7

Source: JICA Study Team, 2008 (The survey covers 11 villages in Foum Gleita)

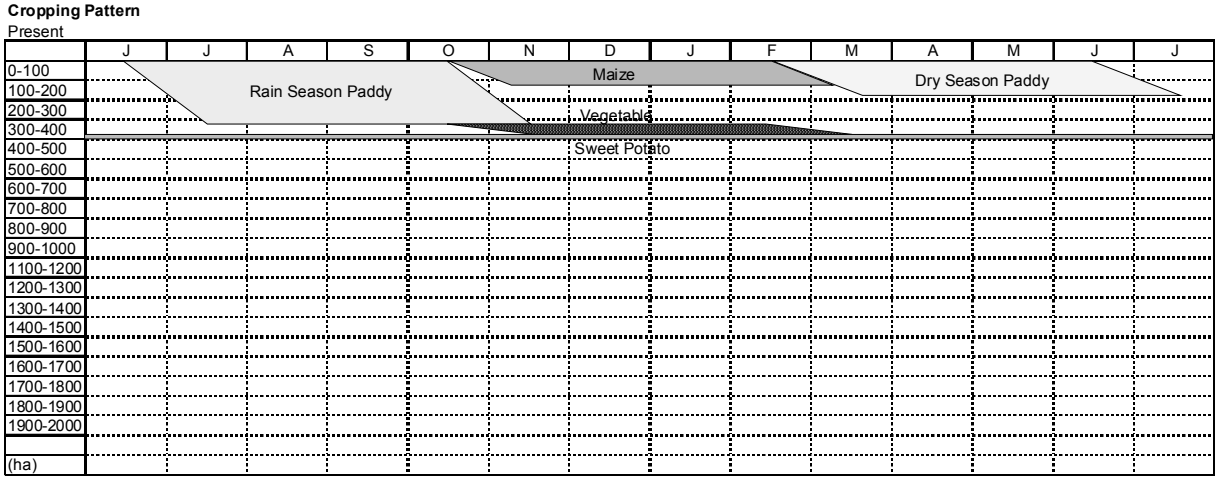


Figure 3.3.4 Existing Cropping Pattern in Foum Gleita (2006-07)

As it can be seen, rice and maize are cultivated in the area of 505.1 ha (rainy and CSC seasons) and 117 ha (rainy and CSF seasons) respectively. Vegetables are cultivated in the area of 82.4 ha mostly during CSF season, while sweet potato is cultivated throughout the year.

Cabbage Cultivation in Foum Gleita

3.3.3 Farm Management

(1) Availability of Inputs

Availability and accessibility of the inputs including seeds and fertilizers (especially for Foum Gleita) is a major constraint because of their high cost (See table 3.3.12) forcing the farmers to obtain loan from government and private agencies. Because of the high interest rate (>14%), the farmers cannot obtain enough loan which force them to use low amount of fertilizers than the recommended use of fertilizers.

The credit is usually obtained from UNCACEM through the unions of the Agricultural cooperatives (guarantor of the credit) on the basis of area to be exploited. Having refunded of 100% of the loan is required to be able to be eligible with a new credit. Although the cooperatives of PPGI, II and Lexeiba manages to obtain loans each year by proper repayment, Foum Gleita farmers could not repay the loan after 1999 flood, and therefore it is pending from then to 2008. Therefore, they cannot obtain from UNCACEM, which forces them to buy loans from private money lenders such as business merchants in Kaedi, and thereby they are obliged to sell their products to those merchants at a lower price. In combination with degradation of irrigation canals, inability to buy inputs also forces the farmers to cultivate only in a smaller area.

In regard to Foum Gleita, there is also a problem of seeds and fertilizer availability especially in the zone of Foum Gleita, where in the absence of approved companies' representatives for the sale of seeds and fertilizers, the rice and vegetable farmers must purchase their inputs from the regional capital Kaedi. Therefore, farmers have to cover transportation cost. Because of the poor organizational capacity of the cooperatives, buying of inputs from Kaedi is also delayed, which delays their farming operations.

As an example, the unit cost to be spent by the farmer for the 2008-09 as recommended by SONADER is shown below.

Table 3.3.12 Unit Cost for Union of PPGII Farmers in 2008-2009 Rice Growing Campaign

Items	Price/ha
Fertilizer	51,900 UM
Seeds	18,000 UM
Labor	13,680 UM
Energy (irrigation)	25,979 UM
Tax	9,000 UM
Total	118,559 UM

Source: SONADER (2009)

Regarding rice varieties Sahel 108, and Sahel 202 are widely used. Although Sahel 201 was also introduced along with Sahel 202, the taste of Sahel 202 is preferred over Sahel 201, and therefore it is widely used. The cropping cycle varies between the two cropping seasons (rainy season and hot dry season), the normal cropping cycle for Sahel 108 and Sahel 202 are 110-115 days, and 117-140 days respectively.

(2) Shortage of Farm Machinery

In Gorgol region, shortage of farm machinery is one of the serious constraints which is reported by almost all the farmers in the region. Farm Machinery Status in Gorgol Region is shown below.

Table 3.3.13 Farm Machinery Status in Gorgol Region (2008)

Types of machines or equipment	PPGI	PPGII	Kaédi owned privately	Lexeiba	Foum Gleita
Tractor	0	0	4	2	0
Harvester	0	0	1	0	0
Offset	0	0	2	1	0
Leveler	0	0	2	1	0
Ridger	0	0	2	1	0

Source : JICA Study Team (2008)

Currently, there are only 4 tractors and one harvesting machine in PPG I, and II, and there are 2 tractors in Lexeiba. These are owned by rich farmers and are lent to the farmers with a rate of 12,000 UM/ha for the tractor and 22,000 UM/ha for the harvesting machine.

In Foum Gleita, cattle and donkeys are used for transportation, but all other farm works are done manually. Since all the agricultural operations have to be done manually, cropping season is delayed, and the farmers could not follow their farming schedules.

Rented Combine Harvester in PPG1(Dec, 08)

(3) Livestock Breeding

Livestock breeding is one of the socio-economical activities practiced by the population of the Gorgol region, and about 10% of the working population is involved only in breeding activities (Reference : http://www.le-gorgol.org/). Besides, most of the farming household breed livestock cattle, goat, sheep or donkey on a smaller scale. Apart from milk, these animals are also used for farming and transport purposes. Most of the farm household breed livestock as 'savings and prestige' for the family.

The livestock population in the Gorgol region is shown below.

Table 3.3.14 Livestock Population in the Gorgol Region (2005-06)

Species	Kaédi	Maghama	M'bout	Monguel	Total
Cows	25,000	40,000	50,000	17,500	132,500
Sheep/Goat	400,000	520,000	320,000	300,000	1,540.000
Camels	6,000	1,000	3,000	1,500	11,500
Donkeys	7,000	6,500	8,500	3,500	2,5000
Horses	600	350	600	150	1,700

Source: Regional Office of Ministry of Rural Development

As per the JICA Study (December 2008), the livestock population in the project areas is shown below.

Table 3.3.15 Livestock Population in the Project Area

Name of Village	Cattle (Nos.)	Camels (Nos.)	Sheep / Goat (Nos.)	Donkeys (Nos.)	Horses (Nos.)
PPGI Kaedi	200	0	3,000	500	250
PPGII Kaedi	3,500	10	5,000	400	450
Lexeiba	4,000	6,000	6,500	1,300	1,000
Vouro Issa	210	0	500	30	5
Sabbouhala	150	0	400	500	40
Lehseye	700	0	2,500	2000	121
Adala	120	2	220	50	20
Kowel Jaavar	1,000	0	2,000	500	
D'Dakhla	500	0	1,000	100	
El Wihda	1,300	0	2,200	800	
Base-vie	1,000	0	3,000	200	
Aravatt	100	0	150	25	
Z'Reigatt	200	0	500	100	
Magta D'Diom	85	0	100	25	

Source : JICA Study Team (2008)

The Gorgol region has two important pastoral reserves:

- The pastoral reserve El Atf: It covers an area of approx. 500,000 ha, which is important for its biodiversity and a great value for food security for livestock. A great part of this reserve is located in Kaedi region and the other part in the Maghama area.
- The pastoral zone of Danayale: It is a zone, where there is a high concentration of livestock and corridor for the passage of nomads. It covers an area as approx. 250,000 ha. It is located on the southern extension of Maghama toward the region of Guidimakha.

As nomadic grazing zone in the region, Department of M'bout - North-west areas covering the area of El Vedra-Batha El Sidi, Foum Gleita, Bidiab and Lahrach, which is border with the Department of Barkeol (Assaba region) Monguel Department – Pasture area is in the north and north-eastern part of the department, where the herbaceous vegetation are grown.

Transhumance covers the period of July to October. The area of El Atf and Danayal receive many numbers of the transhumant livestock.

Drinking water for livestock is sourced from Kaedi, Senegal river in Southwest of Maghama,El Atf and Danayal, there is a lack of water pools in the area, in relation to the number of livestock in hard times (March-June). Therefore, pastoral wells are created by the Ministry of Hydraulics and Energy to meet the needs of the livestock. The wells for the livestock are located in the following locations:

Shallow wells:

- Dept. of Kaedi - Rueben, Hadate, Lenlezimat, M'Boul, Mouftah El Kheir.
- Dept. of Monguel - Jekh El Teiss, Kawssara

- Dept. of Maghama - Danayal, Bir El haba, Toulel 1.

Drilling wells:

- Kaedi: Hadate
- Maghama: Bir E Khaba

Drinking ponds:

- Hadate, M'boul, Tokomadji, Koundel, Patoukone, Garly and Boné Indé

Drinking water is a major constraint for the livestock in Foum Gleita, and they mostly drink in the canals, and thereby causing a lot of disturbance in the canals.

(4) Fishing

In Gorgol region, about 1% of the working population is involved activities (Reference: http://www.le-gorgol.org/). In Kaedi, there is a fishermen community "Soubalbé" (fishermen) who were among the first inhabitants of the town. The fishing activities are carried out in the right bank of the river. In Lexeiba and its surroundings, this activity is carried out at a marginal level. In Foum Gleita, it is practiced at a very low level and often by people coming from somewhere else, for example people from border areas of the Foum Gleita dam or 'Haratins' who come to live with the inhabitants of Ganki Gorgol. The dry fish from Black Gorgol river is sometimes sold in Foum Gleita market.

3.3.4 Agro Economy

(1) Overview of Economic Activities among Foum Gleita Farmers

Major economic activities among Foum Gleita farmers are: (a) production of cereals (rice, maize and sorghum), beans (cowpea), tubers (sweet potato), and vegetables (onion, cabbage and carrot); (b) livestock raising (cattle, sheep, and goat); and (c) seasonal migration. The table below shows the contribution of each of these activities to the economy of interviewed farmers' households.

Table 3.3.16 Annual Returns per Household from Major Economic Activities among Foum Gleita Farmers

(UM/household/year, unless otherwise specified)

	Area (annual cumulative, ha)	Value of Products	Cost of Production	Return	Remark
Rice	**1.00**	**59,625**	**37,511**	**20,700**	*1
	(0.80)	(65,306)	(52,883)	(50,916)	
	[15]	[12]	[13]	[15]	
Vegetables	**0.19**	**97,203**	**10,951**	**86,252**	*2
Onion	0.09	35,000	5,486	29,514	
	(0.15)	(164,219)			
	[20]	[23]			
Cabbage	0.06	37,500	3,506	33,994	
	(0.08)	(34,481)			
	[12]	[17]			
Carrot	0.03	24,703	1,959	22,745	
	(0.07)	(33,787)			
	[11]	[18]			
Other Crops	**3.38**	**246,374**	**21,777**	**224,597**	*3
Maize	0.94	15,800	3,180	12,620	
	(0.50)	(31,119)			
	[16]	[17]			
Sorghum	1.00	60,000	3,473	56,528	
	(0.31)	(101,979)			
	[12]	[15]			
Cowpea	0.94	34,916	2,455	32,461	
	(0.44)	(42,684)			
	[14]	[21]			
Sweet potato	0.50	135,658	12,670	122,988	
	(0.27)	(129,047)			
	[10]	[14]			
Livestock		**50,302**	**10,369**	**39,934**	*4
Cattle		13,073	6,033	7,040	
Sheep		22,309	1,186	21,123	
Goat		14,921	3,150	11,771	
Total		**453,504**	**80,607**	**371,483**	

Notes: Figures in [ ] are numbers of data; figures in ( ) are interquartile ranges. Regarding the agricultural products, value of products is calculated as if all the harvest was sold without being self-consumed. Seasonal migration is omitted from the table bacause reliable information could not be sufficiently obtained. All the labor force needed for these activities is assumed to be able to be provided within the household, and the value of family labor is not included in the calculation.

*1 The value of products, cost of production, and return are each the median value among the respondents. Therefore, value of products minus cost of production does not necessarily equal return. For details, see ANNEX12.

*2 Breakdown of calculating the value of products and cost of production is shown in ANNEX6.

*3 Breakdown of calculating the value of products and cost of production is shown in ANNEX12.

*4 The medians of the number of animals raised among the respondents were 3 for cattle, 5 for sheep, and 8 for goat. However, it should be noted that many respondents hesitated to answer the number of animals that they were raising, probably because the livestock is considered as assets; breakdown of calculation is shown in ANNEX12.

Souce: Agro-economic survey conducted by Study Team (2009)

The table shows that:

a) Contributions of rice farming and livestock raising to the household economy are relatively small;
b) Vegetable production makes a large return for its relatively small cultivated area; and
c) The biggest contribution to the household economy comes from "others crops," which are cultivated in a large scale and also in an extensive manner (i.e., the cost of production is low compared to the area cultivated). Especially, the contribution of sweet potato is remarkably high.

The sum of returns from all the activities amounts to 371,483UM/household/year. Assuming that an average family in Foum Gleita, composed of seven members, expends 1,000UM per day for food items, and the Engel's coefficient is 0.6, annual living cost of this family amounts to 608,333UM (1,000UM × 365days / 0.6). This leads that a return of 371,483UM/year would be absolutely insufficient to sustain a family. The table above was constructed using the data obtained from the farmers whose family scales varied, and the value of total returns calculated based on these data is nothing more than a reference. However, this result still indicates that there might be a large number of families in Foum Gleita, having difficulty in living only with agriculture.

Then, annual per capita total value of products was derived for each farmer by dividing the value of products per household by the number of family members of the corresponding household. The result is shown in the table below, separating the farmers into two groups, one with farmers who currently cultivated rice in a regular basis and the other with farmers who did not, and each group arranged in increasing order of the per capita value of products.

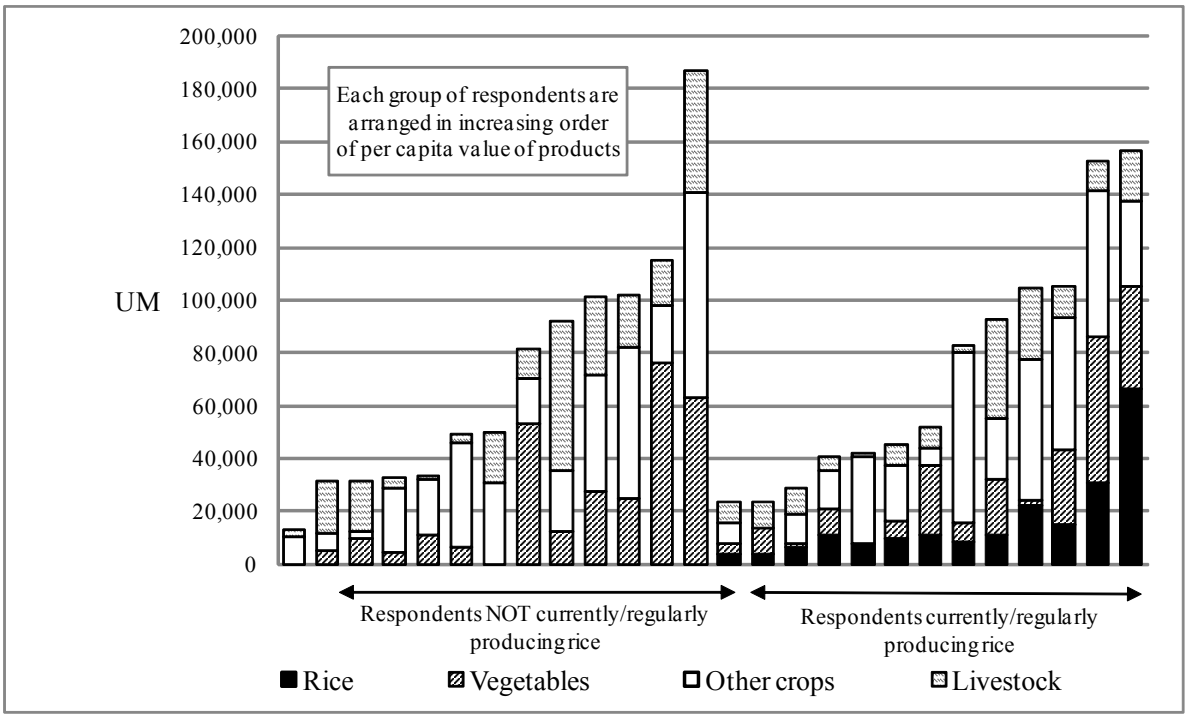


Figure 3.3.5 Annual Per Capita Value of Products among Foum Gleita Farmers

Note: the total number of respondents is 26, which consists of 13 farmers currently producing rice in a regular basis and other 13 farmers who are not. To convert per household data to per capita ones, a man was treated as 1.0 person, while a woman 0.8 person and a child under or equal to 10 years old 0.5 person (regardless of the child's sex).
Source: Agro-economic survey conducted by Study Team (2009)

The table shows that:

(a) Large disparity in wealth exists among the farmers. It appears that the disparity is not related to whether they currently practice rice farming.
(b) No farmer depends on monocropping or livestock raising alone, but most of them live on combinations of producing rice, vegetables, others crops, and livestock. However, contribution of each product to household's economy varies widely across the respondents.
(c) In general, contribution of rice farming to household's economy is low.

The contribution of rice farming to the household's economy is low, even among the farmers who currently produce rice in a regular basis. In the following section, to find out the reasons creating this situation, rice farming in Foum Gleita is analyzed more in detail.

(2) Profitability of Rice Farming in Foum Gleita

All of 9 farmers interviewed in Lexeiba and PPG practiced rice farming only in rainy season. On the other hand, of the 15 respondents regularly cultivating rice in Foum Gleita, only 2 practiced it only in rainy season, 6 only in hot dry season, and 7 in both of these two seasons. To analyze the profitability of rice farming in each zone, annual household budgets and also budgets per hectare for rice production were constructed, based on the collected data. The budgets per hectare are presented below (for the annual household budgets, see ANNEX12).

Table 3.3.17 Budgets per Hectare for Producing Rice at Study Area

				Foum Gleita						Lexeiba	PPG I, II
				N.	Minimum	Mean	Median	Maximum	Standard Deviation	Median	Median
Area (annual cumulative, ha)				15	0.3	1.3	1.0	6.0	1.4	1.3	2.0
Value of Products	Production (paddy, kg/ha)			15	160	2,159	1,600	7,840	1,836	5,750	3,348
	Selling price (paddy,			11	22	46	47	63	12	83	64
	Value of products			**12**	**7,500**	**114,840**	**77,500**	**490,000**	**127,828**	**487,891**	**217,00**
	Max. production (kg/ha)			14	160	3,415	2,960	7,840	2,086	6,000	4,200
	Min. production (kg/ha)			15	160	1,133	864	3,520	1,009	2,176	2,380
	Max. price (UM/kg)			10	28	61	63	109	20	89	94
	Min. price (UM/kg)			9	17	32	31	47	10	80	56
Cost	Material	Seeds	Quantity (kg/ha)	15	18	39	38	64	13	50	45
			Price (UM/kg)	15	0	129	109	600	141	0	159
			Cost (UM/ha)	15	0	4,785	3,600	16,000	4,043	0	6,720
		Urea	Quantity (kg/ha)	16	100	163	198	200	44	300	300
			Price (UM/kg)	15	150	195	200	240	28	150	173
			Cost (UM/ha)	15	16,000	31,482	32,000	48,000	10,307	45,000	51,900
		TSP	Quantity (kg/ha)	16	0	44	11	200	58	0	5
			Price (UM/kg)	7	100	164	160	240	45	38	88
			Cost (UM/ha)	15	0	6,096	0	28,000	8,465	0	0
		Agri. chemicals (UM/ha)		19	0	0	0	0	0	12,000	0
		Irrigation water (UM/ha)		15	0	0	0	0	0	50,000	33,305
		Storage bags (UM/ha)		14	286	4,912	3,732	14,000	3,570	11,638	6,650
		Total (UM/ha)		**15**	**26,214**	**47,206**	**49,234**	**74,513**	**16,883**	**122,385**	**98,210**
	Labor (UM/ha)	Land preparation		14	0	15,357	13,500	54,000	14,717	22,500	12,000
		Nursery preparation		13	500	2,622	1,333	12,000	3,195	2,625	1,800
		Transplantation		12	8,000	24,458	14,500	82,500	22,896	25,781	9,000
		Weeding		13	5,500	25,077	20,000	60,000	16,560	26,000	18,500
		Bird control		9	25,000	67,222	60,000	180,000	48,355	50,000	30,000
		Animal control		13	18,667	151,051	120,000	600,000	151,732	16,250	11,250
		Harvesting/thrashing		13	8,500	34,000	29,000	96,000	23,096	63,344	37,625
		Total		**13**	**83,000**	**252,981**	**191,333**	**687,500**	**176,250**	**143,094**	**155,37**
	Transportation (UM/ha)			9	0	7,257	5,714	31,333	9,419	0	7,250
	Total excl. labor (UM/ha)			**13**	**33,600**	**55,740**	**49,234**	**103,333**	**21,561**	**122,385**	**106,21**
	Total incl. labor (UM/ha)			**13**	**126,314**	**308,721**	**247,757**	**721,100**	**178,761**	**282,732**	**261,95**
Return excluding labor				**15**	**-35,814**	**60,991**	**23,783**	**405,375**	**107,571**	**290,896**	**121,65**
Return including labor				**15**	**-646,10**	**-183,34**	**-167,31**	**14,619**	**141,690**	**149,521**	**-53,604**

N. : Number of data providing viable answers in Foum Gleita (maximum 19: 15 who were regularly producing rice + 4 who had not produced rice recently but restarted this year). Number of data in Lexeiba was 3, PPG I and II are 6.

Source: Agro-economic survey conducted by Study Team (2009)

a) Summary

The median of the respondents at Foum Gleita was 1,600 kg/ha of production (paddy), 47 UM/kg of selling price and 77,500 UM/ha of return, if all the production were sold. Compared to the median of 3 respondents at Lexeiba, the production and prices are low, and the return per hectare is

also 6 times lower.

In cost of inputs, the share of urea was high in all the three areas. Although 300 kg/ha of urea were applied in Lexeiba and Kaédi, it was common that only 200 kg/ha were applied in Foum Gleita. At Foum Gleita, the farmers currently do not pay the water charge, but at Lexeiba and Kaedi, they pay high costs of fuel for the pump as the major expense.

In labor input for each type of farm work, it was found that protection against birds and animals was a heavy task in Foum Gleita. The protection against animals means that farmers have to monitor their fields so that the livestock of others cannot enter. In the Table 3.3.17, the cost of labor was calculated by multiplying 500 UM/day/person to the number of days and persons that the respondents reported that they needed for each task. This amount was set much lower than the cost of the adult labor (according to the interview in the study area, it was generally from 1,000 to 2,000 UM per day), because the children are very much involved in the farm work. Yet, even with this low value, the median of total labor input is 191,333 UM/ha at Foum Gleita, which is 2.5 times more than the return, in case of selling the entire production (77,500 UM/ha).

Thus, due to the low revenue and high costs at Foum Gleita, the median of return was 23,783 UM/ha even if they sell their entire production and exclude the labor cost. If the labor cost was included, the median of return was -167,314 UM/ha in the calculation. The figures in Table 3.3.17 were derived by dividing the figures in each respondent's budget by his cumulative acreage per year. Thus, the calculated returns are also per year. If the benefits of paddy rice in a year do not even cover one month's salary of the adult workforce, then the rice profitability must be considered to be low. If this result reflected all the Foum Gleita farmers engaging in rice production, it could be concluded that its development in the area will not be possible only by the rehabilitation of irrigation facilities, but it will be necessary that improvement in different aspects as discussed below be planed to increase the profitability of rice production.

b) Low Yield

It has been seen that the yields in Foum Gleita were lower than in the other two areas. One of the reasons for the difference would be the amount of fertilizer used. At Foum Gleita, they reported using 200 kg/ha of urea in maximum. This could be because they cannot take a new loan from the UNCACEM due to their debt behind their previous credit, and also most farmers cannot afford to purchase 300 kg/ha of fertilizer before agricultural season. It was also reported that sometimes the irrigation canals were damaged during the agricultural season and the water could not reach to the paddy field, which destroyed the entire rice. Therefore, the high risk may prevent farmers from buying the 100 kg/ha of additional fertilizer (costing about 20,000 UM), even though they knew that the yield would increase. To reduce the risk of production, it is essential that farmers, Union, and SONADER each play their role and improve their abilities to manage irrigation canals.

According to Foum Gleita farmers, they generally eat rice every day at lunch, and couscous made from maize, sorghum or rice for dinner. The daily consumption of an adult of polished rice was 290 g per day at Foum Gleita (30 respondents, mean of 310 g, and Standard Deviation of 110 g). The consumption of each family varied depending on the sizes of the family and was 183 kg per year at minimum and 2,248 kg at maximum, with a median of 548 kg. According to the only miller in Foum Gleita, the paddy produced in Foum Gleita becomes 70% in weight after milled, which means that 548 kg /0.7 = 783kg of paddy should be produced to meet at least annual self-consumption for the half of the farmers and 2,248kg/0.7= 3,211 kg for all. These figures are not unrealistic, as in fact, among 15 farmers interviewed who grew rice regularly, 10 produced in calculations more than the amount they needed for their consumption. However, only one of them reported that he produced more than his family's consumption. This implies that the farmers have to sell a large part of the harvest for cash or to repay their debts. Rice is a staple food, and once there is no more stock, he must purchase it at a higher price than the price at which he sold it, until the next harvest. To avoid this situation, increasing yield is a major challenge for Foum Gleita farmers.

c) Low Price

The selling price of paddy rice produced in Foum Gleita was normally around 50 UM/kg and 60 UM/kg in the highest (Table 3.3.17). According to the three traders interviewed in Base-Vie market, the price at which they purchased paddy directly from farmers was 47-50 UM/kg at harvest, while 63-94 UM/kg during off season. This indicates that farmers sell their products when it is the cheapest. They do not (or cannot) wait until the price increases toward the off season partly because they do not have storage facilities. In fact, many villages where information on the marketing of agricultural products was collected reported the lack of storehouse as a problem after harvest. But a more fundamental problem would be their economic weakness. Farmers who do not have enough cash savings sometimes purchase groceries from retailers and pay with money they obtain by selling their rice harvest. In this case, they should sell rice immediately after harvest to pay debt. Moreover, a custom that has existed in some areas was that when farmers bought fertilizer and other inputs by borrowing money from traders, they had contract that farmers sold their products at a price decided in advance by traders. Such a price was always set much lower than the market price.

According to SONADER staff, although a GIE (Groupement d'Intérêt Économique, Economic Interest Group) was established in 2001 at Foum Gleita to buy rice from farmers at a fixed price, it has not worked yet because of small amount of production. They also reported that between 1993 and 1999, the UCAF bought paddy rice from farmers at a fixed price of 47 UM/kg. In addition, from 1978 to 1999, ILO, WFP and the Norwegian Government established a bank of cereals in the villages of Foum Gleita under the aid program of ACOPAM whose mission was to improve food security in West African countries. Storage were built in the villages, where farmers sold their rice at a fixed price higher than the market price and redeemed at a fixed price lower than the off-season market price, so

that farmers do not suffer from the fluctuations of the grain market. There are still some cereal banks in Foum Gleita. Whether by GIE, UCAF or cereal bank, it is undeniable that the structure to support the selling price of rice is a key to increase profitability of rice production in Foum Gleita.

It is difficult to believe that the reason why the selling price of paddy rice in Foum Gleita was much lower than the selling price in Lexeiba and Kaédi (PPG) was only that farmers are obliged to sell their products immediately after harvest and their price does not receive a grant. Figure 3.3.7 shows recent retail prices of paddy rice at the market of Boghé, Kaédi and Rosso. In Kaédi, the price did not decrease after the rainy season in 2009, staying around 90-100 UM/kg. This would be because rice was not produced at all in Kaédi this year due to the rehabilitation work on PPG I and the problem of non payment of water fee in PPG II. However, farmers in Foum Gleita apparently did not benefit from the price increase in Kaédi, which is located barely 100 km away. A farmer reported that even if he was aware that there was a market where rice price was higher, it was impossible to transport his harvest. Thus, the distribution would be another problem causing the low prices of rice in Foum Gleita.

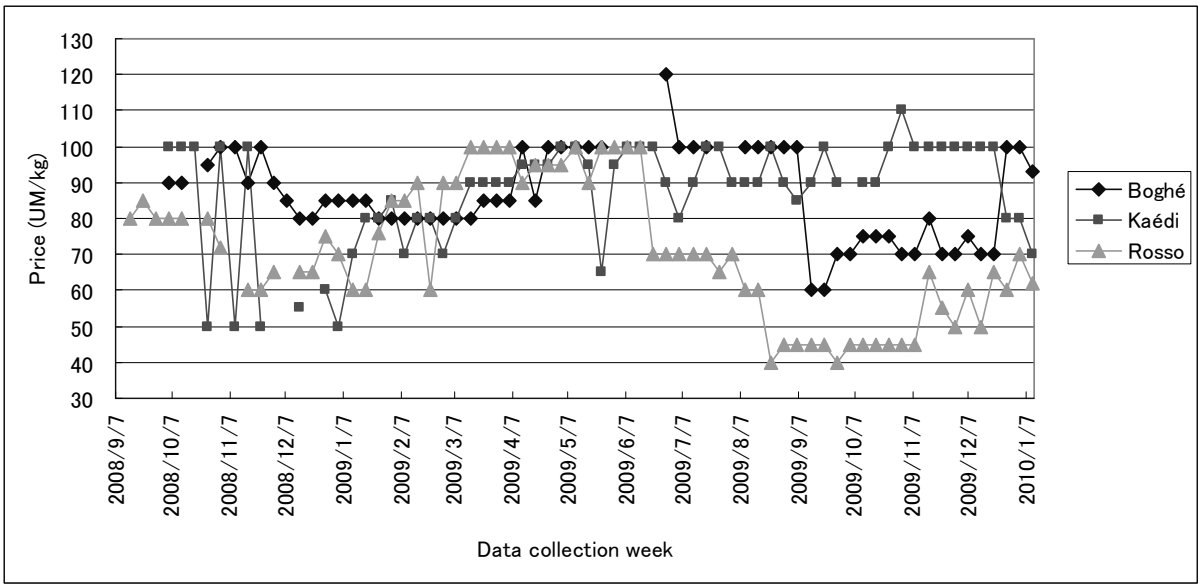


Figure 3.3.6 Retail Price of Paddy Rice in Boghé, Kaédi and Rosso

Source：Plotting based on data obtained from the VISA project (Valorisation de l'Irrigué pour la Souveraineté Alimentaire) by Spanish International Cooperation Agency

d) High Labor Input

Farmers in Foum Gleita, at the peak of the farming season, keep birds and livestock from their plot, from sunrise to sunset (sometimes in the mid night) with all members of the family in the fields. Yet they cannot completely protect against animals that eat a portion of their harvest and it caused reducing yields. Meanwhile they can only do menial work, and it infers that it lost employment opportunities for adults and opportunities for schooling for children. Livestock is important assets and

income source for farmers in Foum Gleita. However, it does not seem to be well managed at all. A farmer was found to be annoyed because other farmers' livestock in the same village destroyed his plot, while he also let his livestock free and did not know where they ate. At Foum Gleita, the rule to prevent livestock from entering the plots is as follows: the owner of the field is responsible in the day time; and the owner of livestock is responsible at night. However, it is not rational at all if watching his own field, he does not see that its own stock is in a neighbor's field, and occasionally it causes disputes with penalty. The owners have to be responsible for their own livestock and also SONADER and UCAF campaign to promote farmers to be organized for achieving protection against penetration into plots of livestock for pasture from the other villages.

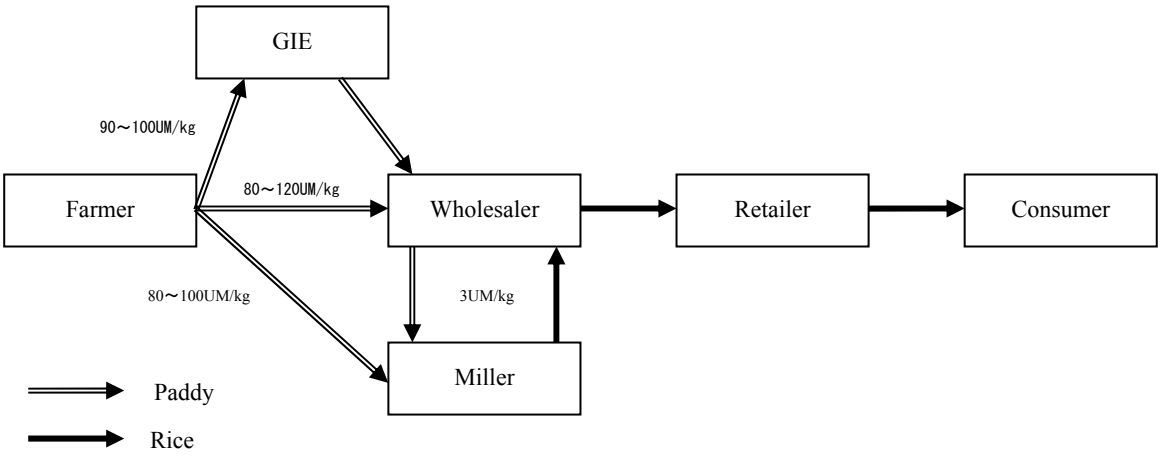
As above discussed, current rice production in Foum Gleita could extremely be low profitability. However, most farmers who currently produce rice have said that they would continue rice production and the great majority of those who do not routinely said that they would if the water came up to their plots after rehabilitation. Rice is an essential staple food in Foum Gleita, and at least the current residents are eager to cultivate it. However, for the sustainable development of rice production in this area, it shall be removed every obstacle of its current low profitability.

3.3.5 Marketing of Agricultural Produces

(1) Marketing of Rice

a) Marketing of Rice in the Gorgol Region

The marketing of rice is successively guaranteed by the State institution SONIMEX (Société Nationale d'Importation et d'Exportation) and a pool of importers link between imports and local purchase with the SONIMEX as the leading institution. The farmers are organizing GIE (Groupement d'Intérêt Économique, Economic Interest Group) receiving funds from the Credit Agricole, and this GIEs purchase the rice from farmers at a fixed price, and then sell them to SONIMEX. However, there are some problems in the flow of production, mainly because of a highly variable quality of production in Mauritania, and the strong competition from imported rice. The agricultural produces from Gorgol region are sent to various cities such as Kaedi, Selibabi, Rosso, Nouakchott etc. In Dec. 2008, and Jan.2009, JICA Study Team conducted the marketing survey of wholesalers and retailers in major cities including Kaedi, Nouakchott, Selibabi, and .Foum Gleita. The general flow of marketing of rice in Gorgol region is shown below.



Note: Un-milled rice is mentioned as paddy

Figure 3.3.7 Marketing of Rice in Gorgol Region

The farmers have different options to sell his produce. He can sell it to GIE at a standard price, or he can sell it to wholesaler or miller based on the price. Sometimes, the farmers borrow the money from businessman to buy his inputs, and in most cases, he is obliged to sell the produce to the businessmen at the price fixed by the businessman which is called as 'Thalasse' system.

In January 2009, the rice miller purchased the paddy (un-milled rice) for 85UM/kg and sold milled rice to the wholesalers for 6,500UM/bag of 50kg (130UM/kg). The fee for milling of rice was 3UM/kg for traders and 4UM/kg for individuals. He stated that the milling waste was from 25% to 30% but it could increase up to 45% if the rice is not of good quality. He sold rice husks for 20UM/kg to 30UM/kg, which can be given to donkeys or cows (but not suitable for sheep or goats.)

In all the big markets of cities such as Nouakchott, Kaedi, Selibabi etc., both the imported rice, and local rice are available. Although the imported rice arrives from different countries including Thailand, Senegal, Pakistan, Brazil etc., Thailand rice is widely available in the markets. In the retail market, the local rice is sold at a price of 150-160 UM (Jan 2009), where as the imported rice is sold at a price of 170-220 UM/kg (Jan 2009), based on the quality of rice. The price also varies from time to time based on the demand and availability, and the price of rice based on a marketing survey conducted by CNRADA is shown below.

Local and Imported rice in Kaedi

Rice Milling in Kaedi

Table 3.3.18 Price of Different Types of Rice at the market in Kaédi

	December 15, 2008		January 12, 2009		January 19, 2009	
	UM/kg	Origin	UM/kg	Origin	UM/kg	Origin
National Rice	200	Kaédi	160	No data	140	Kaédi
Imported	200	Senegal	240	No data	160	Senegal

Source: CNRADA for the project of VISA (Valorisation de l'Irrigué pour la Souveraineté Alimentaire)

In case of imported rice, the wholesalers in the towns such as Kaedi or Selibabi usually buy the produces from Nouakchott. The transport cost varies from 12 to 20 UM/kg. This cost is naturally added to the selling price of rice in the towns. Some wholesalers in Selibabi and Kaedi informed that they purchased more imported rice from Senegal or other countries than the local rice. Although there is a good demand for the local rice, the Mauritanian farmers always have to compete with international market especially in terms of price is shown below.

b) Comparison of Marketing of Rice between Foum Gleita, Lexeiba, and Kaedi,

Foum Gleita

Originally, farmers in Foum Gleita were purchasing input by loans through cooperatives and providing rice to the cooperatives as payment of the loans. And they were selling rest of rice for captive consumption and buying the family needs (payment of foodstuffs, education, and health care etc). After the deterioration of the project area, the marketing system is almost inexistent and the farmer is managing at his own will. For this reason, farmers in Foum Gleita could not use loan since 2002.

Cooperative Rice Storage in Bachatt P2

According to the current condition of the marketing system, after harvesting, the farmers bring their production to their own storage (generally it is a small room in his house). ACOPAM financed by UNDP has constructed rice storage for the cooperatives mainly in P2 area, now it doesn't use since the cooperatives were not functioned. The selling is not organized, and is based on the farmers needs. Almost more than 70% of the production is for self-consumption and the remaining 30% are sold progressively in accordance to the family needs. Foum Gleita marketing method is shown the figure below.

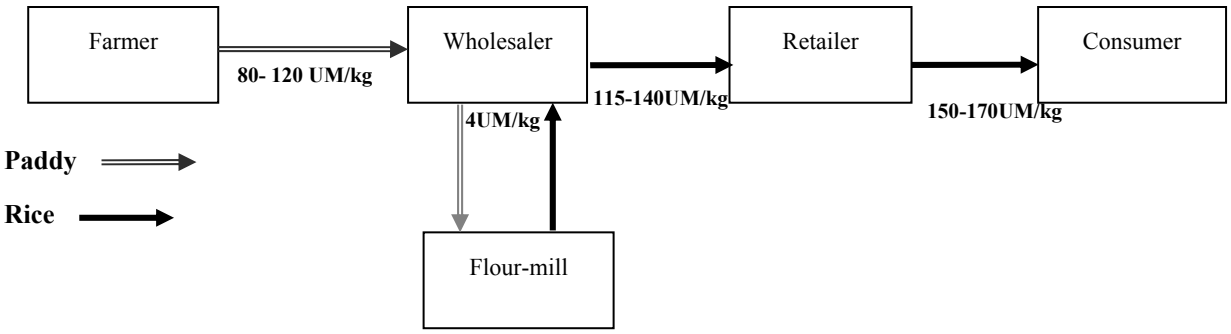


Figure. 3.3.8 Marketing Method of Rice in Foum Gleita (2010)

Each farmer brings his paddy to the market and bargain separately with the merchant. Foum Gleita farmers are selling their paddy in "Moud". Moud is a unit of measurement used by farmers; the weight is between 2.9kg to 3kg. The price of one Moud is from 300UM to 350UM (March 15th, 2010). Hence, the price of paddy sold by the farmer is 100UM to 116UM/kg.

Moud container

Lexeiba

In the Gorgol region, Lexeiba farmers are known as the more organized and business-oriented farmers, contrary to Foum Gleita and Kaédi farmers. More than 75% of the rice production is sold so only 25% used for self-consumption and loan payment. The marketing method is as follows:

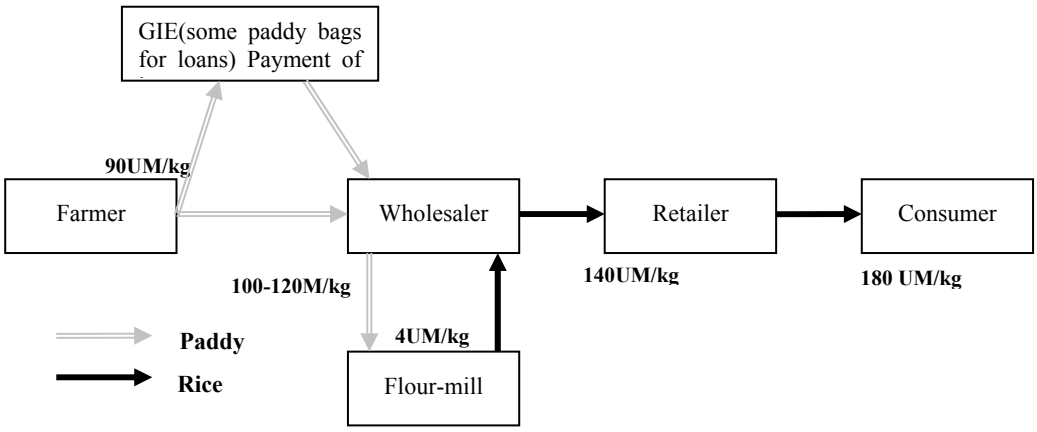


Figure.3.3.9 Rice Marketing Method in Lexeiba

Lexeiba farmers utilize storage facility constructed by PDIAIM and decided to wait for selling their rice until they have a better price. Therefore, it is secure against selling rice at a very low price proposed by the wholesalers. Compare to selling price of rice in Lexeiba, it is 100-120UM/kg, higher and stable than Foum Gleita, 80-120UM/kg.

Storage Facility in Lexeiba

Kaedi (PPG I and PPG II)

In Kaédi, rice is mainly produced in PPGI and PPGII. Because of the high demand in Kaédi, rice produced in PPGI and PPGII are far from being sufficient for the local needs. Rice marketing in Kaédi is almost the same as Lexeiba. After harvesting, some bags of paddy are dropped in the SONADER rice storage facility for the payment of loans. After that, each farmer is free to sell or to keep the remaining rice production. For the last rice campaign in 2008, the paddy price was from 90UM/kg to 100UM/kg. After milling, the rice is sold to the retailers from 120UM to 130UM and sold to the customers at 150UM/kg. The usage of the rice production varies according to the ethnic group. Soninké people are not selling their production which is mainly for food security (90% of the production is stored for self consumption). On the contrary, Pular and Moorish community farmers sell their production (80%). Hence, considering the whole production in PPGI and II, about 60% is sold and 40% is consumed by the farmers. The wholesalers informed that Kaédi is the meeting point of Gorgol and rice is coming from everywhere. Many often, they bring rice from Rosso and sometimes from Senegal.

Rice Storage in PPG I

As mentioned above, Lexeiba and Kaédi established cooperatives and access to loan in order to purchase inputs, but marketing was carried out by individual farmers. Even if they do marketing systematically, the storage of cooperatives are small scale. Therefore, the storage does not have enough capacity to store all of rice produced by farmers.

In Foum Gleita, ACOPAM financed by UNDP has constructed rice storage for the cooperatives mainly in P2 area, but currently it is not used because the cooperatives are not working.In Lexeiba, there is a storage constructed by PDIAM, but it is used for storing rice which was paid as repayment of loan not used for organizational marketing.

(2) Marketing of Vegetables

a) Marketing of Vegetables in the Gorgol Region

Similar to rice, the vegetables from Gogol region are sold to cities such as Kaedi, Selibabi, Rosso, Nouakchott etc. As shown in Figure.3.3.9, the vegetables of Foum Gleita are mostly sent to Kaedi, M'bout, Selibabi, and Nouakchott (in some cases). In Foum Gleita, there is also a GIE to buy the sweet potato at a fixed price. The vegetables from Foum Gleita are mostly cultivated by women cooperatives, and these cooperatives send their produces to cities by arranging the trucks.

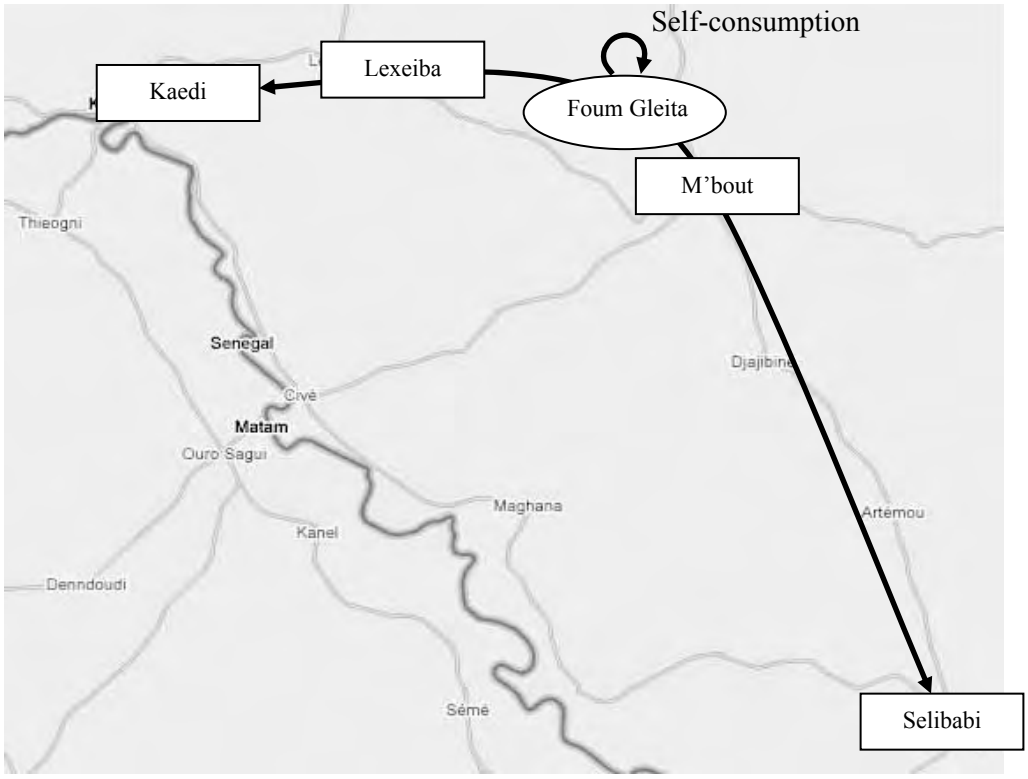


Figure. 3.3.10 Markets of Foum Gleita Vegetables

In the markets of Nouakchott, Kaedi, Selibabi and Foum Gleita, it was understood that most of the vegetables (>90%) are imported from Senegal, Holland, Spain, Morocco, Mali etc. Since the harvest of vegetables in Gorgol region is mostly during the months of February to April, the local vegetables are available only during these three months. Otherwise, mostly imported vegetables are sold in the markets. In Nouakchott, it was understood that onion and potato are imported from Holland at a price of 2,800 UM/ 25 kg (UM 112/kg) of onion, and 2700 UM/25 kg (UM108 /kg) of potato as whole sale price which is added 30-40 UM as wholesalers benefit. The retailers are selling at a price of 140-150 UM/kg. The minimum price of onion is 2250 UM/25kg (UM90/kg) and maximum is 3,750 UM (UM150/kg). It may go up to 5,000 UM/25kg (UM200/kg) especially during festival seasons (Ramadan).

In Sélibabi, a wholesaler informed that the vegetables are imported from Morroco and Spain via Nouakchott and from Senegal and Mali. The purchasing price of carrot and tomato in Nouakchott ranged from 120UM/kg to 150UM/kg. After including the transport, and profit, they are selling at a price of 240 UM/kg.

Retail Vegetables Market in Kaedi

Onion Imported from Holland in Nouakchoot Market

In Kaedi, vegetables from Foum Gleita are sold. Group of women vegetable wholesalers go to "Sunday market" in Senegal, which is located at 25km away from Kaédi and buy vegetables such as cabbages, pumpkins, carrots, and sweet potatoes and sell them in Kaedi.

Farmers of the cooperatives in Kaédi called Moderne Quatre (zone in Kaédi) sold their cabbages in Kaedi market. The selling price fluctuated as follows:

UM300/kg in early January
UM200/kg mid January
UM150/kg later in February-March
UM300/kg in April- June

Lexeiba Vegetable Market

Foum Gleita Market

Prices of vegetables in Kaedi based on a marketing survey conducted by CNRADA are shown below.

Table 3.3.19 Price of Vegetables at the Market in Kaédi

Crop	December 15, 2008		January 12, 2009		January 19, 2009	
	UM/kg	Origin	UM/kg	Origin	UM/kg	Origin
Tomato	250	Morroco	300	No data	250	Morroco
Eggplant	250	Senegal	200	No data	200	Kaédi
Carrot	300	Spain	300	No data	200	Morroco
Potato	150	Holland	150	No data	150	Holland
Onion	150	Senegal	160	No data	150	Holland
Cabbage	250	Kaédi	250	No data	150	Senegal
Lettuce	50/pile	Kaédi	50/pile	No data	50/pile	Kaédi
Turnip	200	Senegal	150	No data	200	Kaédi
Beet	200	Foum Gleita	400	No data	400	Kaédi
Mint	No data	No data	50/pile	No data	20/pile	Kaédi
Sorrel	1,200	Mali	No data	No data	1,200	Mali
Okra	200	Gangui	400	No data	No data	No data
Sweet potato	200	Foum Gleita	200	No data	200	Kaédi

Source : CNRADA for the project of VISA (Valorisation de l'Irrigué pour la Souveraineté Alimentaire)

The prices of vegetables in Foum Gleita market varies between Harvest season (Feb-March) and during other months as shown below.

Table 3.3.20 Price of Major Vegetables in Foum Gleita (per kg)

Vegetables	Harvest Season		Non-harvest Season	
	Farmer to Retailer	Retailer to Consumer	Farmer to Retailer	Retailer to Consumer
Cabbage	80-100	120-150	120-150	200-250 (400)
Carrot	140-150	200	200	250
Tomato	80	100	120-150	200-250
Sweet Potato	80-100	120-150	200-250	-
Onion	60-80	80-100	120-150 (Sometimes from Nouakchott)	200-250

Source : JICA Study Team (December 2008)

Collection, Packing and Storage of Vegetables: Before marketing of vegetable produces, collection and packing of vegetables are normally done by the cooperatives (mostly women cooperatives), and packing of onion, and potato are done in net bags which costs 100 UM/bag (See the picture above).

b) Comparison of Marketing of Vegetables between Foum Gleita, Lexeiba, and Kaedi,

Foum Gleita

In Foum Gleita, vegetables are grown mostly during dry winter season, and the most commonly cultivated vegetables are onion, sweet potato, tomato, carrot, eggplant, cabbage, and okra. Among the vegetables production about 70% are sold, and the remaining 30% include vegetables used for self consumption and spoiled vegetables.

The vegetables are sold in Sélibabi (60%), Kaédi (15%), Foum Gleita (5%), M'bout (10%), and other areas (10%). Presently Sélibabi is the main market where the vegetables are sold.

The transportation fees from Foum Gleita are as follows:

- Foum Gleita--------- M'bout: 400 to 500UM/1bag
- Foum Gleita----------Kaédi: 500UM/1bag
- Foum Gleita---------Sélibabi: 500UM/1bag(25 to 50kg) and 1000UM/1bag(more than 50kg)

The Foum Gleita farmers are sending their main vegetables in Sélibabi for the following reasons:

- Connection between the farmers and the traders is also one of the basic criteria for deciding the market to sell the vegetables. Farmers are selling their production where they have relatives or some family connection. In Selibabi, the farmers of Foum Gleita have close connections for many years and after bringing the vegetables, they stay for a few days until their vegetables are sold to the traders.
- The vegetables production around Selibabi is very limited, and therefore the prices in Sélibabi market are better comparing to the other markets. A comparison of prices of vegetables between the different markets during harvest period (March-April 2010) is shown below.

Table 3.3.21 Price Comparison of the Main Vegetables (March -April 2010)

	Foum Gleita	M'bout	Lexeiba	Kaédi	Sélibabi
Tomato	100	120	100	150	200
Onion	80	100	100	150	200
Cabbage	120	120	150	200	250
Eggplant	100	100	120	150	150

In Selibabi there is a storage space where the Foum Gleita farmers keep their produces for UM20/bag. It facilitates the farmer to keep their produces for some period until it is sold. In other markets such as Kaedi, the cost is higher about 50-100 UM/bag than Sélibabi.

Storage Space in Selibabi Market

Lexeiba

Lexeiba is also known for its higher potential of vegetables growing. The farmers are growing vegetables such as eggplant, and sweet potato even during summer season. Through the discussion with the farmers, it was understood that the vegetables production is mainly sold in Nouakchott, Kaédi and Sélibabi. More than 60% of the production is sold to Nouakchott, 20% to Kaédi and 10% to Sélibabi, and the rest 10% is sold and consumed in Lexeiba. The farmers informed that it is easier for them to

sell in Nouakchott since they have their representatives in charge of selling their production. The transportation fees are as follows:

- Lexeiba----------Nouakchott: 6UM/kg
- Lexeiba----------Kaédi: 200UM/bag/50kg
- Lexeiba---------Sélibabi: 1000UM/bag

Recently in April 2010, 6 cooperatives in Lexeiba have created a GIE for selling vegetables with the support of PDIAIM. They will mainly organize themselves for storage and marketing of vegetables.

Kaédi

In contrary to Foum Gleita and Lexeiba, Kaédi is not a major producer of vegetables. The vegetables produced in Kaédi are quickly absorbed by the local demand and even from the neighboring villages. In PPG I and PPG II, no farmer is presently growing vegetables within the project area. Kaédi vegetables market depends entirely on the production of Lexeiba, Nouakchott, Foum Gleita, Djewole and the neighboring villages in Senegal.

(3) Constraints of Marketing in Gorgol Region

a) Road Network

It is obvious that marketing of food grains and vegetables needs good road network and transporting facilities such as trucks. Although Kaedi and Nouakchott is connected with paved trunk road, the road condition between Kaedi and M'bout, and M'bout and Selibabi are under construction. Currently, the condition of the road between M'bout and Sélibabi becomes so bad during the rainy seasons that the transport by cars is interrupted for weeks.

Bridge Construction on Road Between Kaedi and M'bout

b) Transport Facilities

Apart from road network, the transport facilities are also very weak in Foum Gleita. Except for one or two public bus transport facilities, most of the local transports are by horses or donkeys. For long distance travels (such as travel from Foum Gleita to Kaedi), sometimes they hire a taxi collectively by 5 or more persons together. It costs about 2,000-3,000 UM for a person to travel from Foum Gleita to Kaedi with a distance of about 100km.

Donkey Taxi in Foum Gleita

Horse Taxi in Foum Gleita

c) Collection and Storage of Vegetables before Marketing

Apart from the road network, the storage of vegetables is a major constraint in the region. Usually, the farmers are compelled to sell the vegetables since they do not have any facilities to store the vegetables even for a short time. Construction of small collection centers would be beneficial to store the vegetables before transport.

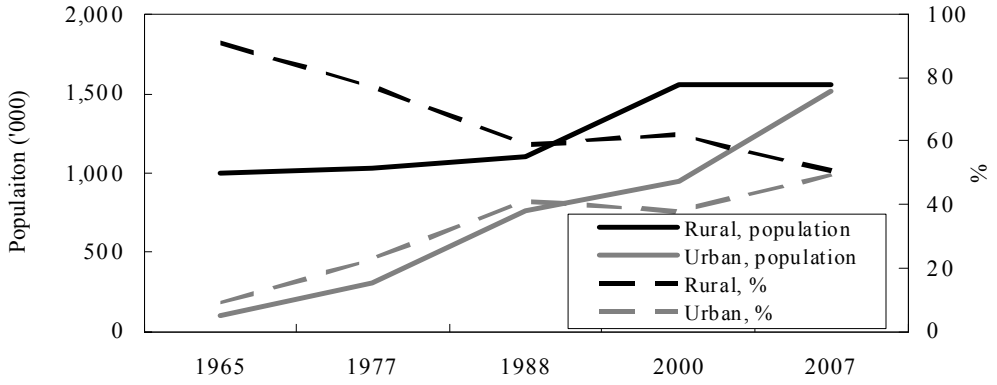
d) Problems Related to Functioning of GIE

Presently GIE exists in Kaédi and Lexeiba for rice, and Foum Gleita for sweet potato. The GIEs were created to defend the interests of the farmers, and GIE members are farmers selected by the General Assembly of Union. Financially supported by UNCACEM, its purpose was to buy the farmers' produces such as rice and vegetables at a reasonable price. Presently GIE is buying the rice only equivalent to the amount of loan which the farmers have to pay to UNCACEM which they borrowed for buying the inputs. The farmers are selling the remaining produces to wholesalers whose prices are slightly better than GIE prices. Presently, GIEs do not have any fund on their own, and they do not have enough facilities for storage or transport. If the GIEs can be strengthened with storage and transport facilities the farmers can sold their produces at better prices based on market demand.

3.4 Rural Society

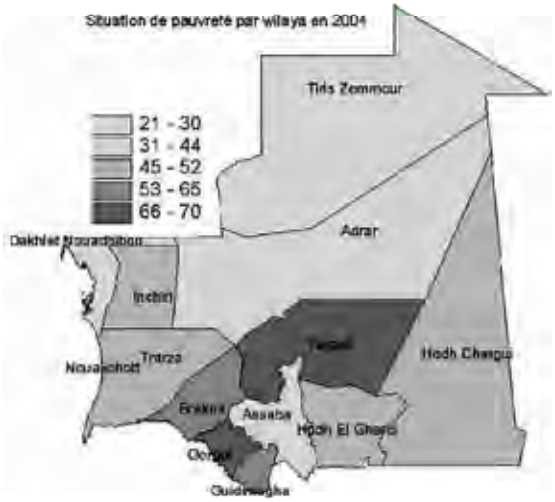
3.4.1 Existing Conditions of Rural Society

Mauritania has a population of 3.1 million and because of the large Sahara, the population density is only 3 person per sq.km with a stable annual population growth rate of 2.4 %. The population of rural and city area is shown as below. According to the population change from 2002 to 2007, the concentration of the population in the city area became obvious by migration from rural area to city area, and presently it is estimated that the ratio of rural area to city area is equal to 51:49 with almost equal population in both the areas. In fact, recently Nouakchott has a population of a million, which means that one third of its national population is concentrated in Nouakchott.



Source : JICA Study Team based on data from Office National de la Statistique, 2007

Figure 3.4.1 Population Change in City and Rural Area



Source: PRSP ACTION PLAN 2006–2010, 2006

Figure 3.4.2 Poverty in Mauritania

Meanwhile, the percentage of people under poverty line of US$ 1.0 per day is 47% of the country, of which three fourth are living in the rural area. As shown in the Figure, Gorgol region is one of the poorest regions in the county, and hence there is a high significance in this Study.

Gorgol region has a population of around 300,000, 10% of the country, of which 75% are living in the rural areas. Kaedi department and M'bout department has a population of about 100,000 people respectively (See the Table shown below).

Table 3.4.1 Population of province

Province	Population
Kaédi	104,978
M'Bout	94,074
Maghama	55,007
Monguel	39,360
Gorgol	293,419

Source: Kaédi Regional Hospital, 2007

About 63% of population in Gorgol are engaged in agriculture and 10 % are engaged in livestock, with a total of 73% which is more than twice of the national average of 35%, and agriculture is considered to be primary industry of the region. Although the people are engaged in agriculture, most of them rely on unstable rainfed agriculture or flood recession agriculture. Therefore, irrigated agriculture is very important so as to

Table 3.4.2 Employment Rate by Industry

Industry	Gorgol	Nation
Agriculture	63	28
Livestock	10	7
Commerce	9	25
Service	6	21
Other	12	19
Total	100	100

Source : JICA Study Team from http://www.le-gorgol.org/geo.php&Office National de la Satistique, 2007

have stable agricultural production.

Moreover, in regard to education, the students entering elementary school are about 30% much lower

than half of the national average. The literacy rate is 29%, which is not even one third of the Gorgol population. The present situations of both the indicators are at the worst level, and left far behind at the country level. During the workshop in Foum Gleita, it was found that even the representatives of union could not write their own name.

Table 3.4.3 Education Index

Item	Gorgol	Nation
Gross enrollment ratio in primary school	49	77
Literacy rate	29	59

Source : JICA Study Team from POVERTY REDUCTION STRATEGY PAPER ACTION PLAN 2006–2010 & Rapport National sur le Développement Humain Durable et la Pauvreté 2005

The results of the existing conditions of the Study Area based on the hearing survey of the Study Team are shown as below.

Table 3.4.4 Outline of the Result from Study Item

	Contents
Population	There are enough human resources with a high productive population of 50~77%. There are very few migration of population from the areas such as PPG (farmers living in Kaedi) and Lexeiba, but there are migration from Foum Gleita to M'bout, and other areas. In the areas close to P1 canal, it was reported that there were migrations to Nouakchott and Nouadhibou.
Tribes	The majority of the community belongs to Poular or Moor except for a few Soninke community in Kaedi. In Foum Gleita, both Poular and Moor communities are living in most of the villages. Some of them speak several languages including French, and others understand only either Hassania (language of Moor) or Poular.
Access	PPG and Lexeiba have roads to Kaedi which are under construction. It takes about 30 minutes from Foum Gleita to the main road in the dry season, and more than 1 hour in the rainy season. And from the main road, it takes more than 1 and half hours to Kaedi.
Drinking water	PPG and Lexeiba have tap water and wells. In Foum Gleita, only 3 villages have wells. The people of the other villages sometimes buy water or most of them are drinking canal water.
Medical Facilities	PPG is located near to the healthcare center. Lexeiba and Foum Gleita have only small medical clinics.
School	PPG is located nearer to educational facilities including elementary, junior high and high school. In Lexeiba, there is an elementary and junior high school. In Foum Gleita, most of the villages have elementary school, but there is no junior high and high school.
Market	PPG is located nearer to the Market in Kaedi. Lexeiba also has stores and some storage facilities. Foum Gleita has a small-scale market with small-scale stores.

3.4.2 Agricultural Cooperatives

The cooperatives, union and GIE are the important farmers' organization in the Study Area. The cooperatives are the organizations approved by the government based on the cooperative act revised in 1993. The cooperatives can be established by the application of 7 farmers who provide the

capital offer capital for organizing cooperatives with the purpose of agricultural production. At the same time, in rural areas, where people mainly rely on agriculture, there is a community organized by the same tribe. In most of the cases, the living places are also near to each other, and even when they live in live faraway places, they maintain a strong connection to each other. In case of Foum Gleita, men cooperatives mostly produce rice, and women cooperatives mostly cultivate vegetables, but some cooperatives include both men and women with the same name. In many cases, the family members or the relatives are working together in the cooperative.

The union is formed by combining all the cooperatives of the project. The representatives of cooperative are the members of the union, and 7～10 people are selected as president, vice president, secretary and accountant, and no salary is given to these executive members. Some union hires full-time and part-time employees for some particular job. The major functions of the union normally include organizing and application of loan, repayment, regional coordination and service for contacting outside agencies. As the national organization of union, Federation of Agriculture and Livestock of Mauritania (FAEM) was formed, and UNCACEM acts as the local agency for loan approval operation to the farmers group.

Moreover, there is a farmers' organization called as GIE. Originally, the function of GIE is to stabilize selling prices by buying agricultural products by themselves using loan from the government and sell them to public agency, which is also to ensure food security for the government, but practically, GIE only plays role of keeping products as for loan of UNCACEM from farmers. However, because procurement price of GIE guarantees bottom price, that of private traders is also improved before introducing GIE. These characteristics of farmers' organization are summarized as below.

Table 3.4.5 Characteristics of Each Farmers' Cooperatives

Item	Union	Cooperative	GIE
Objective	Alliance of local cooperatives. External activity to protect members' benefit	Cooperating organization to increase agricultural productivity and to improve farmers economic and social status	Organization for buying agricultural products by farmers, which were produced by farmers, and sell them to outside
Scale	Composed of a few dozen of representatives from member cooperatives (3 for each), represent several hundred - thousand people	Composed of a few-200 people, all relatives or locally related	Generally, GIE is placed in Union. Composed of some of union members.
Officers	7 - a few dozen of people including president, vice president, secretary, accountant	3-7 people including president, vice president, secretary	3-7people including president, vice president, secretary

Generally, the fee system for the famers in the irrigated area consists of two types of fees: fixed fee and variable fee which are both the targets of agricultural finance. However, it is essential to understand the farmers' organization, and the characteristics of accounting system are mentioned below.

Table 3.4.6 Accounting System of the Irrigated Area

Type	Value	Characteristics
Fixed Fee	16,500 UM/ha/Year	It is used for the maintenance of irrigation system, and the amount is uniform. When SONADER handled the maintenance, the money was paid to SONADER. Since SONADER has become weak, the payment has been replaced by labor service or it is paid to the union.
Variable Fee	Fluctuate	Used for payment of agricultural inputs such as seeds, fertilizers, pump fuel to UNCACEM.

The situation of farmers' organization in the project area is listed below. In the entire area, cooperatives and unions held a general meeting to plan work program and cropping plan for the season.

Table 3.4.7 Outline of the Farmers Organization in the Project Area

Area	Union	Coopera-tives	Situation
PPG I	1	22	The farmers were engaged in agriculture even before the project establishment in 1975. Since it is close to Kaedi, access to agricultural equipment is good. SONADER has staff of the pumps, and hence the management is relatively stable. There are 700 members; two pump operators, a guard and full time staff in charge of collecting fund, and a part time maintenance staff. It has a storage facility for rice. The fixed fee is 10,000 UM/ha/year (paid to the union) and provision of labor. The variable fee with fertilizers is 86,800 UM ha season, and without fertilizer, it was 45,500 UM/ha/season. The problems of irrigated area are 1) need rehabilitation work 2) interested in double-cropping of rice, but there is lack of money and equipment, and 3) superannuation of agricultural machinery
PPG II	1	30	It is an extended area of PPG I, and some farmers have rights to cultivate both of the areas. The situation of resources and management is the same as PPG I. It employs a director, an accountant, a bookkeeper, a guard and an engineer. The fixed fee is 16,700 UM/ha/year paid to the union. Until 2007, the variable fee was 24,000 UM/ha/season, but in 2009, it rose up to 117,000 UM/ha/season. The problems and goals of irrigated area are; 1) the farmers are interested in dual cropping of rice, but there is lack of money and equipment 2) variable fee is a burden 3) completion of adjacent recession irrigated area 4) additional maintenance for 200ha inside of the area, 5) construction of storage facilities, 6) drinking water maintenance, and 7) health center maintenance
Lexeiba	1	41	Easy to unify because of small-sized cooperative unit management. The leader of union has a strong leadership capability, cultivating two crops in a year, and diversification of crops is also introduced. Currently, 5 cooperatives are in a dormant state due to malfunctioning. Each cooperative is financially independent. The union acts as the contacting body to the outside and receiving donations for the project area. The cooperatives pay a

Area	Union	Coopera-tives	Situation
			fee of 500 UM/ha/year to the union. The fees vary depending on the cooperatives, but the emergency funds are also collected. The problems and goals of irrigated area are; 1) needs rehabilitation 2) leveling of farm fields 3) damages by livestock and birds 4) inputs and rising fuel cost, 5) transportation, 6) storage, 7) taking loan from UNCACEM takes time 8) changing of river course.
Foum Gleita	Male1 Female 2	M45 F49	The total members of three unions are male 1,300 and female 2,700, but still some points are not clear enough including fallow area. One the Union of Agricultural Cooperatives of Foum Gleita (UCAF, male union) paid a fixed fee of 16,500 UM/ha/year to SONADER, and the UNCACEM loan was available. However, in 2000, the government exempted the farmers' fee because of failure of crops in the area. Since then, the fixed fee was not paid back and the debt to UNCACEM became 41 million UM, and therefore the UNCACEM could no longer provide loans to the union from 2001 to 2007. Previously the union was paying the salary of a director, an accountant and a storage manager but now the entire organization is not working. The efforts are being made for the reorganization of the union. Please see 4.1 Verification trial for detail of the assistance. According to the information collected by the extension staff during this study, there are 49 ladies cooperatives with 2,700 members, cultivating vegetables in 86 ha area. If it is cultivated by 1 person, it would be 0.03 ha per person. They cultivate collectively, and are doing marketing intensively. Many of them are actively involved in vegetable cultivation, and therefore the potential of vegetable production is high in consideration of its demand. Problems and goals of irrigated area are; 1) need rehabilitation (blockage of water flow by typha, declining of functions, poor drainage, 2) products preservation and poor marketing, 3) damages by livestock, birds and pests, 3) defective water supply facility (waterborne diseases), 4) lack and high input prices 5) lack of agricultural machinery and high rental rate 6) low collection rate of water charge 7) low soil fertility and lack of technology 8) lack of organization capacity.

3.4.3 Roles of Women and Ladies Cooperatives

(1) Roles of Women

In Mauritania, because of tradition, the enrollment of women in schools is low, and hence the literacy rate is low, and often their participation in social activities is limited. They must manage the household, children, fields and livestock and taking water which takes a lot of time. The status of women is different depending on Arab or African descent, the former being confined inside the house and the man working outside, and the later actively participate in outdoor activities and apparently very strong.

(2) Ladies Cooperatives

Based on agricultural production, the ladies cooperatives are expanding various activities of livelihood improvement. In Foum Gleita, 49 ladies cooperatives with 2,700 members formed two unions and cultivate 86 ha of vegetables. The average area per cooperative is 1.7 ha, which is small scale, but there are at least 55 farmers who work there. Although it is not more than 0.03 ha of land per person, they practice intensive cultivation and marketing. Most of the cooperatives are very active and some groups are engaged in vegetable cultivation for over 20 years. In this study, interviews were conducted to 29 ladies cooperatives about the situation of the activity (See ANNEX 11 for details). According to the interview in Foum Gleita irrigation area, it was understood that the training of SONADER and NGO's assistance led them to cultivate vegetables to improve income for the last 12 years. In rainy season, they focus entirely on cultivating self sufficient rainfed crops, and some farmers produced sweet potato, okra and pumpkin. In cold dry season, when it is better to cultivate vegetables, they actively produce onion, cabbage and carrot which have fine preservative quality. They are engaged in the activities as a cooperative unit such as meeting before cropping, procurement of inputs by representatives, farm management as collaborative work, joint marketing, collecting union fee from members, and reserve products marketing.

However, they have very few opportunities of new knowledge and techniques, and therefore, their farming skills has never been updated. Most of the cooperatives are farming outside the project area due to the shortage of water and the cultivation rights. Moreover, while farming outside the project area, they are not aware of the obligation of water charge payment, and the cooperatives do not recognize the merit of union, although union existed. There are problems that it is difficult to gain the cooperation from their husbands for the vegetable cultivation, and the transportation cost increases selling cost, etc. It is the fact that the ladies farmers are working in a hard environment having lots of problems.

3.4.4 Rural Society in Foum Gleita

Farmers in Foum Gleita area were classified into six categories based on the conditions of the village where they used to live (village of origin) before the establishment of Foum Gleita irrigation area and the village where they are living. The characteristics of each category are shown below.

Table 3.4.8 Classification of the Respondents

	Classification
(a)	Persons whose home village were submerged by the dam
(b)	Persons whose home village is located near the dam but whose lands were submerged
(c)	Persons whose home village become a settlement village
(d)	Persons who were settled from around Foum Gleita irrigation area but whose home village still exists.
(e)	Persons from far away areas (around M'bout) but whose home village still exist.
(f)	Persons who refused to be displaced

(a) People whose home village was submerged by the dam

These are people who came on Foum Gleita as the first migrants before the construction of the dam in 1984. The people living in Bachatt and Adala are classified in this group. These people use to practice recession agriculture after the rainy season and had no experience in rice, but as the field and the village were submerged, they were allocated land in the irrigated area as an alternative area. They practiced rice cultivation for their livelihood. Even though the functions of the irrigation facilities declined and the rice was no longer cultivated, some remained in the settlement village to continue rice cultivation, having no place to return.

(b) Persons whose home village is located near the dam but whose lands were submerged

Basically, these farmers are the first migrants on Foum Gleita, as the same as people mentioned above in (a). The people living in Bachatt and Adala are classified in this group. When the functions of irrigation decreased, rice has not been produced efficiently, but most of them remained in the village. A few people came back to their original village around the dam, and practice recession agriculture.

(c) Persons whose home village become a settlement village

These are people who used to live there before the creation of Foum Gleita irrigation area. The village has become a settlement village for people from outside. This category includes those who live in Foum Gleita as home town, and owners who owned a vast land before the establishment of the irrigation area. The residents of Sabahallah, Zreighat and Leyseye are classified in this group. Since the village was existing even before the creation of irrigation project, the people have not left even after the deterioration of the project area.

(d) Persons who were settled from around Foum Gleita irrigation area but whose home village still exists

These are the people from nearby villages of Foum Gleita irrigation area and migrated when it was established. At that time they settled in new villages built near the canals where the water was available all the year. However, there was a large number of cases of malaria. Hence, after the functions of irrigation system decreased, they returned back to their original villages or moved to the village Base-Vie. A part of settlement villages no longer exist.

(e) Persons from far away areas (around M'bout) but whose home village still exist.

People from outside of Foum Gleita irrigated area (especially M'bout), which form part of the second immigrants in 1989 came to settle in this area at the time of the creation of settlement village. In their original village, they were practicing recession agriculture after the rainy season. Since they had no experience in rice and most of them migrated for benefits (food, distribution of inputs). In

addition, the location of the settlement village which was near to canal caused many cases of malaria. Therefore after declining of functions of the irrigation system, a number of people returned to their original village.

(f) Persons who refused to be displaced

These are the people who live around Foum Gleita irrigation area, and were asked to settle at the creation of the irrigation area, but did not want to move. They commuted to irrigation area. The people living in Titrame along the axis-Kaedi M'bout classified in this category. The village is located at about 5 km to irrigation area.

Although these respondents with various situations are living based on various kinds of expectations, major challenges are common among farmers. Each challenge is listed below.

(1) Maintenance and Management of Irrigation Facility

After the establishment of irrigation area, a contract was made between the farmers of Foum Gleita and SONADER for maintenance. The main canals were supposed to be managed by SONADER and the secondary canals were to be managed by the water charges paid by the farmers and SONADER. The tertiary canals and the field were managed by farmers. The majority of the farmers understood the contract, but they were not paying attention on whether the water charges were appropriately operated by SONADER and the Union. However, in 2000, the problem became critical when the irrigation facilities were damaged and needed to be repaired, but was found that there were no reserve money in the water charges fund. The farmers believed that irrigation water would be supplied and functions would not decline if they were paying water charges, and there was no function of checking the account.

In regards to the payment of water charges, depending on the classification of respondents mentioned above, the attitude for payment of the water charge was higher when they depend more on irrigation area. A large number of respondents and members of the cooperative informed that they paid the fee until declining of the functions of irrigation facilities. Moreover, since the functions of irrigation facilities declined, there was fall in income because of decrease in rice production efficiency, and the farmers struggled to pay back the cash or goods. Then the farmers were allowed to pay by giving their labor, and some farmers had paid the fee by giving their labor until 2003. However, even at its maximum, the payment rate of water charges never exceeded 50% and it was not possible to properly verify how much farmers paid the fee.

Regarding the flood damage, there are two types of flooding including the flooding by the end of the facilities because of the increasing of water of Gorgol river, or the flooding of the facilities, because of the canals damages. In the first case of flood, most respondents said that after the irrigation area was established, flood occurred from time to time or every year in some locations. In the second

case of flood, it had never been happened before the massive damage which occurred in 2000. Some farmers who cultivated the flooded field every year abandoned agriculture because of heavy work and declining yield after the flood. It was caused to make farmers's avility of the maintenance low. The massive damage which occurred in 2000 is also caused to difficulty to operate the facilities.

(2) Procurement of Agricultural Inputs

In the first year of migration, SONADER distributed free seeds and fertilizers to those who settled in 1984 for trials of rice production. After this experience, the inputs were provided by loan starting from the second year. Since the second migrants could not receive free supplies, some of them seemed to have the impression that SONADER did not treat them fairly. In addition, the obtaining of inputs by SONADER was the responsibility of the union after its establishment in 1993. According to many respondents, the price of inputs has increased significantly at this time. The change of procurement system of inputs also created some distrust of some of the farmers towards the union. Many respondents informed that the inputs are expensive today, but the fertilizers are essential for rice cultivation in irrigation areas. So, they have to use fertilizers irrespective of the high price, while it is difficult to repay the loan even if they obtain yield.

When the irrigation facility worked properly, there was no repayment problem because proper quantity of inputs at the right time could provide enough profit to cover the loan. It should be noted that most of farmers have their own way to get the fertilizers in Senegal or in the neighborhood.

(3) Obstructive Factor of Motivation to Production

As obstructive factor of motivation to production, it is addressed that farmers only got their cultivation right, but they didn't get ownership for their cultivated land. Respondents in category 【(a) Persons whose home village were submerged by the dam】,【(b) Persons whose home village is located near the dam but whose lands were submerged】and 【(c) Persons whose home village become a settlement village】used to receive a cultivation right of irrigated areas equally instead of their own cultivated land, but they have a strong desire to have ownership. Especially vast land owners who classified 【(c) Persons whose home village become a settlement village】show great displeasure toward the government.

As mentioned above, low motivation to production of farmers was caused by the flood damage and the loss or decline in yields, making it impossible to pay water charge and refund loans. The main obstacle was the profusion of malaria because the houses were close to the canals where the water flowed through the year.

A number of people who decided to settle in Foum Gleita irrigated area had been the promised of providing drinking water supply. There was a well in Bachatt and Adala where the first settlers were numerous, but in almost all the other areas, water was taken from canals and stored in a

tank in the village. The facilities which SONADER promised earlier were prepared, but it is no longer working today. Among those who came to settle in Foum Gleita, except those in category (e) [Persons from far away areas (about M'bout) but whose home village still exists], came from even more disadvantaged insecure drinking water facilities such as taking water in rivers in rainy season or digging a well in the dry river in dry season. Consequently, for the majority of migrants, lack of drinking water should not be a major obstacle for settlement.

(4) Distrust of SONADER and Union (UCAF)

During the hearing survey of the farmers, it was understood that there was organizational dysfunction among the upper level of agricultural cooperatives such as SONADER and union.

SONADER had gained the confidence of many farmers through the activities at the beginning. However, due to opacity in decision-making process, the farmers became to distrust SONADER. Also, when repair was needed, lack of financial management capacity was exposed and it made farmers increase the distrust at once.

Regarding the UCAF, the meaning and purpose of its establishment by SONADER was not clear to farmers, and therefore they distrust the union from the beginning. Additionally, the suspicion grew, since its most influential members were selected by SONADER and have not been changed for a long time.

Among the cooperatives which settled secondly, it seems that some cooperatives have been established only to receive the government support. For them, the cooperative is not an organization for practicing agriculture but to take over the benefits, and some of cooperatives disappeared after receiving the support.

In fact, Foum Gleita irrigated area has many internal problems, but half of them are due to a part of people, but these are problems that can be solved.

3.5 Agriculture Supporting System

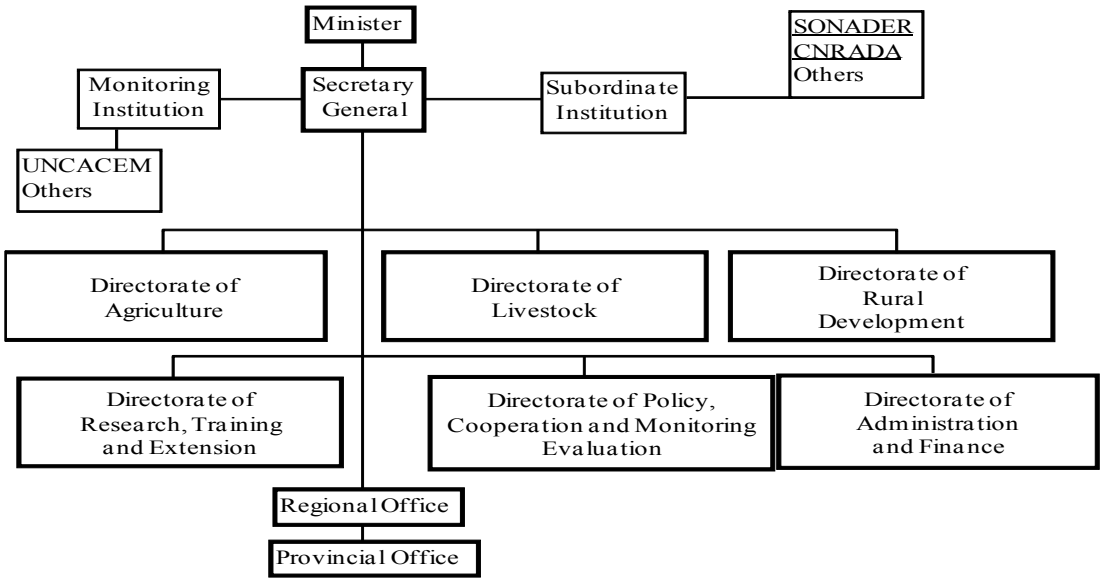
3.5.1 Farmers Supporting Organization

The authorities providing assistance to the farmers are MDR and SONADER. In January 2009, National Society of Agricultural Facilities and Works（SNAAT） was officially launched as a public corporation. Although its capabilities are not yet known, it is expected to work well since there is an increasing demand of mechanical power in different parts of the country.

(1) The Ministry of Rural Development

The Ministry of Agriculture and Livestock has become the Ministry of Rural Development which is results of reformation in August 2008, but the administration itself is not changed. It consists

of six divisions (Administration and Finance, Policy making, Cooperation and Monitoring, Agriculture, Livestock, Research, Training and Extension and Rural Development) and local offices in the region and department level. SONADER the CNRADA are functioning under MRD. The ministry's chart is shown below. Details are shown in APPENDIX 4, and the organization of local offices below the regional level is shown in section "**3.5.2 Agricultural extension**".



Source: JICA Study Team

Fig. 3.5.1 Organizational Chart of Ministry of Rural Development

(2) SONADER

SONADER was set up in 1975 to implement and manage the agricultural water development projects. Initially, it had mainly implemented irrigation water development projects and was involved in various fields such as agricultural credit, supply and mechanization, extension, training and organizing of farmers. After the implementation of the structure readjustment in 1988, its duties were limited to studies, implementation and maintenance of water development projects, land reclamation, extension for farmers and organizing cooperatives. The current budget SONADER is as follows (see Annex 9 for details). In 2007, 90% of budget was invested to project, but 70% of the budget was from donor. Contract Program with government which is signed every 3 years is financial base for SONADER.

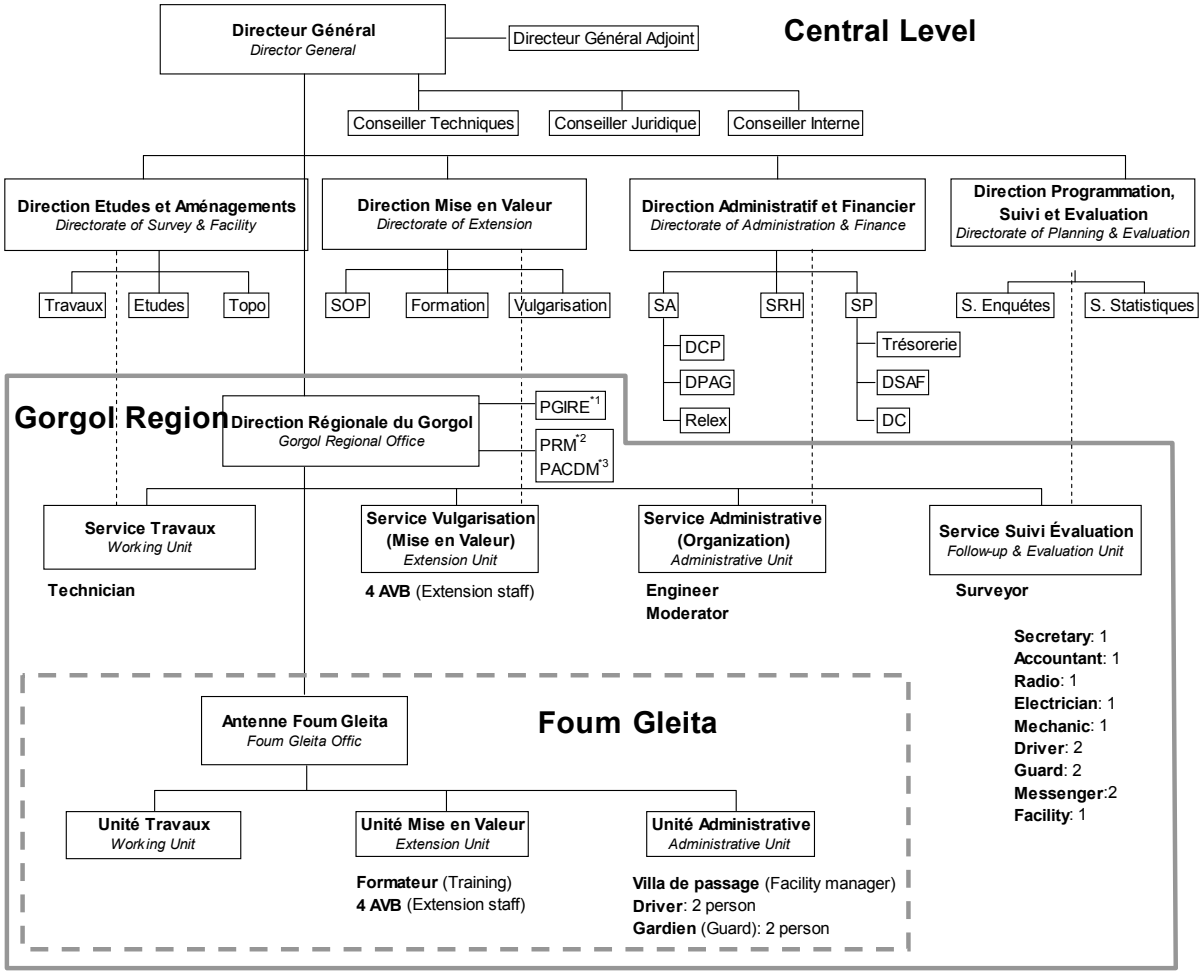
Table 3.5.1 Summary of SONADER Budget

Unit: Million UM

Source	2007			2008 (Plan)		
	Investment	Current	Total	Investment	Current	Total
Mauritania	1,064	532	1,596	880	657	1,536
Donor	5,130	200	5,330	8,699	143	8,842
Total	6,194	732	6,926	9,579	799	10,378

The organizational flowchart SONADER is shown below. At central level, there four departments (Research and Facilities, Extension, Planning and Monitoring, Administration and Finance). At the local level, there are five local offices (Brakna, Guidimakha, Gorgol, Tagant, Trarza) and two project offices (Foum Gleita, Rkiz).

Organigram of SONADER



*1 PGIRE: Projet de Gestion Integrée des Ressources en eau et de Développement des Usages Multiples du Bassin du Fleuve Sénégal
*2 PACDM: Projet d'Amélioration des Cultures de Décrue à Maghama Phase II
*3 PRM: Projet de Réhabilitation du Périmètre irrigué de Maghama III

Figure. 3.5.2 Organizational Chart of SONADER

The roles of SONADER are outlined as shown below.

1. Study on maintenance and rehabilitation of water infrastructure and irrigation area and supervision of construction of the project, and operation and maintenance of the project.
2. Supervision, operation and maintenance, and development of mutual infrastructure facilities.
3. Giving advice and assistance for the water management and development management of Senegal river water resources development.
4. Advice, extension, follow up and monitoring for rural development.

The main role of SONADER work is implementation of projects. Except for on-going projects, it has virtually no budget for maintenance costs, vehicles and fuel, and purchase of office supplies, even the distribution is irregular at the regional level. When the study on irrigated agricultural development program in Senegal river (completed in 1997) was conducted, the administration had 323 staff, but today there are only 197 staff. At the Foum Gleita office, no one has transportation except the director, which is a major obstacle for the extension activities, and operation & maintenance and monitoring of the dam.

(3) SNAAT

SNAAT is an agency dealing with agricultural machinery and heavy machinery, the mission of SNAAT is agricultural development and food security, and there are 4 major areas including 1. agriculture (General), 2. irrigated Agriculture, 3. land improvement projects, and 4. survey. Originally in 2006, CGEMAT（Cellule de Gestion et d'Exploitation du Matériel Agricole et de Terrassement - Management and exploitation Section of Farm equipment and Earth moving） was established in SONADER so as to receive and appropriately use many agricultural machinery and equipment as the grant under the 2KR program of the Japanese Government. However, when more machinery was acquired in 2009 using the Government's budget, a separate organization namely SNAAT was established in January 2009. in consideration of the fact that there were some previous cases of failures in the SONADER's management of agricultural machinery. SNAAT was established as a legal entity as per the Government decree No.2009-037 dated January 25, 2009.

Table 3.5.2 Machinery owned by SNAAT

Machinery	Num.
Grader	13
Crawler dozer	7
Backhoe（tire）	3
Backhoe (caterpiller)	12
Loader	10
Vibrating compactor	2
Combine	29
Tractor + various attachment	26

Although it is public corporation, it is also registered as a legal enterprise, and also participates in the tendering of public works, and was also awarded of the contract. Although the contract program with the Government exists similar to SONADER, the business activities are basically undertaken through the income earned from the public project. It also responds to the requests of the farming machinery from the groups such as the agricultural cooperative societies. The capital of SNAAT is 300 million UM (The value of machinery is not included). They are involved in various public works other than the rehabilitation works of irrigation projects. In 2009, the total sales was 1.4 Billion UM, and expenditure was 0.7 Billion UM.

All the machinery were provided by the government including the machinery supplied by the Japanese Government under 2 KR program (2006), and the machinery which were acquired by the Government's budget (2009). However, machinery worth of 8 billion UM which was provided the Government budget including two airplanes for spraying agricultural chemicals were not yet arrived. The present status of the available machinery is shown in the Table. Presently, the machinery are kept in the garage in the outskirts of Rosso. However, there is a plan to build a ware house of 40,000m^2 and

to maintain those machinery in the ware house.

Presently there are only two offices including the head office (office and Garage) at Rosso and the mobile team in Boghe. Since it is an organization established newly, the set up is not yet complete; the organization chart of the present setup of SNAAT is shown below.

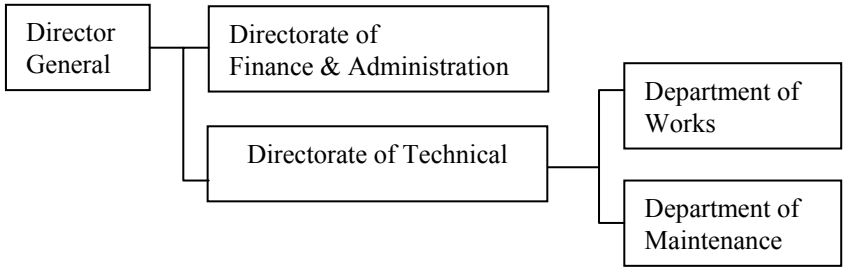


Figure. 3.5.3 SNAAT Organization

In the Dept. of Works, and Dept. of Maintenance there are 4 engineers each. Besides, there is a survey engineer, and the total number of staff is 110 (70% - technical staff) including the part time workers. There is also a plan to increase the number of staff. If there are requests in the future, it is also possible to open new section offices at other places of Foum Gleita.

SNAAT has an obligation to provide rental service by cheaper cost, and unit price of land leveling is 7,000UM/ha, and plowing is13,000 UM.

Backhoe

Grader

Combine of 2KR **Sticker of Japanese Government Property machinery of SNAAT**

3.5.2 Agricultural Extension

In regard to extension, as mentioned above in section 3.5.1, MDR has a department of extension at the central level, a responsible extension in the regional level, and an extension officer at the province level. The organization of regional MDR is shown below. In case of Gorgol region, there are 6 employees in the regional office, 2-5 in the four in department offices (Kaedi 4 Maghama 5 M'bout 2 Monguel 2). They have limited resources such as vehicles, and their activities are mainly dealing with administrative procedure for provision of license.

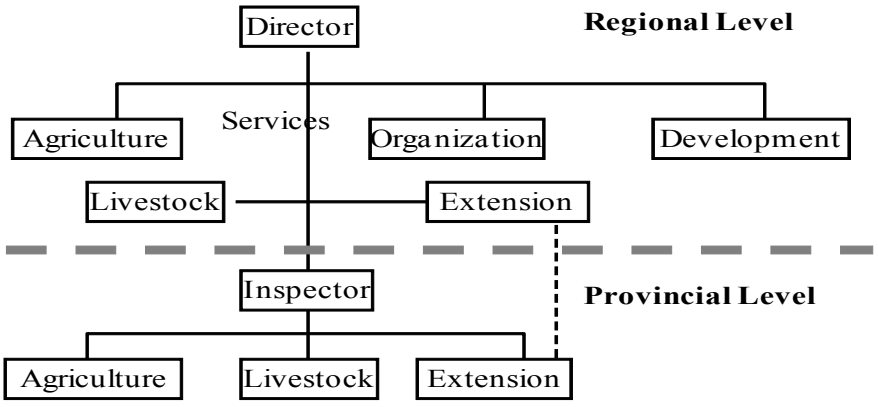


Figure 3.5.4 Ministry of Rural Development

SONADER also has an extension department and extension service in its regional office. The Gorgol office employs 6 extension officers in addition to a chief who are responsible for technical matters related to extension. Besides, there are 2 experts who are responsible for the activities related to farmer organizations. In Foum Gleita office, there are an extension chief, a training officer and four extension officers. SONADER is responsible for areas with stronger potential than MDR, but the extension activities are also quite limited, focusing on supervision of loan applications from farmers'

groups and monitoring.

3.5.3 Agricultural Finance

Initially agricultural finance was provided by SONADER, but because of the increase of negative effects and inefficiency, the agricultural credit for farmers groups represented by National Union of Agricultural Cooperatives Credit and Savings of Mauritania (UNCACEM) was set up as the governmental bank in 1992. There are branch offices in Rosso and Kaedi. The loan is offered only for rice production farmers and farmers' group. This organization has a primary role of financing for agricultural inputs, and offers three types of loans such as short term (one crop season) in the medium term (5 years), and long term (7 years). The credit rate is 14%. The short-term loans are provided for the purchase of fertilizers, seeds, fuel and other farm inputs and must be repaid at the end of the harvest. The medium and long-term loans are provided for the purchase of farming equipment, and maintenance of medium and large size of facilities. UNCACEM plays important role for small scale farmers in rural area, because they don't have the choice except borrowing high interest loans by the merchants.

In those three types of loan, short-term loan is essential for farmers to manage their farm. The flow of general loan procurement applications is indicated in the Figure below. The farmers apply for necessary inputs to the cooperatives before the cropping season. The cooperatives gather these applications and apply to union. The union collects the applications from the affiliate cooperatives and submits to UNCACEM. The UNCACEM requests material procurement from SONIMEX (Société Nationale d'Importation et d'Exportation - Public Corporation for Import and Export) or approved suppliers and pay the money. The organization which received the request provides materials to the applicants, the union. After that, the materials are distributed by the unit of cooperatives and distributed to farmer members among the cooperatives. The farmers produce rice by using the inputs and then repay the loan with equivalent amount of production to GIE (Groupement d'Intérêt Économique - Economic Interest Group), existing inside of union. The buyers mediated by UNCACEM purchase rice which are collected by GIE, and the buyers pay the money to UNCACEM.

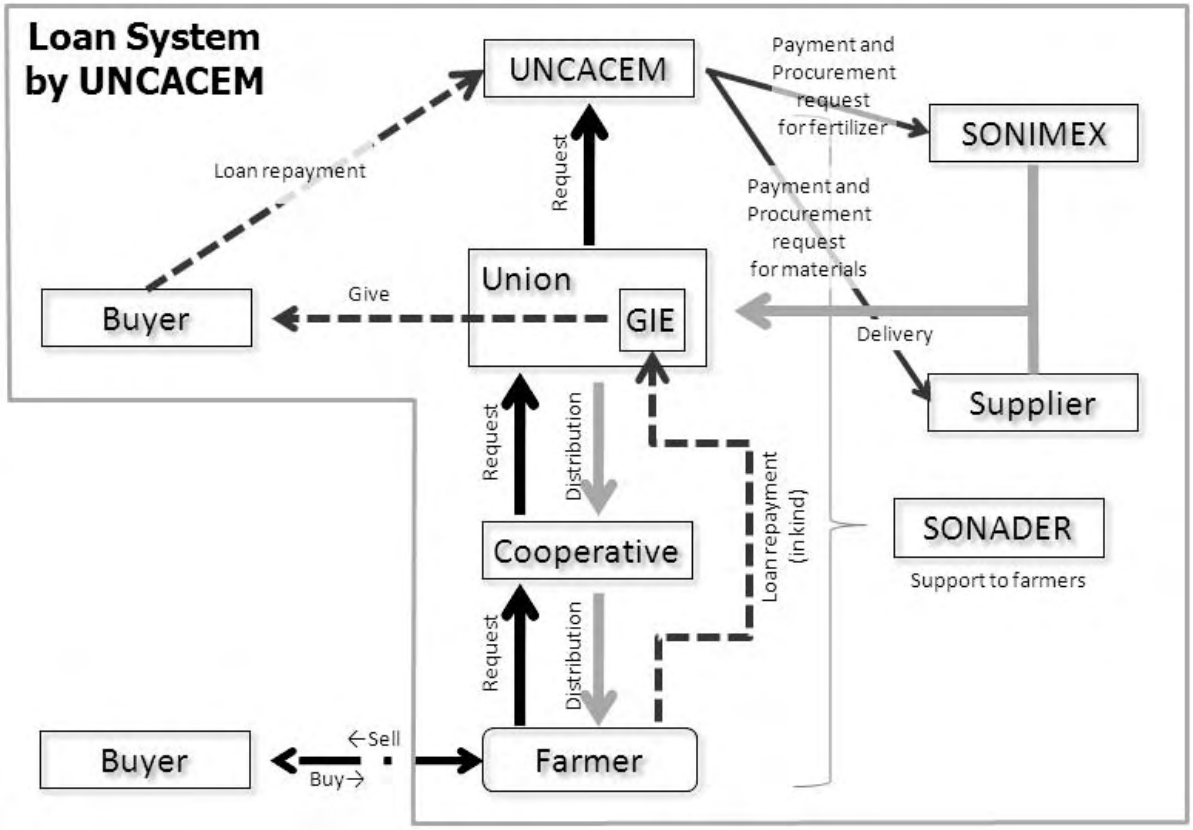


Figure 3.5.5 Flow of Loan Procurement Procedure in the Study Area

In this system, it is easy to manage because GIE does not deal with the cash directly. It is also easy in marketing aspect because the buyers which are selected by UNCACEM purchase and UNCACEM gets back the payment more accurately. Since it is marketing with official price, it plays a role of safeguarding of bottom price when the farmers sell their surplus rice individually. The marketing of surplus rice is mostly dealt outside of the loan system. Initially, GIE was created in order to collect and sell most of the harvesting products, but in fact, it has a limited role to manage the products for repayment of the loan.

SONIMEX is a public corporation established in 1966 and used to deal with import and distribution of rice, tea and sugar, but it faces competition from privatization and presently has a low share. Now, it has diverted its focusing point and handles the food supply to remote areas to stabilize the market prices, buying products from domestic producers and resell them in markets.

The roles of SONADER are totally different from each area, and even Lexeiba SONADER has almost no activity, but in Foum Gleita, SONADER has been supporting from level of farmers up to union as follows.

- Examination of amount of input materials application corresponding to the cropping area
- Apply to UNCACEM
- Call for repayment

- Instruction on direct fund management

In case of no harvesting by natural disasters, three actors such as borrower (farmers' group) SONADER, and UNCACEM discuss and reschedule the repayment.

As mentioned above, this is a general short-term UNCACEM loan system and some points are different from each area or group, but the major bottleneck which affects the cropping plan is that the procedure for the loan takes time for every cropping season. Moreover, especially in case of FG, the loan could not be used for long period because of past debts. However, presently, the government changed the policy that the loan of 2008/09 would be available even for the group having a debt. In 2010, it would be less of burden for small scale farmers because the government decided that 1. the farmers shall pay only half of debt from UNCACEM and 2. The repayment period for farmers shall be extended for a few years. Therefore, burden of farmers will be reduced.

Other than UNCACEM, there are other financial institutions dealing with microcredit such as CAPEC (Caisses Populaires d'Épargne et de Credit - Savings and Credit Associations), Bank Nisa (Women) and BDFG (Women's Bank of Gorgol), but the utilization is very limited. Moreover it is common to borrow money from local retailer with high interest rates, and some retailers are taking advantage of ignorance and vulnerable farmers and charge about 50% of interest.

All the three irrigation zones in this study target area utilize the loan and the situation of each zone is listed as below.

Table 3.5.3 Loan Situation of each Irrigation Zone

Zone	Situation
PPG I, II	The farmers submit requests to cooperatives and the union brings them together for the entire area and make the loan application. Almost all the farmers rely on short term loans, but have difficulty in continuing the second season because of the cycle: delay input distribution →delay cropping→ delay harvest →delay loan repayment → Loss of the second cropping season. PPG I, PPG II were affected by flooding in 1981, and 2007 respectively, and the government entrusted loans
Lexeiba	Each cooperative brings requests of farmers together and makes loan application, and 80-90% of them are using it. If fertilizers delivery is delayed, emergency funds are utilized to raise minimum input with giving priority to the timing of cropping. Repayment loan is evaluated as the best area in the jurisdiction of Kaedi UNCACEM office
Foum Gleita	The men cooperatives adapts the system of applications through the union similar to PPG, but between 2001 and 2007 they accumulated a debt of 41 million UM, and hence they could not borrow. GIE of rice exists, but currently loan has not been used. The cultivated area is decreasing and most of the rice is used for self consumption and the amount of quantity is relatively less. Therefore, there is no activity of GIE like the other zones. On the other hand, as mentioned above, when the loan system was working, SONADER used to play an important role in the process. In 2008, the president of Mauritania established a new type of loan, but it was a period when the government policy was revised, and the obligation of repayment of the previous loan is still remaining. The women cooperatives cultivating vegetables cannot use the UNCACEM, but some of them are using microcredit.

3.5.4 Agricultural Research and Training

In Mauritania, there are only a few institutes and training schools for agriculture research and training working under the control of the Ministry of Rural Development as mentioned below.

- CNRADA: National Centre for Agronomic Research and Agriculture Development., located in Kaédi, which is the main center for agricultural research in Mauritania.
- Laboratory for the Control of Seeds and Seedlings Quality located in Kaédi.
- Training Centre for Boghé cooperatives located in Boghé, in the province of Gorgol, and
- National Centre for Breeding and Veterinary Research, located in Nouakchott.
- National School for Training and Agriculture Extension (ENVFA), which is presently closed, but it is expected that it shall open soon.

Besides, there are a Technical High School in Boghé in the province of Gorgol, and a Technical Institute, in Rossso in the province of Brakna, which are under the Ministry of Education.

(1) CNRADA: National Centre for Agronomic Research and Agriculture Development

CNRADA was created in 1974, and is working under the jurisdiction of the Ministry of Rural Development. The mandate of CNRADA is to ensure, organize, conduct and disseminate all the research activities relevant to the agriculture and promotion of agricultural production. They have 5 major research programs as mentioned below.

- Irrigated Area Program
- Oasis Program
- Peri-urban Area Program
- Livetock & Forestry Program
- Rain fall and Flood Recession Area Program

These main programs are divided into the following sub-programs.

- Sub- program of rice and others food crops.
- Sub- program of forage cropping activities.
- Two sub-programs of gardening.
- Two sub-programs of fruit cropping.
- Sub-program of date palm cultivation.
- Sub-program of grara cultivation.
- Sub-program of aromatic and ornamental plants
- Sub-program of management of forests.
- Sub-program of agro –forestry.
- Sub-program of improvement of rainfed agriculture.
- Sub-program of improvement of cropping activities on flood recession areas.

They have five regional centers as mentioned below.

- Regional center of Trarza which pilot the irrigated program.
- Regional center n of Adrar which pilot the oasis program.
- Regional center of Assaba which pilot the livestock and forestry system.
- Regional center of Nouakchott which pilot the peri-urban system.
- Regional center of Guidamakha which pilot the rainfed agriculture.

The research areas of each regional center are shown below.

- Gorgol : Bélinabé - 25 ha ; Rindiao - 20 ha ; Sylla Semencier - 25 ha ; Diéri - 2,5 ha ; Sylla Embouche - 9 ha
- Assaba : Kankossa - 80 ha ; Kiffa - 3,6 ha ; Sani - 2,5 ha ;
- Trarza : Rosso (M'Pourié) - 14 ha
- District de Nouakchott : Nouakchott - 1 ha

There are 3 laboratories of plants improvement, pedology, and plants protection.

Research on NERICA rice (mainly upland rice) was conducted in experimental plots during the periods between 2000-2001 and 2002-2003, and it was reported that a yield of about 7 t/ha was obtained. However, the research was not continued because of shortage of budget and other administrative reasons, and NERICA was not put into registration process to adapt it widely. Therefore, it cannot be used in the farmers fields, although CNRADA has the authority to conduct the experimental trials once again in farmers fields.

In 2000, the center had 144 employees including 44 researchers, and more than 60% of the researchers had higher university education with 17% of researchers with Ph.D degree. CNRADA underwent restructuring in 2000 as part of the Agricultural Services Project (PSA)—an agricultural research development project predominantly funded by a World Bank loan—and in accordance with the Government of Mauritania's National Agricultural Research Program (PNRA). PSA's principal objectives were to strengthen CNRADA and to improve the coordination and collaboration between them. More specifically, the reorganization was intended to stimulate on-farm and applied research and to establish direct links between research and extension. However, at the end of PSA project, some of the experienced researchers left for more attractive opportunities. At present (2008), there are only about 15 researchers involved in various research activities.

CNRADA has developed an important network with institutions both in Africa and Europe. The exchanges are still continuing with the neighboring countries such as the Senegalese Institute of Agricultural Research (ISRA), Institute of Rural Economy of Mali (IER) and the Agronomic and veterinary Institute of Hassan II of Morocco (IAV). CNRADA collaborates actively with different other research centers and networks as the advisory Group on International Agricultural Research

(GCRAI), the African Network for the development of Horticulture (RADHORT), the Western African Network of Research on Millet (ROCAFREMI), the Western African Network of Research on the Sorghum (ROCARS) and the Western and Central African of Research on Rice (ROCARIZ). It also collaborates with Association for the Development of rice in West Africa (WARDA).

(2) Laboratory for Control of Seeds and Seedlings Quality

Laboratory for Control of Seeds and Seedlings Quality functions under the authority of the Direction of Agriculture and Breeding, and the main mandate of the laboratory is to control the quality of the produced seeds and seedlings in order to allow their certification through the country. In addition, it is in charge of:

- monitoring the whole seeds production plots in order to see if they are filling the production criteria
- take samples for laboratory analysis for certification
- give technical opinion to the Ministry of Rural Development for any approval request made by seeds and seedlings production institution
- collect and store all the data on seeds and seedlings production at the national level
- active participation to the national committee of seeds and seedlings
- manage and insure the maintenance and the functioning of the materials put at their disposal

The Laboratory is supported by the State, and some allowance paid by the seeds and seedlings production institution and donors.

(3) Training Centre for Boghé Cooperatives

It was opened in 1978 to meet the needs of the farmers who need basic training. The training covers the following fields:

- technique of processing and conservation of the agricultural products
- monitoring and maintenance of motor pumps and agriculture materials
- cooperatives management
- training of rural farmers

The centre has trained nearly 600 farmers including 75% of women. The staff is composed of 22 teachers of high level, and the budget is nearly 4 million UM.

(4) National Centre for Breeding and Veterinary Research

The mandate of National Centre for Breeding and Veterinary Research (CNERV) includes genetic improvement of livestock, diagnosis and detection of animal diseases, epidemiological research of livestock ailments, meat product control, and the analysis of forages. CNERV accounted for 20 percent of Mauritania's total researchers and agricultural R&D expenditures. CNERV is

headquartered in Nouakchott and disposes of a regional station in Kaédi.

(5) ENFVA: the National School for Training and Agriculture Extension

It was created in 1962 under the name of training college. It has created more than a thousand civil servants for rural sector: agriculture, breeding and the protection of the nature. The school has two categories of training:

- 2 years training to receive a diploma in extension of rural economy or breeding
- 3 years training to receive a diploma in extension of agriculture and plant protection or assistant of breeding.

ENFVA is now closed but is expected to open soon.

3.6 Irrigation and Drainage

3.6.1 Existing Irrigated Agriculture Development Plan

(1) Foum Gleita Irrigated Agriculture Development Plan

The Foum Gleita irrigated agriculture development plan was prepared in the mid 1970s to fight against the poverty, and to settle down the nomads including the people living in submerged areas. In 1984, the stage I of irrigated agriculture was started at the same time as the completion of the dam construction. Although the area initially planned for future development was 3,600 ha, and the objective area of the Study is 1,950 ha.

Stage I	550ha	Service started in 1984
Stage II	1,400ha	Service started in 1989
Stage III	1,670ha	Not yet started in 2008

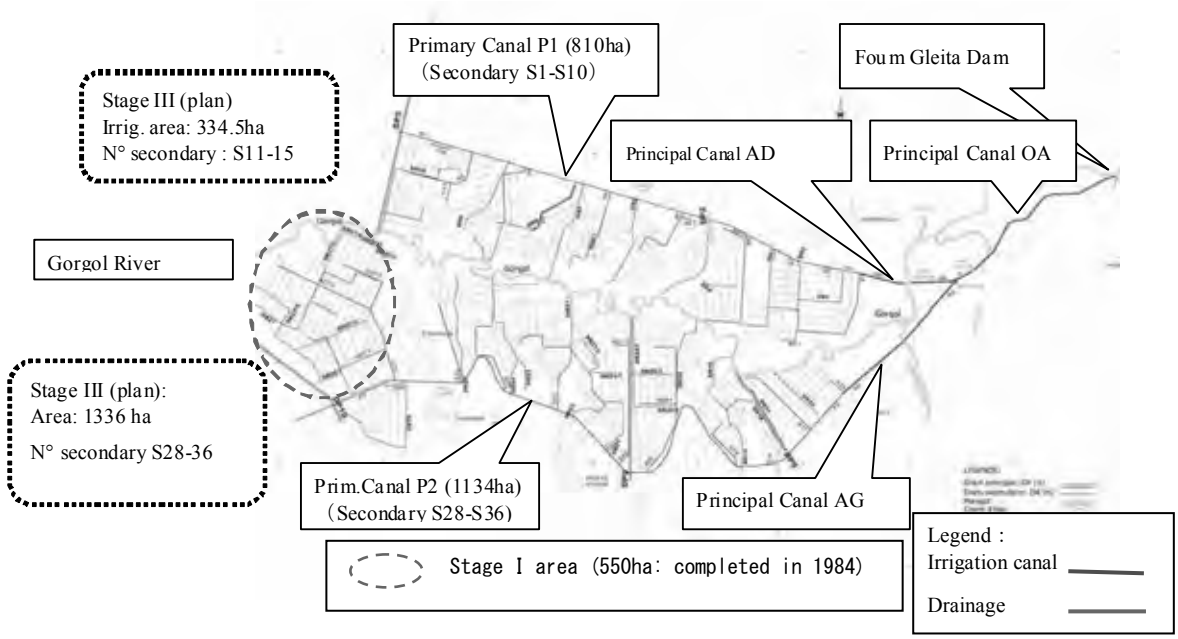


Figure 3.6.1 Location of Each Stage

During phases I and II, 0.5 ha of land was distributed to each nomadic farming household. The Phase III was planned to be implemented depending on the success of Phases I and II, but so far no plan is implemented.

This program aims at 2 cropping seasons in a year. Since the rainfall quantity is scarce with an annual average of about 290 mm, Foum Gleita dam is the main water resource for agriculture in both the rainy and dry seasons. The irrigated area of our study is developed in both the sides of the Gorgol river and its net area is 1,140 ha on the left bank and 810 ha on the right bank.

(2) Study by PDIAIM

a) Outline

In PDIAIM, the revival of irrigated area of Foum Gleita was an important component and made a Study twice. Since the result of Study is important as basic of this development study, its adequacy should be verified in this Study. Therefore, the results of reviewed contents of this study is mentioned in this section. The first study entitled “Etude APD de rehabilitation des grands perimetres collectifs Foum Gleita（Phase I）: Diagnostic et Proposition de Solutions (APDI) was completed in July 2006. The objectives of the Study were (i) optimizing the use of water facilities and (ii) creating the employment opportunities and increasing the income, (iii) sustainable operation, and maintenance of infrastructure facilities and (iv) securing of water resources. Based on the results of the diagnostic survey, Etude APD de rehabilitation des grands perimetres collectifs Foum Gleita（Phase II）: Etude d’Avant Project Detaille (APDII) was conducted in June, 2007 and decided the outline of the project. Both analysis of current situation and work planning were determined as reasonable and rehabilitation of irrigation facility plan in this study almost follows the contents.

b) Result of Study

It clarified the status of all the facilities in the entire area and found that the current amount of water flow in 2006 was estimated as 1.4 m^3 / s (1.2 m^3 2010) while the planned amount of water flow was 10.7 m3 / s for 3,600 ha. It was found that the reason for the reduction of water flow was mainly due to the accumulation of silt and profusion of aquatic weeds in the canals, and damages caused by the livestock on the canal embankments. The siltation and superannuation of irrigation facilities including principal canal, primary canal and secondary canal were identified by the diagnostic survey. The topographic siltation survey was also conducted on the drains, and a brief study of additional facilities was carried out to calculate roughly the required rehabilitation works and its cost.

The rehabilitation plan proposed included the reinforced concrete lining of the section of 8.6 km of principal canal. Although the cost is high, the reinforced concrete lining which do not require maintenance is proposed in consideration of financial situation of SONADER for maintenance, and capacity of participatory maintenance of farmers' cooperatives.

(c) Priority of Rehabilitation Works

The prioritization of rehabilitation works of irrigation and drainage system are proposed in APD1 as mentioned below.

1. Rehabilitation of principal canal (concrete lining)	Approx. 8 km
2. Rehabilitation of primary and secondary canals (earthern canal)	30 km
3. Rehabilitation of drains (earthern canal)	30 km
4. New construction of some irrigation and drainage facilities	1 set
5. Removal of bushes and reclamation of farm lands	500 ha
6. Rehabilitation of roads	27 km
7. New installation of drinking water system	1 set
8. New installation of maintenance office	1 building
9. New installation of multipurpose sheds	40 locations

d) Reinforced Concrete Lining of Principal Canal

In the APD I study, a comparision is made between the earth canal (scenario I) and the concrete lining of principal canal (scenario II). The approximate costs of construction and annual operation and maintenance of each option are listed below.

Table 3.6.1 Comparison between Reinforced Concrete Lining Canal and Earthern Canal (UM/ha)

Description	Scenario 1	Scenario 2	Difference
Investment cost	1,125,043	1,966,078	841,035
Operation & management cost	35,000	31,000	4,000

Source: Etude APD de rehabilitation des grands perimetres collectifs Foum Gleita (Phase I): Diagnostic et Proposition de Solutions, 2006, SONADER, et al.

It is better to choose the reinforced concrete lining in consideration of capacity of maintenance of earthern canal by SONADER and cooperatives, and resource conservation even though the earthern canal has more economical advantage. Furthermore, it is determined that APD1 is reasonable because reinforced concrete lining has advantage of sustainability.

- In the vicinity of principal canal outside the project area, vegetables are currently produced temporarily by women for whom the canal maintenance is very hard. The principal canals are wide and deep (3.5 to 8 m wide in bottom, water depth of 1.8 to 2.45 m) and hence their maintenance is not feasible. Even if all the men of the unions get together, it is difficult to overcome the typha in the canal. Therefore, it cannot be denied that the capacity of water flow will inevitably be reduced even if the rehabilitation is carried out for the earthern canal.
- The canals have high embankment which easily can cause large scale collapsing of dike by overflow. The free board of canal is large (75 cm) and the decreasing capacity of flow in case of typha should be accompanied with either rise of water level or the reduction of the irrigated areas for the case of earthen canal.

3.6.2 Outline of Foum Gleita Dam

(1) Outline of the Dam

Foum Gleita dam was built to irrigate 25,000 ha of dry farmland between the dam and Kaédi, stretched over a distance of 100 km downstream from the dam. Its characteristics are as follows:

River： Black Gorgol valley on the northern mountain chain Wa-Wa
Dam catchment area： 8,950 km^2
Gross storage of normal water level (33.80m)： 500 MCM (Effective Storage：400MCM)
Reservoir area of normal water level (33.80m)： 159.2km^2
Period of construction： 1981-1984

Table 3.6.2 Outline of Foum Gleita Dam

Description	Value
Dam type	Concrete arch dam
Maximum dam height	45 m
Crest length	117 m
Crest width of non-overflow section	3.05 m
Bottom width	13 m
Spillway type • Capacity • Overflow crest elevation	Free overflow (non gate) 300 m^3/s EL. 33.80 m
Normal water level (at effective storage of 400MCM)	EL. 33.80 m
Low water level (at 69 MCM of top of intake mouth)	EL. 30.00 m
Maximum water level (1100 MCM for probability of 1/10000)	EL. 36.90 m
Maximum storage capacity	500 MCM
Sediment flush gate	1.70 x 1.70 m x 2 valves
Intake structure	3.70 m dia. with a valve
Irrigation discharge	6.00 m^3/s

Source: Directorate of Water Management and Planning of Gorgol Valley SONADER, 2001

(2) Level of the Reservoir and Storage Volume

The maximum and minimum levels of the reservoir and the volume stored in the past 10 years are shown below. This table shows that：

① The lowest level of the reservoir is observed in June and July, and the highest level is observed between August and October.

② The difference of the storage volume between the highest level and the lowest is the volume of difference of the annual inflow and outflow (Max-Min in the table). Conversely, if the volume of outflow is added to the Max-Min of the year, it will be the inflow volume of the reservoir. Therefore, the inflow is much higher than Max-Min.

③ The maximum level of the past ten years was observed on August 5, 2007 with an EL.36.25 m, which occurred a month and a half earlier than the maximum level of Kaedi water gate. According to SONADER, the flood was caused by the late release of White Gorgol river.

④ The maximum water level of 2006 was very high, but there was no flooding.

Table 3.6.3 Level of the Reservoir and Storage Volume

Year	Minimum			Maximum			Deversement				Inflow
	Date	(El.m)	MCM	Date	(El.m)	MCM	MCM	m3/s	from	to	MCM
1998	20/7	30.60	130	10/10	34.40	600	100	25	15/9	25/10	570
1999	20/6	30.75	140	25/10	35.90	875	375	140	20/8	5/2	1,110
2000	10/7	32.15	265	20/10	35.65	825	320	115	20/8	15/12	880
2001	20/6	32.30	285	25/8	35.30	765	265	80	5/8	10/12	745
2002	15/7	32.20	275	25/10	33.40	445	-	-	-	-	-
2003	20/6	31.35	185	25/9	35.75	840	340	110	10/8	30/1/04	995
2004	30/6	32.35	290	20/9	35.35	770	270	85	15/8	30/12	750
2005	30/5	31.65	330	20/9	35.45	795	295	95	20/7	13/1/06	760
2006	25/7	32.35	290	15/9	36.00	900	400	150	20/8	15/1/07	1,010
2007	15/7	32.30	285	5/8	36.25	950	450	180	5/8	15/1/08	1,115
Average		31.80	248		35.35	777	313	109			882

Source: Dam Operation Office, Foum Gleita Antenna

The average annual reservoir storage for the past 10 years is 248MCM, which shall not create problem even if the irrigated area upto Kaedi is increased. According to SONADER, the volume of the reservoir is used only in the Gorgol basin, and the water rights for the reservoir water are allocated at the same time as the approval of application for irrigation development.

(3) Diagnosis Survey of the Dam

In principle, the dam must be diagnosed once in every five years, and the last diagnosis was made in 2004.

3.6.3 Irrigation and Drainage Facilities of Foum Gleita Project

The area is almost flat with a gentle slope (1 / 500) towards the black Gorgol river. The primary canal is placed along the contour line.

The main structures are shown in figures 3.6.2 and 3.6.3.

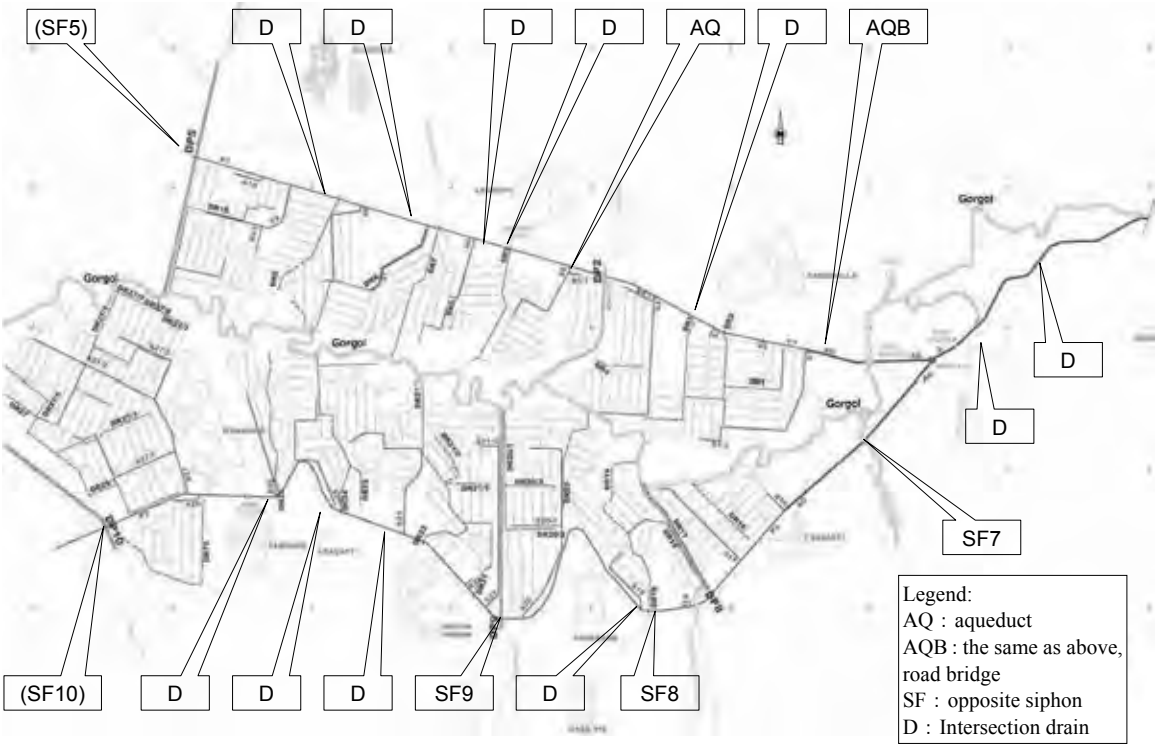


Figure 3.6.2 Intersection Structures

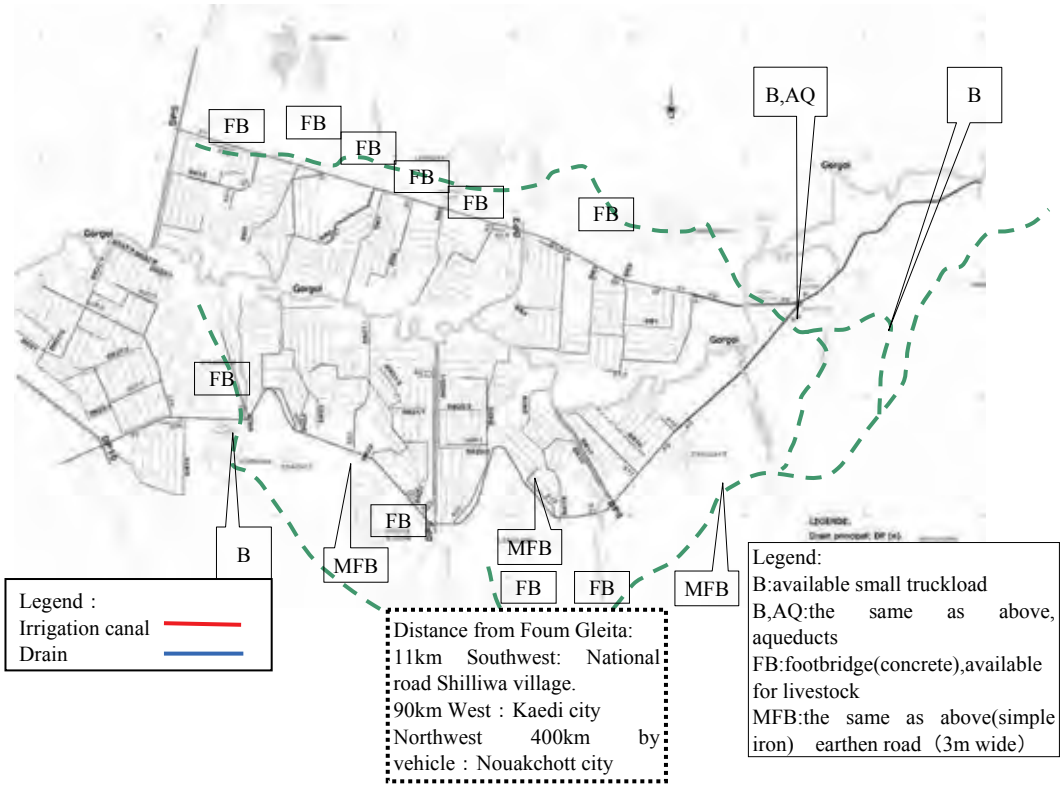


Figure 3.6.3 Road bridges and Foot Bridges

(1) Principal Canal

The irrigation water conveyance to the irrigated area is taken from the tunnel at the left bank of the dam, and the flow is controlled by a radial gate (hydraulic gear broken). After the gate, the water is conveyed by gravity through the principal canal. From the gate, the water is conveyed by the earthen canal until the round diverter which is located at 3.5 km downstream at the junction of the right and left bank. At this point, OA is divided into principal canal AD (right bank) and the principal canal AG (left bank). (See figure 3.6.2 and 3.6.3). The principal canal AD reaches the primary canal P1 at the diversion of the first secondary canal located at 1.5 km downstream side and from there, it becomes as primary canal P1. At the halfway of principal canal AD, it crosses the black Gorgol river through a bridge with an aqueduct. On the other side, the water is conveyed to the left bank of principal canal AG, and reaches the primary canal P2 at the first diversion which is at 3 km downstream, and from there and it becomes P2 primary canal. The principal canal AG crosses the tributary of Black Gorgol river at siphon (SF7). The characteristics of principal canal are mentioned below.

Table 3.6.4 Characteristics of Principal Canal

Principal	Area(ha)	Q(m3/s)	L (km)	Lf (m)	Lc (m)	H (m)	Canal gradient
OA (main)	3614	10.73	3.781	8.0	2.5	2.99	0.000074
AD (right)	1144	3.12	1.821	3.5	2.5	2.56-2.54	0.0000286-345
AG (left)	2470	7.33	3.005	6.0	2.5	3.22-3.20	0.000024

Q: Design discharge; L: Length; Lf: Bottom Width; Lc: Dike width; H: Dike height
Source; Etude d'Avant Project Detaille, Perimetre de Foum Gleita (Phase 2), Juin, 2007

Since As-built Drawings were not found, the characteristics of secondary canal are mentioned by the results of the field study and implementation plan drawing for the construction. The characteristics of the principal canal and primary canal which were obtained from cross section of implementation plan cand current situation is shown ANNEX 4.1and 4.2. The location and pictures of infrastructure facilities are shown in ANNEX 4.3.1.

(2) Primary Canal

The P1 primary canal distributes water to secondary canals S1 to S10 which irrigates on the right bank of Black Gorgol river. The P2 primary canal distributes water to the secondary canal S16 to S27 which irrigates the left bank.

Table 3.6.5 Characteristics of Primary Canal

Primary	Area1 (ha)	Area2 (ha)	Q (m3/s)	L (km)	Lf (m)	Lc (m)	H (m)	Gradient
P1 (right)	810	1,144	3.0 0.9	8.180	3.50 1.50	2.50 1.50	2.54 1.02	0.0001
P2 (left)	1,134	2,470	7.13 3.5	11.805	6.0 4.0	2.50 2.50	3.21 2.50	0.00003

Source: Etude d'Avant Project Detaille, Perimetre de Foum Gleita (Phase 2), Juin, 2007

In the Table, the Area1 is developed area and Area 2 is considered to be extended in the future. It is planned that an area of 334.5 ha can be added on the right bank, and 1,336 ha can be added on the left bank to Area 1. The P1 primary canal crosses the black Gorgol tributary DP2 by an aqueduct with bridge. The P2 primary canal crosses black Gorgol tributaries DP8 and DP9 by inverted siphons SF8 and SF9. This primary canal is an earthen type canal, equipped with gates for secondary canals and check gates, outlets, evacuation outlets, weirs, and concrete road bridges.

(3) Secondary Canal

Secondary canal is also an earthen type canal which are directly divided from the primary canal P1 (right bank) and the primary canal P2 (left bank) have 10 canals in P1 and 12 canals in P2. There are about 10 tertiary canals which are divided from the secondary canals. The characteristics of secondary canals are mentioned below.

Table 3.6.6 Characteristics of Secondary Canals

Irrigation Canal	Area	Length	Bottom W	Dike H	Gradient
Secondary					
S1	98.17	2274.66	0.8	1.17	0.0001
S2	36.50	122.59	0.6	0.87	0.0001
S3	35.48	169.06	0.6	0.87	0.0001
S4	65.92	2194.86	0.6	1.06	0.0001
S4.1	46.00				
S5	97.23	1307.73	0.6	1.02	0.0003
S 5.1		193.84			
S6	88.64	958.16	0.6	0.83	0.0002
S7	76.91	1045.10			
S8	94.69	1471.04			
S9	139.60	1481.16			
S9.1		365.73			
S10	30.90	440.61			
Sub total (P1)	**810.04**	**12024.54**			
S16	40.12	311.39	0.6	0.91	0.0001
S17	59.53	1614.67	0.8	1.07	0.0001
S18	25.50	93.28	0.6	0.84	0.0003
S19	36.78	841.59	0.6	1.02	0.00009
S20	185.07	1849.15	1	1.31	0.00009
S20.1		270.89			0.00014
S21	93.25	2090.48	0.8	1.21	0.0001,2,4
S22	23.78	110.28	0.6	0.82	0.0001
S23	118.92	1509.15	0.8	1.12	0.0001
S24	69.20	2011.56	0.6	0.91	0.0004
S25	51.77	1548.60	0.6	1.03	0.0001
S26	71.69	382.20	0.6	0.8	0.0004
S27		1937.17			
S27.1	136.70	1508.98	0.8	1.23	0.0001
S27.2	164.50	1652.00			
S27.3	57.00	416.12			
Sub total (P2)	**1133.81**	**18147.51**			
Total	**1943.85**	**30172.05**			

Source: APD Phase II for FG (Scet-LIM, et al, 2007) except W, H, I from the available design drawings 0.45 m high freeboard is applied to all secondary canals

The main facilities of secondary canals are diversion facilities for tertiary canals and drop structures, which are made of concrete. The diversion facility for tertiary canals consists of diversion weir and prise modulee (or module A'masque: consisting of a set of iron gates of 5, 10, 20, 40 l / s.). It is set up at the diversion for tertiary canals which are over 100 numbers in the entire project area (Source: APD Phase II for FG, 2006).

(4) On-Farm Facilities

The on-farm facilities are equipped tertiary canals, quaternary canals and diversion facilities. The diversion facility from a tertiary canal is a simple structure of PVC pipe attached to a 50 cm wide concrete slab or to a 15 cm x 30 cm iron valve instead of PVC pipe. One parcel of farm land is 100 m wide, 200 m to 1000 m long along the contour line, and the land is almost flat so that the tractors can be used. It is 30-50 cm wide at the bottom of the tertiary canals which is equipped along the length of the parcel. Their total length is estimated as 200 km. The secondary canal S2 was under the control of women cooperatives. Five iron gates were set up 20 years ago on 500 m of tertiary canals. Although they are not locked for maintenance, they look brand new, which indicates the moral standard of the people of Foum Gleita.

(5) Primary Drain

The drains are also the earthern canals, and their characteristics are as follows.

Table 3.6.7 Characteristics Primary Drains

Main Drainage Primary	Length m	Bottom W m	Dike H m	Gradient I=1/L	Dike distance m	Crest Width m
DP2	1985	25	2.65	0.0006	57.6	3
DP5						
DP8	1875	13	2.65-5.0	0.0013	31	1.5
DP9	2900	20	2.22	0.0003	51	3
DP10	4800	25	4	0.0009		3

Source: Etude d'Avant Project Detaille, Perimetre de Foum Gleita (Phase 2), June, 2007 for Length and available design drawings for other data.

(6) Secondary Drain

The secondary drainage canals are earthern canals of 0.5 to 6.0 m wide. The total length of the canals is 30.7 km. They are equipped with 1 - 4 parts of concrete box culvert to cross primary canal as they also receive the flow outside the irrigated area. The characteristics of secondary drain are as follows.

Table 3.6.8 Characteristics of Secondary Drains

Secondary Drain	Length m	Bottom Width m	Dike Height m	Gradient I=1/L
DR1	1338.40	1.0	1.3	0.0005
DR2	767.62	1.0	1.8	0.001
DR3	910.55	1.0	1.3	0.002
DR4	615.66	0.5	1.2	0.001
DR5	1056.84	6.0	2.0	
DR6	548.00	0.5	1.3	0.0025
DR7	1689.98	6.0	1.8	0.00094
DR8	2227.55			
DR9	2400.00			
DR10	1500.00			
Sub total (P1)	13054.60			
DR16	1050.00			
DR17				
DR18	1625.00	0.5	2.5	0.001
DR19	11.00	2.0	2.7	0.0003
DR20/1	495.09	0.5	2.0	0.0005
DR20/2	629.43			
DR20/3	682.60			
DR21	1260.60	1.5	2.0	0.0006
DR22	920.20	1.5		0.00076
DR23	666.30	1.5	1.8	0.0003
DR24	1600.00	1.5	1.7	0.00137
DR25	1600.00	1.5	1.8	0.001
DR26				
DR27	1700.00	0.5	4.0	0.000535
DR27-1	550.00	0.5	3.0	0.00159
DR27-2	1250.00	0.5	2.6	
DR28	2117.80		1.5	
DR28-1	1500.00	0.5	2.0	
Sub total (P2)	17658.02			
Total	30712.62			

Source: Etude d'Avant Project Detaille, Perimetre de Foum Gleita (Phase 2), Juin, 2007 for Length and available design drawings for other data; and Gestion Reseau, Assistance technique au Projet, Gorgol Noir a Gorgol, 1991

(7) Main Structures

The principal canal and the primary canal crosses the streams of tributaries from outside the area to Gorgol river at the siphon and aqueducts. These structures are all made of reinforced concrete. The characteristics of aqueducts and siphons are mentioned below.

Table 3.6.9 Characteristics of Aqueducts and Siphons

Name of Structure	Location	Length	Dimension	
		m	B (m)	H (m)
Pont Aqueduct	Gorgol/AD	85	1.5x2	1.00
Aqueduct	P1/DP2	62.5	1.24	2.24
Siphon SF7	Tributary/AG	62.3	1.375x2	2.00
Siphon SF8	P2/DP8	51.8	1.375x2	2.00
Siphon SF9	P2/DP9	72.9	1.125x2	2.00

Source: SONADER, JICA and detail drawings

The aqueducts and bridges that cross the primary irrigation canal are shown below.

Table 3.6.10 Aqueducts and Bridges

Name of Structure	Location	Structure	Dimension	Length
			B (m)	m
Road bridge No.1	Dam site/OA	RC	4.0	10
Road bridge No.2	OA	RC	4.0	20
Road/Aqueduct	Gorgol/AD	RC	4.0	60
Road bridge No.3	P2/S25	RC	4.0	15
Passage Buse	P1/DR5	Corrugated pipe	-	5
Foot bridge	8 places/P1,P2	RC	1.0	7-15
Metal foot bridge	3 places/P2	Metal	0.7	15

Source: SONADER, JICA and detail drawings

(8) Farm Road and Additional Facilities

The farm road was constructed by the soils excavated from drainage canals along almost all the drains and secondary canals with a width of 3-5 m. Currently they are widely covered with low shrubs and are partly usable. There are about 80 km of length in total, and fertilizers and agricultural products are carried by donkey.

3.6.4 Basic Values of Foum Gleita Irrigation and Drainage

This section covers the estimation of quantities of irrigation and drainage water, and rehabilitation plan for the rice irrigation.

(1) Irrigation Water Requirement

Since there are no other documents available (beginning of 1980's), irrigation water requirements are analyzed by referring APD Foum Gleita phase 2 (hereinafter APD II) in 2006.

Table 3.6.11 Existing Irrigation Water Calculation Sheet

Cultures	Area (ha)	Monthly Diversion Water Requirement ('000 m^3)												
		J	F	M	A	M	J	Jt	A	S	O	N	D	Annual
Rice (Rainy S.)	1,170						3,376	3,614	2,036	2,102				11,128
Rice (CSC)	195		195	842	704	728	310							2,780
Sorghum (Rainy S.)	195						192	311	281	200				984
Vegetables (Rainy S.)	195						206	224	215	190	136			973
Vegetables (CSF)	390	673	694	453								318	515	2,654
Sorghum/ Maize (CSF)	195	397	178									142	328	1,044
Requirement for Net Project Area (m^3)		1,069	1,067	1,294	704	728	4,085	4,150	2,532	2,492	136	460	843	19,561
Requirement for Gross Project Area (m^3)		1,426	1,422	1,726	939	971	5,447	5,533	3,376	3,323	182	614	1,124	26,082
Gross Requirement per ha (m^3/ha)		731	729	885	482	498	2,793	2,837	1,731	1,704	93	315	576	13,375

Source: APD Phase 2 Foum Gleita (SONADER, 2007)

In 1980s, the plan of principal canals for the Foum Gleita project was 10.7 m^3 to cover an area of 3,600 ha.

It was reported that irrigation area of wet season rice was 1,170 ha, and 195 ha of dry paddy rice area which is 10% of the total area as above table. In rainy season, an area of 195 ha each was planned for sorghum and vegetables respectively, and in dry season, 390 ha of vegetables and 190 ha of sorghum and maize were planned. The maximum irrigation water demand was 5,533,000 m^3 in July which corresponds to 2.1 m^3/sec of flow. In addition, the original plan planned in 1980s included two seasons of rice cultivation in one year in 1,950 ha area. If the amount of water is estimated for 1950 ha based on maximum of 842,000 m^3 in March (dry season rice) as indicated in the table shown above, the volume of water required will be 4.2 m^3/sec, which is below 6m^3/sec (10.7 / 3600 x 1950 ha), the initial amount of flow. In fact, 4.2m^3/s/1950ha corresponds to 2.15 l/ ha. The SONADER's standard of planned flow is 3 l/ha.

(2) Irrigation Efficiency

The overall irrigation efficiency indicated in the APD Foum Gleita (Phase II) is 75%. The field application efficiency is 85%, and the conveyance losses are 5% in the secondary, tertiary and quaternary canals, and 5% in P1 and P2 primary canals. If the conveyance loss in principal canal is 5%, the total irrigation efficiency is calculated as 73%. However, since the canal is an earthern canal, a lower efficiency of 65% was used as the standard irrigation efficiency.

(3) Crop Coefficient

The following figures based on FAO and the irrigation program of the Senegal river (JICA).

Table3.6.12 Crop Coefficient

Growth stage	Transplanting	Tillering	Formation	Ripening stage	Maturation
Kc Rice	1.00	1.10	1.25	1.35	1.15

Source: Senegal River Irrigation Project (1997, JICA)

(4) Water Requirement for Land Preparation

In consideration of the method of rice transplanting in Foum Gleita APD II used 150 mm, 100 mm, 250mm in every two weeks as the water requirement for land preparation, which are reasonably appropriate and are adapted.

(5) Percolation Losses

Based on the plan of APD Foum Gleita (Phase II), and Senegal river irrigation plan, and in consideration of the soils based on the soil maps of the area, 1mm/day was adopted as appropriate for the area.

(6) DWR: Diversion Water Requirement

In regard to Evapotranspiration (ETo) estimation, Penman-Monteith method was adapted and the monthly gross water requirements were estimated in consideration of the crop coefficients (Ref : Irrigation program of the Senegal river) and area ratio as shown below (Caculations are shown in ANNEX 4.4.1 and 4.4.2). The maximum gross water requirement was calculated as 3 l/s/ha occured at the end of the land preparation. This unit of water requirement was in consistent with the original design.

Table 3.6.13 Evapotranspiration (Penman-Monteith: mm/ day)

Month	J	F	M	A	M	J	Jt	A	S	O	N	D
ETo(mm/day)	5.9	7.4	8.6	9.6	10.0	8.8	7.4	6.4	6.4	6.2	6.1	6.0
DWR(l/s/ha)		1.3-2.9	2.5-2.0	2.4-1.8	0.7	1.0	2.6-1.8	1.0-1.6	1.0-1.1	1.2-0.4		

(7) Quantity of Drainage

Based on SONADER standards, 1.5 ltr/s/ha was adapted.

(8) Water Requirements of Livestock Drinking Water

The daily needs of livestock drinking water were estimated as follows:

a. Goats, sheep, donkeys: 6 l liter/ day on average, 50% water losses
b. Cattle, horses, camels: 25 l liter/ day on average, 50% water losses

Based on our survey, the number of heads owned by beneficiaries of the irrigation is shown below.

Bovine	5,365		
Camelins	2		
Hrse	150	Total 5,517 x 25 liter = 276 m^3	
Ovins	12,570		
Mule	1,600	Total 14,170 x 6 liter = 85 m^3	Total - 361 m^3/day

The total water requirements of livestock are 360 m^3 per day, which is negligible compared to the needs of irrigation water (4 liter / sec.).

3.6.5 Situation of Irrigation and Drainage Facilities

(1) Situation of Irrigation and Drainage Facilities

As a result of this field study, adequacy of exist Study was confirmed. That is, the canals serve drinking water for livestock which caused damage on the inner slope of the canals. The soils were piling up at the bottom of canals, which reduced the cross section area of flow. Furthermore, typha growth caused decreasing of water flow and the fallow lands were invaded and covered with bush which was worse than other project area. However, the concrete structures were obviously constructed stronger, and the water supply facilities are secure.

The Study team analyzed various reports collected to support the above statements and the conditions additionally noted were as follows:

- Nearly half of the project area was flooded in August 2007 because of unprecedented flooding. There was also a flood in September, 2009 which exceeded the flood level of 2007, and the maximum flooding depth are shown as 3 cases including over 0.5m (red), 0-0.5 m (blue), and no-flooding (green). The flooding map was prepared by the cooperation of farmers and SONADER (See ANNEX4.5).
- The rainfall in August, 2008 caused the entrance of water to the starting point of the principal canal near the dam site, and the level of the canal increased. The water overflew from the left upstream bank of the siphon SF7 in the principal canal, damaging the canal embankment and the discharge outlet. Emergency measures were carried out one month later, but some part of the canal embankment base became hollow, which is dangerous. This place was also damaged previously in 2001, and the amount of water supply was reduced up to 1.5 m^3/sec. The damage from this time was enormous, and the flow was reduced to 1.2 m^3/sec.
- Repair of the radial gate and hydraulic pressure system which were set up at the water diversion tower at the downstream side of the dam needs to be repaired. For this repair, stop log, batardeau and lifting equipment are needed.

- To prevent from entering of livestock, the assistance of other agencies is also required. However, it was found out from head of SONADER that there was less possibility for such assistance.
- The situation of other irrigation and drainage system and the field facilities was not different from the diagnosed results.

The location and pictures of the infrastructures which needed rehabilitation are shown in ANNEX 4.6.1 and the situation of typha and bush along the primary canal is shown in ANNEX4.7.1-3.

The secondary canal connects with the primary canal P1 at 10 places and P2 at 12 places, but parts of this intake gates are often lost, and therefore, an additional survey was conducted. As a result, it was revealed that there was no gate in one place, 13 places had no lift handles (including handles to be replaced), 6 places had no lifting shafts, and there was no gate frame in one place.

In regards to the area downstream to the level of secondary canals, the survey was conducted based on Stage II (started in 1984) using S9 and S27/1 system. Ther results are shown in the ATTACHMENT of ANNEX 4. Based on this survey, it was found out that the farmers can maintain the plots sustainably by doing the regular operation and maintenance works.

(2) Countermeasure for Vulnerable Part

Along the primary canal, there were several vulnerable places which has possibility of enormous damage on larger area if maintenance is not taken immediately. From SONADER Foum Gleita office, the following priorities were proposed. It might also affect on verification trial and extremely highly urgency is confirmed in the field. Therefore, this Study tries to take measurement on many of these places through farmers' participatory approach, direct management of SONADER and reconsignment and currently risk from the damage is reduced.

- Repair of siphon SF7 of principal canal AG (reinforcement of the banks needed for about 200 m, and siphon)
- Strengthening the banks of the aqueduct canal at AD principal canal (bank protection of about 100 m).
- Repair the specific points where the freeboard of the canal has disappeared due to the ravages of livestock at upstream and downstream structures in particular, separation of drains in the rear of OA principal canal (construction of box culvert).

Repair of the canal embankment is necessary where the illegal water is taken mainly by the pipes plunged into the canal, and that is dangerous. No area satisfied necessary free board of the embankment planned at the beginning of the construction time. The principal canal and primary canal are large-scale canals and have many high embankments which are in dangerous conditions. The

important matter is that most of the areas of the canals have dramatically insufficient free board even for 20% of planning flow because of the invasion of typha.

- There are plans to expand the irrigated area from 1,950 ha to 3,600 ha in the future, which is not easy to achieve with the earthen canal.

The Study team decided that the reinforcement concrete lining of the principal canal (scenario 2) is the most appropriate in terms of sustainability

(3) Measurement

Since final drawing is lacking for the existing canals, the work should be done based on the plans which are collected during the Study, and the topographical measurements made by the consultant of APD1. But, OA measurements were not made, and mostly cross-sectional measurements of every few hundred meters were made, which do not meet the design standards for this work. Therefore, it was remeasured in this Study and reflected in consideration. The final drawing is very important to design rehabilitation. Continuous efforts on collecting the final drawing is expected on SONADER.

3.7 Operation and Maintenance and Water Management of Irrigation and Drainage Facilities

3.7.1 Existing Conditions of Operation and Maintenance

Regarding maintenance and management of irrigation facility, in case of small scale and medium scale (less than 200 ha) irrigation projects, the farmers are responsible for operating and managing the facilities. In case of large scale project of over 200 ha, operation and maintenance of terminal facility is responsible for the farmers' groups and SONADER is for basic facility. In fact, in Lexeiba where small scale irrigation areas are accumulating, the irrigation facility is managed by farmers autonomously and in PPG where is big scale irrigation area, it is managed appropriately supported by engineers of SONADER. Except, in Foum Gleita, maintenance and management of basic facility by SONADER and terminal facility by farmers are insufficient. The crop acreage are decreasing up to one fifth by declining in function.

The farmers pay a fixed fee of 16,500 UM/ha/year and manage together with SONADER who used to manage the basic facility maintenance. However, from the late 1980s, not an exception of the structure readjustment, the ability of operation and maintenance of SONADER diminished dramatically by budget cuts and shrinkage of the organization. In the mid of 1990, since SONADER could no longer manage facility, fixed fees have been collected as a reserve fund of cooperatives. The government provides support for the large scale strengthening of facilities and repair. The situation of maintenance in each area is detailed below.

Table 3.7.1 Maintenance Situation in Each Irrigated Area

Area	Maintenance Situation
PPG I	Initially the farmers paid a fee of 16,500 UM / ha / year of which 10,000 UM were paid to union, the rest was used to provide labors. Repair of the main structures are done with the hired labors. The two operators are permanent employees to maintain the pumps with the help of engineers and technicians of SONADER. Since the site opened in 1975, only the embankment was repaired, but from 2009, a part of the rehabilitation is provided with OMVS in Programme de Gestion Intégré de l'Agriculture Irriguée en Mauritainie (PGIRE).
PPG II	Farmers paid a fixed fee of 16,500 UM/ha/year to the union. The regular maintenance and repairs of the main structures are done with the hired labor. A pump technician is a permanent employee to maintain the pumps with the help engineers and technicians of SONADER. The embankment was repaired in 2008 which was damaged by the flood of 2007. Except that, since the project area was opened in 1997, no special rehabilitation has been made.
Lexeiba	Between 1993 and 1996, the farmers paid a maintenance fee of 3,000 UM/ha/year to SONADER, but currently the cooperative members operate and mainten the structures by themselves, and some cooperatives established fund assessment system. Since the facility was constructed by them, the minimum function has been maintained. The pumps are evacuated during the floods. Applications from many irrigated areas have been sent to PDIAIM rehabilitation project (70% - government, 20% - long-term loan and 10% - the expense of farmers) 10 years ago, but only one was fulfilled the requirement and selected.
Foum Gleita	When the facilities of Foum Gleita were completed, SONADER's position was weakened because of restrucuturing, and hence, the operating and maintenance system have been at a very low level. Until the early 1990, the farmers used to pay 16,500 UM/ha/year to SONADER, but then the charge was reduced and the share of labor charge increased. Until 1999, the management fees were provided, but in 2000, after the extensive damage and loss of crops, the government exempted the farmers from this charge and therefore the money has no longer been collected. Until 2002, SONADER made rounds to inspect the facilities, but after the loss of the vehicle, they were interrupted. Currently, the farmers groups are involved in the management of the canals at the downstream of the network, and the primary canals are supported by the labors hired by SONADER within its budget, which simply cut the grass or repair the earthern canals. Only in case of massive damage, the government conducts emergency treatment, but it is not fast enough and gives enormous impact on harvest. From the workshop, it was found that level of possible maintenance for farmers are grass cutting until the primary canal and dredging until tertiary canal. The dam facility is assigned to SONADER, but in fact, it has only one engineer in Foum Gleita with no vehicle and almost no budget and the access is difficult in rainy season. The engineer strives for the minimum functions of superannuated facilities, but it is far from proper maintenance and operating system of the dam and its facilities.

3.7.2 Existing Conditions of Water Management

The main water resource of Gorgol basin is Foum Gleita dam on black Gorgol river. Foum Gleita irrigated area takes water directly from the reservoir, while the water of black Gorgol river is pumped in Lexeiba and PPG at the downstream side. SONADER manages the flow of the dam and the intake water in each area. There is no rule of operation but when the water run short in the downstream side, water use more water is released from the dam in consideration of water use efficiency.

The situation of water management in each area is shown below.

Table 3.7.2 Water Management Situation

Area	Water Management Situation
PPG I	According to an irrigation plan, the water supply is managed by the vice president of the union for the entire area. In each cooperative, there is an irrigation manager named 'Aigadie' to manage the distribution of irrigation water.
PPG II	The water management is supervised by a SONADER engineer for the entire project area. In each cooperative, there there is an irrigation manager named 'Aigadie' to manage the distribution of irrigation water.
Lexeiba	In principle, there is a cooperative and a set of pumps for an irrigation area and each cooperative plans its program of intake and distribution of water independently.
Foum Gleita	Until 2000, SONADER operated the sluice operation based on the request of the farmers until the tertiary canal, but since then, as there was no vehicle, SONADER had to limit the management of intake water from the dam. To improve the situation, SONADER has trained water police who are in charge for distribution of water and was hired by farmers group on each secondary canal. The water police was selected and trained by SONADER. This system was abandoned as farmers' groups refused to pay the charge to them. The damages in P1 and P2 prevented the normal flow of water that is narrowed down to 1.2 m3 /s. Nothing is done by the union or the cooperatives, and there are not even rotations at the primary canal. Yet, the farmers recognize the importance of management when the functions of facility are restored, and they plan to comply with appropriate irrigation plan.

3.8 Basic Rural Infrastructure Facilities

3.8.1 Rural road

There is a paved road with a traveling distance of 400 km linking from the capital Nouakchott to the city Kaedi, located in south-eastern part of the country and the center of the Study.

Table 3.8.1 Distance from Capital to Field Areas

Zone	Distance
Nouakchott ~Boutilimit	101 Km（National Road N.3）
～Aleg	108 km（National Road N.3）
～Along Senegal river Bogue	70 km（Arterial road）
～Kaedi	105 km（Arterial road）
Total	384 km

Between Kaedi and Foum Gleita, the road is under construction between Kaedi M'bout. At a distance of 80 km east from Kaedi, it is bifurcated at Siliwa, and Base-vie, the center of the project area is located at about 15km distance from Siliwa.

(1) Kaedi - M'bout Road

For the purpose of increasing agricultural potential and regional development, "Projet de Construction de la Route KAÉDI- M'BOUT- SELIBABY- GOURAYA the road Kaedi – M'bout – Selibaby – Gouraya" was started, and the details of the project are mentioned below.

- EU Contribution : 66.6 million Euro (26 billion UM)
- Inauguration of works : 9/02/2007
- Implementation period : 52 months
- Implementation agency : Ministry of Transportation (Infrastructure, Transport and Mines)
- Project scale : New construction of 1,000 km route, 2,800 km of National road network rehabilitation

The construction contract for the road-Kaedi M'bout was signed in July, 2006 for a duration of two and half years. The details of the works are mentioned below.

- New construction and paving of a two-lane road	Approximately 100km
- Drainage culvert	126 locations (Ferroconcrete)
- Causeway in rainy season	26 places (Ferroconcrete)
- Bridges	6 locations (Ferroconcrete)

Work was delayed slightly in June, 2010. However, the road was made almost on the entire section, paving was completed for about 10km and more than 90% of concrete work was completed. The road can not be completed before rainy season in 2010, but when the construction will be completed, it will take only 1 hour from Kaedi to Foum Gleita. (It takes about 4 hours to reach from Kaedi to Foum Gleita during the rainy season instead of 1 hour and 50 minutes in the dry season).

On the road between Kaedi and M'bout, there is a road line connecting Foum Gleita dam – Base-vie - Kob El Lyemani for a distance of 25km. A part of basic construction is started. It shall take 2-3 years to complete this road.

In summary, the road works between Kaedi to M'bout, and Foum Gleita to Kob El Lyemani need not be considered in the components of the project plan.

(2) Distance Between Siliwa-Base Vie

The shortest way to travel between Kaedi to Base-vie is to bifurcate from the main road to local rod at 85 km from Kaedi at Siliwa. The local road goes up to 15 km to reach Base-vie. This road easy to travel in dry season with a 4x4 vehicle. However, one of four ferry crossings in black Gorgol is submerged during the rainy season with a 50m width. It sometimes take 2-3 days at this point for draining of water. It is necessary to solve this problem of crossing the river in order to revive the agricultural economy of the region throughout the year. Therefore, the local residents request for constructing of bridge. However, if the road FG dam - Kob El Lyemani mentioned above is improved,

it can become the main access road to reach to FG.

3.8.2 Rural water supply

(1) Outline

Although there is no water supply facility which covers whole Foum Gleita, there are 5 foot pump wells D'Dakahla (1 place), El Whida (2 places) and El Adala where is close to downstream of P1 primary canal (2 places), are using foot pump wells from the beginning of development. In the center Base vie, the water supply network in the center Base vie was established with irrigation water in the nearby primary canal by ANEPA (Agence Nationale d'Eau Potable et d'Assainissement). including a pump station, water facility and water supply tower, but after 2009, the maintenance has not been made continuously because of facility trouble. In regard to water supply for the villages around the irrigated area, a Chinese study team planned for water supply reusing groundwater which was just below the dam outflow, and also used for the dam construction as the water resource. In 1996, a project was initiated by SONADER, However, because of the contractual trouble, the construction stopped.

Almost all the farmers in the irrigated area rely on irrigation canals for their living needs. However, turbidity level (less than 5NTU) and opacity (342 NTU) of the water is beyond the WHO standards, which is quite detrimental to health. Even though the farmers in the area are facing the problem of drinking water, they accept the low quality water. In this regard, the following observations were made.

- The villagers make efforts to access to a better quality water by digging the dried river beds
- The visitors from Nouakchott cannot drink water from canals, and they usually draw the water from distant wells.

As mentioned above, residents make lots of efforts to obtain drinking water supply. Since the demand of rural water supply facility is very high, it was discussed in this section.

(2) Proposed Villages for Water Supply Area

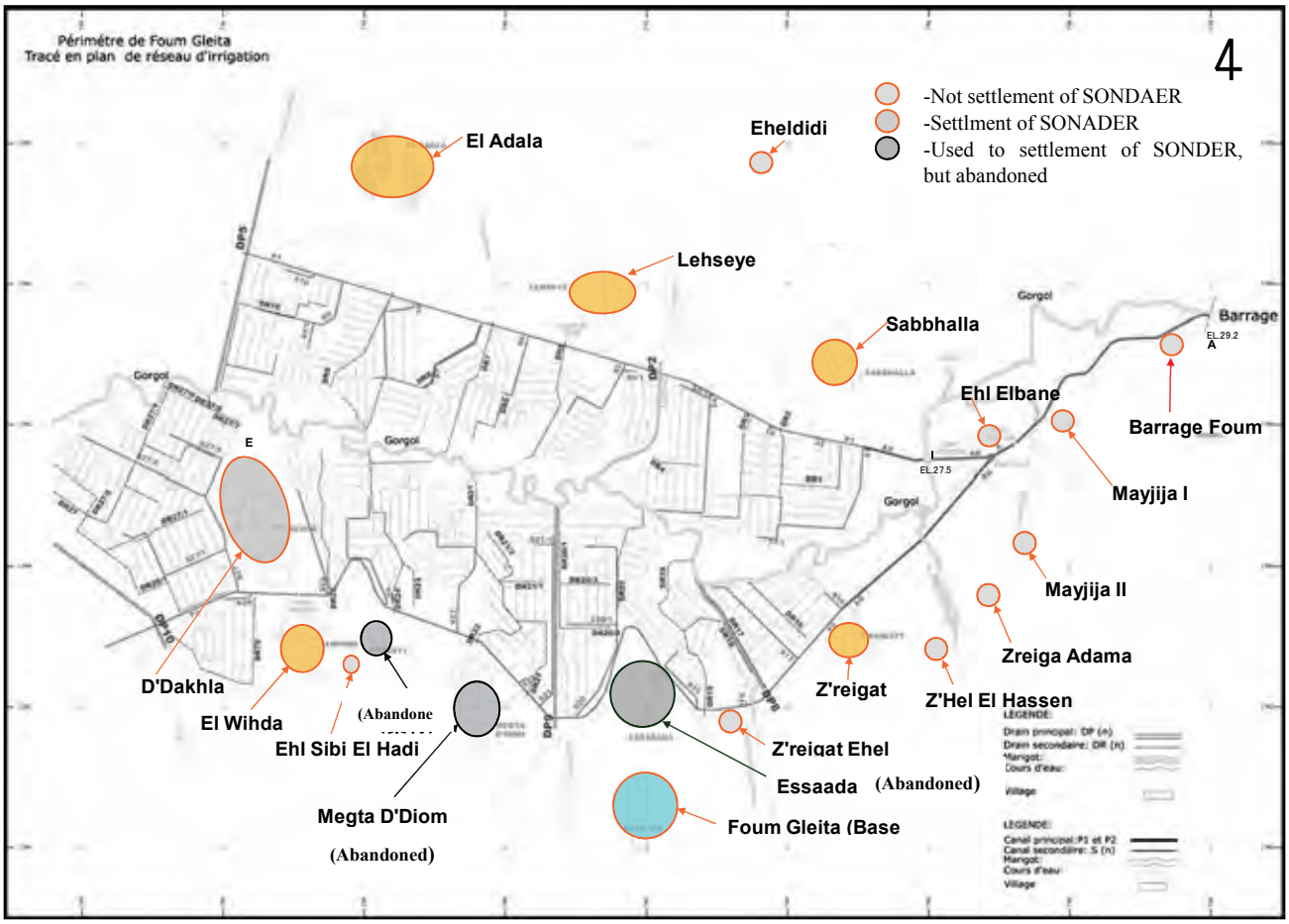


Figure 3.8.1 Villages in the Study Area

The villages in the Study area are shown in Figure 3.8.1. The villages of Foum Gleita project irrigated area consist of the settlements set up by SONADER which are created for the irrigated area, not settlements but village where the farmers have a right to cultivate, and Bas vie in the center of irrigation area with SONADER office. Most of the inhabitants of Bas vie have a right to cultivate in the irrigated area.

The irrigated agriculture began in 1984 on an area of 550 ha as Stage I, and additionally 1400 ha was started in 1989 as Stage II. In consideration of easy operation of farm management and irrigation activities, SONADER created 9 settlements that can accommodate 500 to 600 families along the canals and the farmers were settled in these areas. El Whida, D'Dkhla and El Adala were established in Stage I. They were provided with wells, schools, clinics and markets, and today they are better organized than most of the other villages. In stage II, Aravatt, Megta D'Diom, Essaada, Z'reigat, Sabbhalla, and Lehseye were created, but virtually no infrastructure was provided.

In course of decrease of irrigated agriculture, these settlements were also abandoned. According to the survey by SONADER in 1993, there were no resident in both the villages of Aravatt

and Essaada. Presently, the village Megta D'Diom disappeared, but seven villages not listed in 1993 have resurfaced, and five of them are located along the canals. The inhabitants of these villages have the rights to cultivate in the irrigated area.

(3) Socioeconomic Conditions

a) Number of Households, Household Structure, and Population

The following table shows the number of households in each village, members of household on average, and estimated village population. (See ANNEX 15 Results of study in each village)

Table 3.8.2 Number of Households and Estimated Population in the Study Area

Area	Number of Households	Number of Households according to the Survey	Number of Members in the Household on an average	Estimated population	Foum Gleita (2007)		
					Household	Population	Members in household
Settlement total	16	1,035	9.3	9,645	921	6,046	6.6
Study area total	31	2,171	11.7	25,409	-	-	-

The table shows that the number of households is only 2,000 at the maximum and 1,000 households on the settlement area. It is difficult to quantify the number of houses because the farmers live in compound, houses made of several houses, and some of the Poular group are reluctant to tell on number of people in their family and identification exists only from 18 years old. Comparing the data of Foum Gleita commune of 2007 and data of this time, there is a big difference in the number of people in a household, and therefore the figures of estimated population shall be used only as a reference.

b) Livestock

All the interviewees 31 households are breeding cow, donkey, sheep and goat and they are using irrigation canal or water from Gorgol river, and hence there is no need to consider the livestock population in the planning of water supply facilities.

c) Estimated Number of Households and Cultivated Area

Acoording to SONADER, the farmers in Foum Gleita received the cultivation right for 0.5 ha equally, irrespective of the number of couples in one farm household even in the case of large families having several couples. However, some of exceptions are also found in this Study. In addition, there are farmers who manage the farm lands for which the rights were borrowed from the families who have abandoned the farming. Some farmers claimed that they owned most of the area before the rehabilitation. So, even if the farmers who left the area, return back after the rehabilitation of the network, it will be difficult to estimate the number of households in each area from the area of irrigated plots.

d) Job Opportunity Outside the Area

Nearly 70% of the households have family members who went for work outside the area. They mainly went to Nouakchott, Nouadhibou and Selibaby. Some households complain that there are no jobs for younger people, and hence the migration to cities would continue. It is also another cause of the difficulty of counting the number of members per each household.

e) Basic Infrastructure (Public Facilities)

The survey of the basic infrastructure facilities focused on the wells, schools, clinics and mosques. There are five wells. There are schools and mosque in the settlement except the abandoned village and Aravatt, but the capacity of the schools is very low. Although there are two clinics with doctors, there is no health facility in north of Gorgol river which is difficult to access. The villages other than the settlements have almost no basic infrastructure. (See ANNEX 15 Infrastructure in each village).

f) Major Problems Encountered in Daily Life

The top five difficulties of villagers in daily life are mentioned below.

Table 3.8.3 Major Problems of the Residents

Category	Point	Details
Drinking water	(28)	Except in El Wihda which has wells, all the villagers have placed the issue of drinking water as the highest priority. However, the reliability of responses is not so high, because the respondents know the fact that this survey involved the construction of a water supply system.
Healthcare	21	Poor medical facilities (19)、poor health care for pregnant women, and many mosquitoes
Education	17	Lack of school facilities (15)、low level of education (2)
Farm management	15	Damage by birds and livestock (8), lack of agricultural inputs (3), shortage of land (2), equipment for post-harvest processing, and sale of agricultural products
Irrigation facility	13	Lack of water (8), superannuation of facilities (2), inappropriate use, unmanaged drainage, insufficient protection of farmlands.

Note) 31 respondents providing multiple responses

According to the household survey, the villagers need more basic infrastructure such as health facilities or schools.

g) Diseases

Hearing survey was conducted to know the disease conditions. As a result of the interview, many symptoms were reported such as diarrhea and eye disease, which seemed to be related to water quality. It is indicated that it is crucial to improve water and sanitation conditions in the Study area (See ANNEX15 Disease suspected the relation with symptoms).

Table 3.8.4 Results of the Hearing Survey on Diseases

Symptom	Number of Answers
Diarrhea	29
Eye disease	24
Fever	28
Blood urine	19
Digestive disorders	15
Skin diseases	27

Note) Multiple answers of 31 persons
Source : JICA StudySource : This study

h) Infrastructure (domestic water use)

In order to recognize water reserve and use of water by the residents, hearing survey was conducted on current water resource, time required for fetching water, and purpose & quantity of water use. The results are shown below.

<Water Source>

The villagers normally use the water from wells, irrigation canals, Gorgol river, tank car by AWSA, and dry wadis (stream bed). Irrigation canals are the main water source, and Gorgol river becomes the supplemental source. Wells become the main source of supply in the villages with wells, but it costs 5UM/20L. Since fetching water takes time, laundry is done with canals water.

Table3.8.5 Water Resource of Domestic Water

Source	Number of Households
Canals	30
Wells	13
Gorgol river	23
Wadis(rainy season only)	2
Tank car by ANEPA	5

Note) 31 respondents;
Source: JICA Study

As shown in the table, all the villagers took water from the irrigation canals. Eventhough there are some alternative resources, the irrigation canals become vital resource for the residents. Therefore, it is necessary to reach an agreement with the villagers to cut off the water for repairs or maintenance of canals. It is necessary to act with caution and inform them properly (About one week before this survey, sending water was stopped for the measurement. There was no complaining from the local farmers because the stoppage of water was informed in advance through SONADER to farmers.

<Amount of Collected Water and Transport>

The amount of water per person in average was calculated as 33L by dividing the value of the number of 20L water tanks used for collecting water at once and the number of times of collecting water per day.（See ANNEX 14 frequency distribution of 10L/day/person）. Water use is described in the following section. Since irrigation canal which could be available throughout the year exists

nearby, lots of amount of water are used for laundry, bath, livestock and watering kitchen garden. These are common especially in the majority of households (6 out of 9) who use more than 50 L. Mostly, women and children are in charge for collecting water and donkeys are used for transport.

<Water use>

The water transported from canals is used preferentially for drinking, cooking, washing dishes, while the washing, bathing and livestock water are done directly at the canals. Even if a supply facility is installed, it is prospected the water for laundry, bathing and livestock continued to be relied on the canals.

(4) Problems and Considerations of Rural Water Supply Plan

In Foum Gleita, the water supply facilities are essential for farmers who are engaged in farm management for sustainable living in the rural society. However, when the development plan is made, it should be concerned of the problems and considerations as mentioned below.

- The residents to be resettled are basically the former residents, and their intention to relocate is strong. However, the concrete plan for resettlement such as the village and the number of farmers who will return is not yet prepared. Many issues are still not yet clear including the consistency of the villages which have already been installed. The resettlement plan should be prepared before the rehabilitation, but it is anticipated that there would be inappropriate cases to the villages in the area, and in extreme cases, it is assumed that there will be no returning to the village at all.

- During the interview with farmers who have left the village, it was found that they will work on the rehabilitated area, but many farmers choose to return only during the agricultural season. For example in Base-vie, which is near the irrigated area and have less mosquito problem, the farmers farmers would mostly be engaged in farm management work without being displaced from the accustomed living conditions.

- It would take several years even after rehabilitation in order to achieve the full production capacity and stable villages after resettlement. In order to prepare and maintain an efficient water supply system, it is necessary to consider the stage when the formation of villages is stabilized.

- The Ministry of Water Resource and Planning is responsible for planning and to carry out water supply work in the rural areas targeting Gorgol region including the irrigated area using the water resource from Foum Gleita dam (Study of Drinking Water Supply of Aftout El Charghi Region from the Foum Gleita Dam[1)]). In the hearing survey with Department of Hydraulics & Dams, it was understood that decision was made to supply water quickly to the villages with high-priority residents along the canal P2 such as Base vie and Bachatt. The villages along the

primary canal P1 is also part of this plan.

[1] Study of Drinking Water Supply of Aftout El Charghi Region from the Foum Gleita Dam

The region of Afout El Charghi (Gorgol, Assaba and Tagant) suffered drought during the past 30 years resulting in decrease of ground water level. In this region, lack of many basic infrastructure facilities concerning water supply, education, health, transportation and agriculture have led the population to inefficient and unsustainable circumstance causing severe problematic decrease of agricultural products and activity of regional local life. To improve such local life standard and to cope up with poverty, a project for drinking facilities as one of the important basic infrastructures was prepared recently for the development of this region. The project will target on more than 500 villages with 110,000 habitants (2000 Statistics) and have about 600km of principal water lines consisting of three (3) divisions at the south, west and eastern part of the Foum Gleita dam.

The areas including Base Vie, Bassat etc. of Foum Gleita area along the P2 principal canal which have rather a dense population in the southern area are considered to be the high priority area. The design and tendering for the southern area are planned to be carried out in 2010 by the Mauritanian Government (responsibility of Ministry of Hydrology and Development). The villages along the P1 principal canal in the Foum Gleita Project belong to the western area where the procedure for tendering is considered to be taken basically in parallel with the other areas. The project budget will be supported by the Bank of Islamic nations in the Middle East and the amount of US$ 60Million within the total project cost of US$ 80 Million is already agreed to be funded by the supporting agency according to an article of the news paper dated the beginning March 2010.

3.9 Environmental Considerations

3.9.1 Outline

This Study was conducted as a part of the irrigation program in the Gorgol river basin called as PDIAIM program which is supported by the World Bank. The components proposed in the report of PDIAIM program are as follows.

1. Rehabilitation of principal canal (concrete lining)	Approx. 8 km
2. Rehabilitation of primary canal, (earthern canal)	20 km
3. Rehabilitation of secondary canals and tertiary canals (earthern canal)	30 km
4. Rehabilitation of drains (earthern canal)	30 km
5. Removal of bushes and reclamation of farm lands	500 ha
6. Rehabilitation of farm roads	27 km
7. New installation of maintenance office	1 set
8. New installation of multipurpose sheds	40 locations

In addition to these components, it was planned in PDIAM to include two farm roads, five

bridges crossing the canals, watering places for livestock, and laundry places in Gorgol river. At the present situation of the Study, consideration is made on the rehabilitation of principal canal, primary canal and secondary canals (removal of sediments in drainage canals and rehabilitation of dikes).

3.9.2 Environmental Society Consideration Regulations in Mauritania

(1) Environmental Supervisory Authority of Mauritania

The Ministry of Environment is responsible for the environmental considerations of the country. Until 2007, it functioned as an Environmental Directorate under the Ministry of Rural Development and Environment. Currently, it is an independent ministry under the direct control of the Prime Minister, and oversees the environmental issues.

(2) Environmental Society Consideration Laws

In Mauritania, the environmental society consideration law consists of 10 regulations, which are included in the constitution of July 20, 1991. Main regulations are below.

- Environmental Law - No.2000－045, July 26,2000 proclaimed
- General Administrative Agency of the Cabinet on environmental impact studies No.2004-094, November 4, 2004 - Cabinet approval
- Amendment of General Administrative Agency of the Cabinet No.2007-105, March 14, 2007 - Cabinet approved

The environmental law was enacted to promote harmony between the socioeconomic development and the environment, with the aim of environmental conservation. The first section of the Act defines the guidelines of government policy, as mentioned below:

- Protection of biodiversity and sustainable use of natural resources
- Control of desertification
- Control of pollution
- Improvement and protection of living conditions
- Harmonization of development and environmental conservation

The Chapter 2 of the Act states that environmental society consideration supervisory authority responsible for environmental issues is the Department of the Environment, under the responsibility of the Prime Minister (separated from the Ministry of Agriculture, Pasturage and Environment in August 2006), and formulates the environmental management system and funds through environmental impact studies. The Chapter 3 describes the nature and the resources to be protected including fauna and flora, soils, forests and protection areas, oceans, water and air. The Chapter 4 explains the formalities such as environmental impact studies and elements of protection: waste, hazardous materials from the sea, noise and vibration, smell and dust, landscape and ruins. Chapter 6 explains the penalities for

environmental violations.

The general administrative agency of the prime minister's office on environmental impact studies and amendment formulates the definitions of Section 2 and environmental categories in Section 4, and the existing environmental impact studies in categories A. The studies are simplified for category B of development actions with a comparatively low environmental burden. The other article defines the screening criteria, the contents of studies and the supervision procedures.

(3) Screening Criteria

The screening criteria include 18 items: water (dams, drinking water, irrigation drainage, river structure), groundwater and waste, forests and wildlife, fisheries, agriculture, livestock, mining, industry, energy and oil, public works, town planning, health, crafts, prison, land management, national defense, youth and sport, tourism and hotels, and these development activities and facilities are classified in category A/ B (See Table 1 Environment).

Screening of irrigation and drainage activities are classified in category A for development of more than 200ha and category B for less than 200ha. Screening of agricultural activities concerns cotton cultivation, agricultural processing & storage, irrigation and rainfed irrigation.

(4) Environmental Screening Procedure and Environmental Outline

The verification process for environmental and social consideration including Environmental Impact Assessment (EIA) is carried out based on the Decree and Amendment of General Administrative Agency of the Cabinet, and the outline is shown in ANNEX 5. The Amendment stipulates preparation and approval of TOR (terms of reference) for EIA and environmental notice, public hearing, announcement on news papers, etc. which require at least 3 months.

(5) Actual Operations

The director for control of MOE and the interim director for the study and work, SONADER agreed on Sept. 2, 2010 that the rehabilitation of Foum Gleita irrigation will be applied by simplified environmental notice because the works mainly consists of the retrieval of the existing facilities to the original condition completed in 1984-89. This meeting decided also that preparation and approval of TOR, public hearing, announcement on news paper, summary of the environmental notice, etc. are not required. The verification procedure needs as soon as about 2 weeks.

3.9.3 Initial Environment Examination

In this Study, there are three main activities including 1. improvement of farm management program, 2. participatory water management program and 3. rehabilitation program of irrigation and drainage facilities. If these activities are implemented, it is expected that the rural farmers will improve their living standard by increasing agricultural income and rural economy will be activated.

Therefore, the impacts expected from these activities in both the natural and social environment were clarified by Initial Environmental Examination (IEE). The result of IEE and situation of environment in this area are shown in ANNEX 5. Through the review of With & Without the project, it was clarified that "in the case of not implementing the project", the poverty of farmers will become more serious, and "in the case of implementing the project", the poverty can be reduced dramatically. Besides, since the objective of rehabilitation of irrigation and drainage facilities is to recover functions of the existing facilities, no negative impact is expected on environment such as land acquisition or forced relocation of farmers. Besides, the smaller small impacts such as pollution during works or accident could be reduced or lessened, and monitoring of environmental activities should be carried out.

Table 3.9.1 Summary of IEE Results

Potential Impact		Without Project/Program	With Project/Program
Social Environment			
1	Involuntary Resettlement	∗	∗
2	Local economy (employment, livelihood, etc)	--/B	++/B
3	Land use and utilization of local resources	--/B	++/B, --/C
4	Social institutions (social infrastructure & local decision-making institution)	∗	++/B
5	Existing social infrastructures and services	--/C	++/C
6	The poor, indigenous and ethnic people	--/B	++/B
7	Misdistribution of benefit and damage	--/C	++/B
8	Cultural heritage	∗	∗
9	Local conflict of interests	--/C	++/B
10	Water Usage or water rights and communal rights	--/B	++/B, --/C
11	Sanitation	∗	++/C
12	Hazards (Risk), Infectious diseases as HIV/AIDS	--/C	=/C
Natural Environment			
13	Topography & Geographical features	∗	∗
14	Soil Erosion	∗	++/B
15	Groundwater	∗	++/C
16	Hydrological Situation	∗	∗
17	Coastal Zone	∗	∗
18	Flora, Fauna and Biodiversity	∗	∗
19	Meteorology	∗	∗
20	Landscape	∗	∗
21	Global Warming	∗	∗
Pollution			
22	Air Pollution	∗	∗
23	Water Pollution	∗	--/C
24	Soil Contamination	∗	--/C
25	Waste	∗	--/C
26	Noise and Vibration	∗	∗
27	Ground Subsidence	∗	∗
28	Offensive Odor	∗	∗
29	Bottom sediment	∗	∗
30	Accidents	∗	--/C

Remarks: Left side; ++: Positive impact --: Negative Impact =: Neutral Impact
Right side; **A**: relatively significant impact, **B**: relatively medium-size impact, **C**: relatively small impact, **D**: unknown as of now,
∗: No impact or no corresponding impact
No comments means 'not applicable'

The table shown above indicates that the implementation of this Project/Program will be positive if the negative impacts can be lessened or mitigated.

CHAPTER 4 VERIFICATION TRIALS

4.1 Objectives of the Verification Trials

The pilot projects were carried out aiming to formulate the specific policies on sustainable management and maintenance of the irrigated area after the rehabilitation works. From the analysis of various problems, it was found that the priorities were "to adjust the functions of the irrigation system" to recover irrigation area, "to improve the production techniques" to increase productivity and "to adjust the management of farmers groups".

If the maintenance is not carried properly, all the effects of rehabilitations will be lost, and hence priority was given to the improvement of functions of the irrigation system to retrieve the irrigated area. The results of this study will have an impact on the plan of Grant Aid Project. Besides, priority is given to improve production techniques in order to increase productivity, since the existing farm management techniques provide low productivity. Finally, proper functioning of the administration farmers group is placed as high priority, since it is necessary to strengthen the activities of the farmers groups who are not currently active.

4.2 Outline of the Verification Trials

The main components undertaken in the verification trials are 1. adjustment of the functions of the irrigation facilities, 2. improvement of the production techniques, and 3. improvement of the management of farmers groups. The summary of details of the activities is listed below.

Table 4.2.1 Summary of the Verification Trials

Item		Details
Summary of the Study		
	General objective	Manage sustainable irrigated agriculture in Foum Gleita project area
	Specific objective	Verify management conditions for sustainable irrigated agriculture in Foum Gleita project area.
	Achievement	1. Verify the ability of farmers' group on appropriate management of irrigation facilities except the major facilities (dam, principal canal, and primary canal) 2. Verify the possibility of sustainable farm management system 3. Verify the level of organization ability of farmers' group to ensure the sustainability of irrigated agriculture
	Activities	1.1 To increase the stability and water flow in the canal by sandbags. 1.2 To prevent invasion of livestock in the canal. 1.3 To clean sand deposits in the canal 1.4 To remove typha in the canal 1.5 To collect water charges 1.6 To formulate appropriate operation and maintenance plan 1.7 To improve the management support system of SONADER 2.1 To implement extension activities in the demonstration plots

Item	Details
	2.2 To visit advanced sites by the farmers 3.1 To strengthen the support for organization management of SONADER 3.2 To train the leaders of farmers 3.3 To strengthen organization of Union

The implementation sites of each activity are listed below.

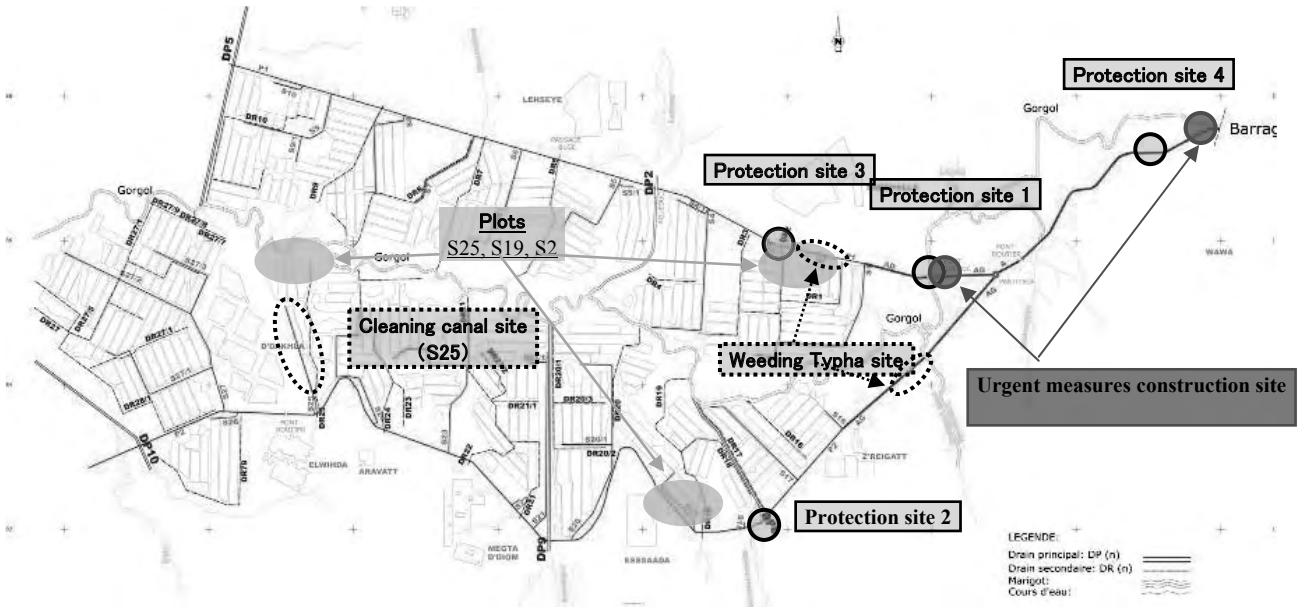


Figure 4.2.1 Verification Trial Sites（Including Urgent Measures Construction Site）

The progress of activities of the verification trial is shown in the figure. Regarding participatory irrigation facilities management, the implementation was delayed, because the timing of dredging of canals and cutting typha were changed to match the timing of cropping season. The restart of collecting water charges was not implemented even though SONADER and farmers' groups held discussion on this matter. Regarding farm management trials at the verification plots, although the rice production was delayed, it was damaged by livestock in the plot P1 and vegetables and fruit trees were flooded in the plot P2 during the rainy season, and finally resulted in corresponding damages. In regard to the strengthening of farmers groups, the revival of union (UCAF) was started in December 2009, and electing a new union is now under discussion in June 2010. The progress on each component is summarized below.

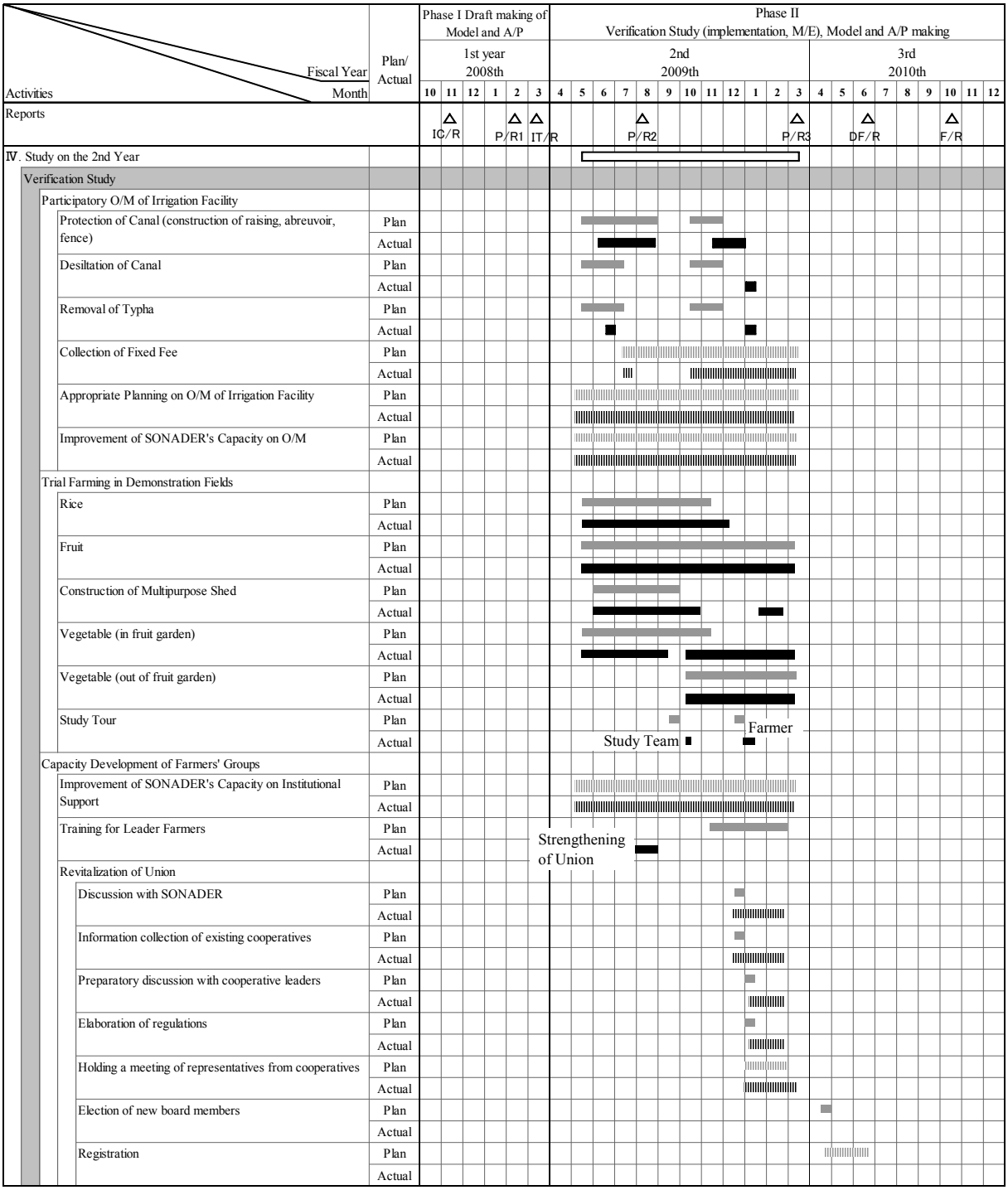


Figure 4.2.2 Schedule of Operation of Verification Trials

4.3 Outline of Results of the Study

Results of the Study are mentioned in the next chapter, and the outline of the results of verification trial is summarized in the table shown below.

Table 4.3.1 Outline of Results of Verification Trial

Activity	Results	Apply for A/P
1. Participatory Management of Irrigation and Drainage Facilities	Although there was a prospective achievement for a part of the individual techniques, it could not be verified as a system because of the limitation on time and condition. If the environment is supportive enough, it is possible that the farmers' groups could operate and maintain the irrigation facilities except the basic facilities (dam, principal canal and primary canal) appropriately.	Under the right conditions such as recovering of functions of irrigation facilities, revitalization of organization and restarting of cultivation, it is necessary to strengthen the capability of SONADER and the union in terms of operation and maintenance.
1.1 Strengthening of canals by sandbags	The local materials and techniques were utilized, and therefore, it was understood that the farmers could construct canals with the guidance of local engineers. Regarding the effect of the trials, the livestock drank water in the drinking water troughs, and was prevented from invading the canal. The embankment of the canal could be strengthened by the sandbags. Also, it was seen that the farmers volunteered to repair canal using sandbags. It means that if suitable materials such as sand bags and necessary equipment are available, the farmers will do the operation and maintenance by themselves.	It is necessary to provide the farmers about the details of the way of operation and maintenance and to construct the system of irrigation facilities for independent operation and maintenance. In this time, the trials were made only in a small area. To prevent the invasion of livestock in a wider area, it is important to build consensus of the livestock breeders and fencing of the entire area should be done by rehabilitation work.
1.2 Protection against invasion of livestock		
1.3 Removing of accumulated sands in the canals	It was verified that the farmers could do weeding and dredging at the secondary canal level. Farmers realized the increase of amount of passing water and continued to work on voluntary basis. In order to improve the work efficiency, emptying of the canal is necessary. However, systematic implementation is needed in consideration with the cropping period.	Strengthening of capacity of farmers' cooperatives is needed to plan canal cleaning and to prepare a suitable implementation system.
1.4 Clearing of typha in the canals	At the primary canal level, it was verified that the typha could be removed in both dry and in water conditions. Typha grows stronger and needs to be removed twice in a year. The water management during the typha cutting period is important, because the growth can be restricted by keeping the remaining part of typha under water.	In the O&M of beneficiaries, it is necessary to include typha removal at least once a year, or if possible, twice a year, dropping of canal water, supply of water, and right time of implementation. It is necessary to make efforts on utilizing typha.
1.5 Collection of water charge	Even though the farmers admitted the necessity of collection of water charge, it was found out that the organizational aspect needs to be improved, because UCAF is not working and SONADER is not trusted by the farmers.	Recovery of trust of SONADER and revitalization of UCAF is necessary. Besides, it is necessary to explain the farmers and to build a transparent accounting system for collecting and utilizing water charge.
1.6 Formulation of appropriate operation and maintenance plan	The water charges were not collected, cropping area was only one fifth of the total area, and the organization is not functional. It was clarified that the operation and maintenance condition was not right, and was found out that O&M system was totally absent in the project area.	It is necessary to formulate and implement appropriate operation and maintenance plan at the right time including recovery of function of irrigation facilities, revitalization of organization and restarting of agriculture cultivation.

1.7 Improving the support system of operation and maintenance by SONADER	As a result of instruction of OJT, it was verified that the staffs became actively involved, and they could instruct the farmers more efficiently on operation and maintenance. However, the limitation of transportation is the obstruction of efficient operation and maintenance for the entire area.	Ensuring the transportation of the staffs and more improvement of the ability are needed.
2. Extension Activities Based on Experimental Trials	The availability of recommended techniques to improve the yield of different crops was verified. Especially, there is a possibility for a great improvement in vegetable cultivation. Extension of these techniques will be needed in the future.	It is necessary to extend the cultivation techniques among farmers in the area. It is also important to strengthen extension structure of SONADER.
2.1 Implementation of extension activities based on experimental trials	**＜Rice＞**As a result of applying various recommended techniques while extending to the farmers, it was verified on the improvement of yield by optimum use of fertilizer, shortening of nursery period, and improvement of work efficiency by using farm machinery.	It is necessary to improve productivity with extension of various suggested techniques.
	＜Fruits Trees＞ It was confirmed that the fruits trees grow well with appropriate cultivation management. However, comparatively a high cost and labor input shall be required in the initial stage.	There is a potential in the medium and long term, and it is also expected to provide additional effects such as providing shade of tree which is valuable in the area and improvement of nutrition. Therefore, there is a possibility to introduce fruits trees in the area.
	＜Vegetables＞It was verified that the yield can be increased by 3-4 times by using the various suggested techniques. Mainly, it was a valuable income resource, and it was found out that more economic impact could be expected by the extension of techniques.	Extension of various recommended techniques shall be carried out, which shall improve the productivity and living conditions of the area. Strengthening of marketing is also expected.
	＜Multipurpose Shed＞It was verified that the multipurpose shed could be utilized by the farmers' meeting, rest, and storage; Onion was stored to delay the selling period in order to sell them at a high price.	Various diversified functions including marketing is expected. Maintenance of facility should be done properly.
2.2 Visiting advanced Area	FG farmers have very limited opportunity to visit the farms of other area. By verification trials, it was confirmed that positive exchange of opinions could be made, which is an efficient way to strengthen their knowledge and information.	It should be enforced for improvement of production techniques and to strengthen the ability of organization.
3. Strengthening of Farmers Organizations	Regarding strengthening of support system for SONADER and revitalization of UCAF, self-reliant operation could not be achieved because of time limitation. However, it was found out that there is a need to ensure the transportation of SONADER staff, and they should improve the relationship with the farmers.	Continuous improvement of ability of SONADER FG staffs and strengthening of office and organization of UCAF are expected.
3.1 Strengthening of SONADER	As a result of instruction of OJT, it was verified that staffs became active, and provided support for farmers' organization more efficiently. However, limited transportation is a major obstacle on efficient support for organization in entire area.	It is expected to ensure transportation of staffs and improve their ability.
3.2 Training of Farmers Leaders	It was verified that the organizational ability of leaders of 5 cooperatives who were engaged in the farm management of the verification trials was improved and their activities became more intensive.	Training of leaders of other cooperatives is needed in a similar way.

3.3 Strengthening of UCAF	Although the discussion of revitalization of UCAF was active, forming of a new organization could not be achieved. The main reasons were not only the time limitation, but also the deep-seated distrust of officers in UCAF and speculation of each group after reformation.	It is necessary that they achieve a self-reliant organization management and take time for discussion among the farmers for mutual understanding. Strengthening of UCAF shall be continued.

4.4 Participatory Management of Irrigation and Drainage Facilities

The irrigation facilities in Foum Gleita, especially the main canal needs to be rehabilitated immediately, since it is in a critical condition. It is essential that the farmers' groups are maintained properly and independently for the sustainable management in the short and medium term. Therefore, it is necessary to clarify if the management by famers groups is possible in the future after the rehabilitation. It is also important to clarify the responsibility clearly between the farmers groups and SONADER, and to apply this distinction to refine the rehabilitation works, as well.

In the first field Study, the major causes of obstruction to water supply of the irrigation facilities were identified as follows: 1.There is almost no allowance height in several places of the main channel; 2. livestock damaged dikes canals, 3. the canals are filled with sands, 4. Typha growth in the canals and preventing the water flow. In addition, the water charges were not paid in recent years, and no maintenance budget is available for the maintenance of facilities. The fiscal situation of SONADER was also severe, and hence the irrigation facilities have not been managed anymore and these factors caused the declining of functioning of irrigation facilities. In order to address these difficulties, seven activities were selected in this Study.

In the future, since each work will be operated with participatory approach by the farmers, they will manage them independently, and SONADER would support them. In this case, there won’t be any payment for farmers’ labor provision or there shall be a small incentive. In the verification trials, 2,000 UM/day was paid to labor in total, 1,000 UM is paid to them and rest 1,000 UM is reserved for future maintenance cost. If the water charges are well managed in the future, there shall be would be more freedom and will be easier to pay the wages as maintenance and operation cost to those farmers who participate to the work. Contents of each activity are listed below and the details are mentioned ANNEX 1.

Table 4.4.1 Details of Participatory Management of Irrigation and Drainage Facilities

Activity		Details	Notes
1.1 Strengthening of canals by sandbags		Elevation of the dikes with sandbags on the sides of the primary canal where the allowance height is insufficient (see details in ANNEX 1).	In principle, the activities 1.1 and 1.2 generate synergy on one site, and sandbags and barriers were installed after the construction of drinking water troughs. Apart from the four locations listed above, the following additional locations were been identified, such as downstream from SF7 (AG left bank), SP19 (P2 left bank), and S16 (P2 left bank).
1.2 Protection against invasion of livestock			
	Construction of watering troughs	To provide drinking water to livestock without invading the irrigation canal, and to observe the effects.	Reinforced concrete trough construction of 6 ~ 12 m (details in ANNEX 1). The construction was done by the farmers under the guidance of a local mechanic.
	Construction of fence	To prevent livestock from entering the irrigation area and observe the effects (Photos).	Mesh fence of 1.5 m high. Barbed wire was placed at the top, middle and bottom of the fence. Stakes were made of steel L-shape (2.5 m spacing) and a concrete pillar was placed in every 12.5 m. The base of the pillars was embedded in concrete. (Details ANNEX 1).
1.3 Removing of accumulated sand in Canals		Removing the sand was not done for a long time in secondary canals	Completed in January 2010 (ANNEX 1 details)
1.4 Clearing of typha in the canals		Clearing of typha in the primary canals during the drainage of primary canal and then observe the rate of recovery. The removal was done underwater after recovery of water levels.	The efficiency rate of both the methods was observed (details Appendix 1). [Dry cutting] drainage from June 25 and cut on 27 and 28 June Two methods were used: 1. Removal of root, 2. Cutting off a length of 50 m from the canal. [Cutting in water] In January 2010 during the irrigation period, cutting of typha was made under water.
1.5 Collection of water charge		Since the exemption by government in 2000 because of the flooding, water charges have not been levied which caused decline in functions of facility. Negotiations were started to call the collection of fees in place to ensure the maintenance costs.	Through discussions, it was found that the famers shall pay the water charge only after establishing a fund management and improvement of structure of SONADER and UCAF could be condition for paying the water charge. Therefore, strengthening of capacity of SONADER and UCAF was implemented. See details in [4.1.5Strengthening of farmer groups]
1.6 Planning of appropriate management and maintenance		Discussion to clarify the division of roles in the maintenance of the irrigation facility and identify a plan of management and maintenance	Particularly including each facility, role of operation and compensation of the labor, penalties, and distinguishing the areas.
1.7 Improving the support system of management and maintenance by SONADER		On the job training for the employees of SONADER during the verification trials (pilot projects) to strengthen management and maintenance support system.	Setting up the structure of management and maintenance that should exist after the rehabilitation, which are undertaken in order to provide appropriate service to farmer groups.

As the outline of results of the entire verification trials, if the suitable environment is achieved, it is possible that the farmers' groups can operate and maintain irrigation facilities except (dam, principal canal and primary canal) appropriately. The results of all these activities and proposals

are listed below. Under right conditions such as recovery of functions of irrigation facilities, revitalization of farmers' organization and restarting of cropping, it is necessary to strengthen the capability of SONADER and union in terms of operation and maintenance.

4.4.1 Activities for Protection of Canals (Sandbag, construction of water troughs for livestock, and fence)

(1) Results

The watering troughs for livestock were used at the sites and the fence was protecting the livestock from entering into the canals. The stacking of sandbags in the canals proved effective as an emergency measure, and it was observed that the farmers were occasionally using it on their own initiative to repair the canals.

Strengthening by Sandbags S3

Watering Trough for livestock with Many Foot prints of animals

Protective fence against the Invasion of Livestock

Poster to Prohibit the Invasion of Livestock

The canals protection activities were conducted as set of activities on 4 sites, (building up of sandbag was made only on two sites). The work efficiency of building up sandbags was 0.51 m^3/hour/

person. It took 10 days in total to build one watering trough which costed 536,100 UM including materials and labor. The cost of fence was 247,562 UM /100 m.

Some of the works required expertise (making steel frames, setting siphon and concrete pillar for the watering places), but the other operations were implemented by the farmers following instruction of the Study team, and the technicians of SONADER Foum Gleita office.

Regarding strengthening by sandbags, the work was done in August, but the necessity for re-maintenance on the aqueduct S3 was reported in December. In this location, it was proposed by Sabahallah village cooperatives (El Whida, Tahara, Dar Salem) that, the repair could be easily undertaken by building up sandbags even in the busy season provided that the sandbags are supplied to them. The Study team provided the sandbags, and the repairs of the canals were made by the farmers' cooperatives.

The water supply for water troughs of livestock is taken from the primary canal and siphon and the drainage was diverted to flow into the drainage canal. However, the drainage canals are filled with sand, and after construction of the watering trough, cleaning of drainage canals was required in several locations (downstream of the aqueduct (right bank of AD) and aqueduct S3 (right bank of P1)). Protecting the canals by the fence was very effective, but the livestock (especially the camels) going through near the fence caused breaking of the pillars that had to be repaired.

(2) Suggestion

The stacking of sandbags was a simple work, but it needed direction so that the bags were arranged effectively. Besides, sandbags are needed for maintenance by sandbags. Although it was not the verification trial site, the farmers in S7 requested to repair the canal at P1 in November 2009. The Study team and the staff of SONADER Foum Gleita have provided the tools and technical assistance to make repairs without sandbags. It was verified that it required a great care on the operation and time when compared to doing the work with using sandbags, but it was possible to be done without sandbags by farmers, if the farmers are provided enough technical assistance. The possibility of adapting these repairs without sandbags shall be explored especially when it is not possible for the farmers to buy them, and they have enough time to do the work.

This watering trough for livestock is already under use. Besides, the fence is also effective to protect from livestock invasion. After the verification trial, these facilities are maintained by the cooperatives around each site under the supervision of SONADER Foum Gleita office. In order to gain understanding of more farmers in Foum Gleita, it will be necessary to publicize the information and enlighten the farmers.

(3) Results of Verification Trial and Application in the A/P

The local materials and techniques were utilized, and therefore, it was understood that the farmers could construct canals with the guidance of local engineers. Regarding the effect of the trials, the livestock drank water in the drinking water troughs, and was prevented from invading the canal. The embankment of the canal could be strengthened by the sandbags. Also, it was seen that the farmers volunteered to repair canal using sandbags. It means that if suitable materials such as sand bags and necessary equipment are available, the farmers will do the operation and maintenance by themselves.

In order to apply to A/P, it is necessary to provide the farmers about the details of the way of operation and maintenance and to construct the system of irrigation facilities for independent operation and maintenance. In this time, the trials were made only in a small area. To prevent the invasion of livestock in a wider area, it is important to build consensus of the livestock breeders and fencing of the entire area should be done by rehabilitation work.

4.4.2 Cleaning of Secondary Canals

(1) Results

After cleaning and dredging of canals, the flow of water increased at the downstream and the farmers were interested to continue the cleaning for the remaining part of canal at S25.

Cutting Typha, and Shrubs

Dredging (Canal cleaning)

The work efficiency of dredging of canal, and removing of typha and shrubs in the vicinity of the canals was 3.7 $m^{2/}$ person / hour by dredging of 10.6 m^2. A lot of workforce was needed not only to remove typha in the vicinity of canal, but also the shrubs in the area.

For dredging of canal, it was needed to define the depth of the work, but the canal was filled with typha and grass, and hence it was difficult to estimate the depth. Therefore, the first day was spent to remove the typha and shrubs, and then SONADER did a survey and measured the depth of

dredging. The dredging was actually started in the second day. Vegetables had been cultivated on the whole plot of S25, and therefore, it was not possible to stop irrigation even temporarily and canal could not be drained. In Foum Gleita, it was recommended to dredge the canals before the start of agriculture campaign and it was done in January, but the participants complained that water was too cold.

In S25, the canal is about 1 km long, and it was not be possible to dredge all of canal during the verification trial. Four agricultural cooperatives of El Wai Taghada, Amar Sidi and Bokki II continued the canal cleaning for three days without payment even after the end of verification trial.

(2) Suggestion

It is necessary to drain the secondary canal, in order to carry out accurate dredging, and to eliminate any complaint about the work in the canal. It requires understanding and cooperation of related farmers' cooperatives and also needs enlightenment and strengthening of organizations for each area of secondary canal. In addition, the work was done outside the periods of implementation of the project, because the four cooperatives understood the necessity of such a cleaning and its effects. The enlightenment of this experience is also necessary.

(3) Results of Verification Trial and Application for A/P

It was verified that the farmers could do weeding and dredging at the secondary canal level. Farmers realized the increase of amount of passing water and continued to work on voluntary basis. In order to improve the work efficiency, emptying of the canal is necessary. However, systematic implementation is needed in consideration with the cropping period. In order to apply to A/P, Strengthening of capacity of farmers' cooperatives is needed to plan canal cleaning and to prepare a suitable implementation system.

4.4.3 Cutting of Typha in the Primary Canal

(1) Result

Typha was relatively easy to cut, but to remove them from the canal was difficult. Typha should be cut twice in a year, because they grow by 3.5 m in every six months.

The work efficiency was 2.3 m^2/hour/person during dry cutting, and 5.1 m^2/hour/person for roots removing, and therefore the performance of the roots removing is 44% higher than cutting. The removal of roots required a lot of human power and typha has deep roots in the mud. Hence, it was a labor intensive work to remove them outside the canal. Moreover, as it was heavy and was difficult to manipulate, and could not be reused because of bending or getting dirty because of roots. In terms of labor cost, it was 52 UM/m^2 for removing roots, and 16 UM/m^2 for cutting. The work efficiency for

cutting in the water was 7.2 m^2/hour/person on the average, and the labor unit cost was 21 UM/m^2.

It was found out that there was not much difference in the work efficiency between cutting dry and cutting in the water. However, since the dredging and cutting of typha was made in January before the agriculture campaign, the participants complained that water was too cold.

In general, the farmers obtain the typha they need, but it is also sold among them with a price of 1,000 to 1,500 UM per cart. However, since the price just covers the labor cost including loading and transportation, it will not generate any profit.

(2) Suggestions

Currently, typha is used only for roofing. In Rosso, a research is conducted to test charcoal made from typha, which provide benefits. If it is profitable, it is also possible to introduce this technique in Foum Gleita project area.

(3) Results of Verification Trial and Application on the A/P

At the primary canal level, it was verified that the typha could be removed in both dry and in water conditions. Typha grows stronger and needs to be removed twice in a year. The water management during the typha cutting period is important, because the growth can be restricted by keeping the remaining part of typha under water. .In order to apply to the A/P, it is necessary to include O&M plan including typha removal at least once a year, or if possible, twice a year, dropping of canal water, supply of water, and right time of implementation. It is necessary to make efforts on utilizing typha.

4.4.4 Collection of Water Charges

Water charges are the sources of funding for the maintenance of irrigation facilities, and hence, if their management of fund is not done properly, even the facility maintenance would not be done well. In Foum Gleita, when the project was started, the farmers paid 16,500 UM/ha to SONADER, which was used as the source of maintenance of irrigation facilities. However, the maximum rate of collection was only 50%. In order to stop providing water to those who did not pay the water fee, SONADER closed tertiary canals as a countermeasure. In 1994, the upstream side was closed because of unpaid water charge before the agricultural season and water was not provided for one year. After that, discussions were initiated to solve the problem. It was agreed to pay 60% by cash or products, and 40% by labor. But it was still difficult to collect the fees based on this plan. In 2000, the canals suffered a serious damage, and supplying irrigation water was stopped. As per the requests by the farmers groups, MDR exempted the water charge. It was again collected from 2001 to 2003, but was finally stopped now.

Currently, no agreement is made with the farmers, and it became difficult to make the farmers pay the water fee. As the first stage of the collection of water fee, a list of payment cost for the entire irrigation area was prepared. According to the list, the cultivation rights were given to all the area, but presently only some of the farmers in the lists are cultivating in the area. Therefore, based on the water fee payment receipts from 1988 to 1993, a list of water fees paid at the time was prepared. This important document will be finalized during the rehabilitation project. Moreover, it is necessary to continue the enlightenment activity towards the strengthening of the union (UCAF) in order to understand the importance of fees for the maintenance of irrigation canals.

Even though farmers admitted the necessity of collection of water charge, it was found out that there is a need to improve situation of organizational aspect, because UCAF is not working and SONADER is not trusted by the farmers. In the Action Plan, firstly, recovery of trust of SONADER and revitalization of UCAF is necessary. And then, it is necessary to explain the farmers and to build transparent accounting system for structure of collection and utilization of water charges.

4.4.5 Operation and Maintenance Plan

To secure irrigated areas sustainably and to use the areas for medium and long term, it is important to maintain the irrigation facilities. Since the start of operation of the project in 1990, maintenance of primary canal facilities such as principal canal, primary canal, and secondary canal has been under responsibility of SONADER. Besides, they collected the water charge for management, which was the source of funding for maintenance works until they stopped collection in 2000. Now the fees are not collected, and even in the case of vast damage of the canal, SONADER does not have budget for maintenance, and hence, there is no effective countermeasure. The government guidelines recommend that the maintenance should be undertaken exclusively by the beneficiary farmers. Taking into account of the real situation, the farmer groups need to take the initiative of maintenance of this area. The maintenance of irrigation facilities has a huge impact on the overall irrigated area. The union (UCAF) organizes for the entire agriculture activities and arranges meetings with cooperatives under the technical support of SONADER. However, at the same time as the Study team started strengthening the organizations, the UCAF which almost stopped its activities has reactivated to function; but in fact, it still did not function practically. Since the participatory activities were not sufficient enough for sustainable maintenance of irrigation facilities, it is necessary to maintain it independently. Although it is necessary to provide information, only 400 ha is cultivated and those who cultivated the remaining 1,600 ha are living away, which made it difficult to form a consensus. Under this situation, the expected maintenance of irrigation facilities is listed in the Table shown below.

Table 4.4.2 Direction of Operation and Maintenance of Irrigation Facilities

Item	Details
Sharing roles	Until now, SONADER collected and managed the water charges, and also maintained the principal, primary and secondary canals, but now it is very difficult for them to manage. The UCAF is responsible for the general maintenance of all canals and the collection of management fees with the technical support from SONADER. The UCAF will discuss with the cooperatives and demand labor and fee contribution as needed.
Work division	General maintenance consists of inspection, cleaning canals (including grass cutting), dredging and repairs with manual work. Below secondary channel, beneficiaries of the area (farmers) shall carry out the operation and maintenance. For the primary channels, the segment is defined by the cooperative, and work shall be conducted twice in a year before cropping. The primary channel will be inspected by UCAF, and shall conduct general maintenance work as needed. In case of finding any defects on the facilities, UCAF and SONADER shall consult to find a solution that shall be implemented after the approval by the review committee of UCAF.
Staff structure	SONADER shall provide technicians as needed. The UCAF shall be responsible for maintenance, and an accountant shall manage the water charges. Under the UCAF, about 5 water masters are provided for water management and maintenance.
Water charge	Under the supervision of SONADER, the UCAF shall collect and manage the conventional water charge of 16,500 UM/ha. The penalties for those who do not pay are decided and made known to all cooperatives. If an amount beyond the specified expenses needs to be spent, the decision of the committee will be needed. To ensure the transparency of account, an external audit is needed twice in a year and the intervention of the governor of the province shall be requested to solve any trouble.

It is necessary to discuss with the farmers' groups and SONADER to prepare for framework and to organize better through practice. To prevent livestock from entering irrigated area, it is important to discuss the matter with the union of livestock farmers.

The water charges were not collected, cropping area was only one fifth of the total area, and the organization is not functional. It was clarified that the operation and maintenance condition was not right, and was found out that O&M system was totally absent in the project area. In order to apply for A/P, it is necessary to formulate and implement appropriate operation and maintenance plan at the right time including recovery of function of irrigation facilities, revitalization of organization and restarting of agriculture cultivation.

4.4.6 Capacity Development of SONADER

Capacity development of staff of Foum Gleita was conducted by on-the job training of the verification trials. Specifically, it was implemented under the supervision of the Study team to plan canal protection facilities by discussing with farmers to participatory implementation, explaining and understanding on operation details to farmers and selecting and organizing participant groups.

Even though the number of employees of SONADER Foum Gleita is limited, they have the advantage of being the residents of Foum Gleita and they provide service as much as possible to the farmers. They are very friendly with the farmers and have shown exceptional ability to select the groups to form participatory activities. Since everyone has good ability, a rational organizational structure is needed to make them work more effectively in the project.

Guidance by SONADER before Verification Trials

In terms of operation and maintenance of irrigation facilities, specialists of irrigation techniques and employees of irrigation engineering and technicians from private consultant as needed shall be employed for future maintenance of the irrigation facilities. In addition, it is expected that water masters shall be selected from farmers as irrigation technicians at each secondary canal to work which will be initiated by SONADER. The water masters cooperate with the officials of the cooperatives, and participate in the general maintenance of the irrigation facilities. Currently under this concept, SONADER staffs are explaining to farmers on the active participation for maintenance of irrigation facilities.

As results of verification trial, through OJT, it was verified that the staffs became actively involved, and they could instruct the farmers more efficiently on operation and maintenance. However, the limitation of transportation is the obstruction of efficient operation and maintenance for the entire area. Ensuring the transportation of the staffs and more improvement of the ability are needed.

4.5 Extension Activities Based on Experimental Trials

Regarding the outline of result of verification trial on farm management, it was verified on the availability of recommended cultivation techniques for the improvement of yield of various crops. Especially, there is great improvement on vegetable cultivation, and extension of the vegetable cultivation shall be one of the main challenges of the future farming in Foum Gleita. While it is necessary to extend the cultivation techniques among the farmers in the area, it is also important to strengthen the extension system of SONADER.

4.5.1 Rice Cultivation

(1) Outline

In Foum Gleita, the rice cultivation is carried out in both rainy (June to October) and hot dry

season (February to June), whereas the vegetable cultivation is practiced mostly in cold dry season (October to February). However, the present technological level and the yields are relatively low. The major technical problems related to rice cultivation in Foum Gleita area are as follows:

1. Although the farmers are aware of transplanting, the techniques of nursery preparation and management are improper, and hence the amount of rice seeds used is more than the normal conditions.
2. The quality of seeds is low, since the farmers are using their own seeds or the seeds acquired from the neighboring farmers.
3. The amount of fertilizers recommended in the region has not been used due to the problem on the shortage of money, and marketing problem.
4. Most of the rice cultivation activities such as seeding or fertilization are not carried out in time, since the farmers cannot obtain the loan in time which is required for buying the inputs.
5. Weeding works are not carried out properly.
6. With the reduced function of SONADER's activities, there is no proper training to the farmers, especially there is no chance for the younger farmers to attend any kind of technical training related to farming.

(2) Objectives of the Verification Trials

In this regard, the main purpose of the trial cultivation was to identify the cultivation technologies suitable to the area so as to improve the productivity and to practice sustainable agriculture. Besides, in regard to extension of agricultural techniques, the extension agents and the agricultural researchers can carry out the extension of agricultural techniques in the trial farm, and thereby the technical levels of the farmers can be improved. The following 4 items are verified in the verification trials:

1. To verify the proper cultivation technology related to rice farming, and to extend such cultivation technologies to the farmers,
2. It is aimed that the farmers acquire the proper cultivation technology through the verification trials, and improve the production capacity.
3. It is expected that the cultivation area of rice farming in the project area will increase.
4. It is expected that there would be coordinated activities between the agricultural research and extension organizations

The following verification trials were conducted in order to improve the cultivation management by applying the optimum amount of inputs based on the economic conditions of the farm households.

Table 4.5.1 Objectives and Details of the Rice Cultivation Trials

Contents	Objectives	Details
Fertilization trials	The comparison was made between the recommended amount of fertilizer, and the low amount of fertilizer, and the possibility of introducing low inputs were verified.	Plots of no fertilizer area, fertilizer applied area with 100kg of TSP + Urea (100kg, 200kg, and 300kg). Random planting and row planting were verified. The urea recommendation by CNRADA is 300kg/ha.
Possibility of low inputs	Possibility of introducing upland NERICA with low input, minimum labor and low usage of water. Verify the possibility of NERICA as an alternative to the hot dry season rice.	Direct seeding was carried out; water management included regular irrigation, and partial irrigation; The fertilizer application of two cases were no fertilizer, and 100kg/ha of TSP. The growing conditions and yields were verified.
Introduction of small-farm machinery	In order to reduce the labor requirement, weeder and thresher were introduced and their effects were verified.	Row planting and random planting were verified, and the usage of weeders were compared. Based on the results, row planting shall be popularized.

(3) Study Area

As targeted areas of the rice trials, two areas were selected in P1 (Primary Canal 1), and P2 (Primary Canal 2) areas. The details are shown below in Table 4.1.5. (More details are mentioned in the ANNEX 2).

Table 4.5.2 Details of the Rice Trials Area

Main Line : P-1 Secondary : S-2	Main Line : P-2 Secondary : S-25
Village : Sabbahalla	Village : D'Dakhla
Cooperative : El-Wihda (52-Male)	Cooperative : El- Wai (38-Male)
Area : 0.5ha×2 plots	Area : 0.5ha×2 plots
Land cultivation rights : SONADER	Land cultivation rights : Individual
Inputs : Seeds (Sahel108、Sahel202、NERICA-4), Fertilizers (Urea and TSP)	
Materials Lent : wheelbarrow, hoe, axe, shovel, pickaxe rice planting rope etc.	

The implementation of experimental trials and its extension to the farmers were conducted through AVBs (extension agents) in accordance with the objectives and details of the verification trials, through a local contract with CNRADA under the supervision of the Study Team.

4) Results

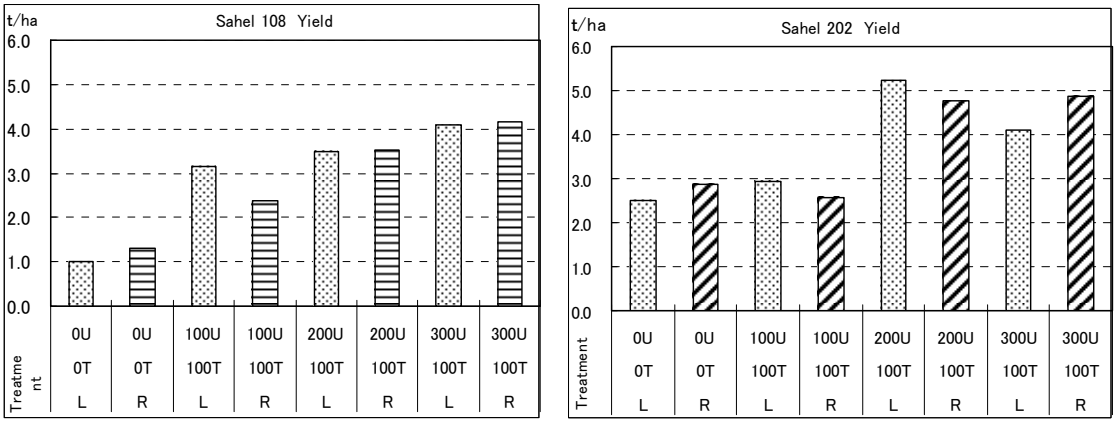
a) Rice Yield

Although 300 kg/ha of urea is recommended, the farmers are usually applying a fertilizer of about 100-200 kg/ha. According to the hearing survey, about 1.2-1.6 t/ha of yield is obtained by applying 100 kg/ha of urea.

The yield results from P2 area are shown below in Fig.4.1.3. It is thought that the reasons of why the graph didn't show correlation clearly are to leak water from dike because of the poor land preparation techniques and to show the differences between fertilizers to the expected yield because the layout of the experimental plots was not properly treated. In case of Sahel 108, by applying no

fertilizer, a yield of about 1-1.3 t/ha was obtained which is similar to the existing condition. By applying a basal fertilizer (TSP 100 kg/ha), and the top dressing of 100, 200, and 300 kg/ha of urea, and yields of 2.4-3.2, 3.5 and 4.1 t/ha were obtained respectively.

In case of Sahel 202, by applying no fertilizer and 100kg/ha, a yield of about 2.5-2.9 t/ha was obtained. By applying a basal fertilizer (TSP 100 kg/ha), and the top dressing of 200 to 300 kg/ha of urea, and yield of 4.1-5.3 t/ha were obtained. The yield difference of about 2 times were noted between 0 kg and 100 kg/ha and 300 kg/ha of urea.



Note: 'L' means Line planting, 'R' means Random planting

Figure 4.5.1 Rice Yield Results of the Two Varieties

Besides, the result of low inputs farming, the yield of line planting which was practiced newly was about 1-2 t/ha, which is almost the same yield as random planting. Hence the importance of fertilizer application of 300 kg/ha as recommended by CNRADA was confirmed.

NERICA trials were conducted mainly to verify the minimum input (labor, water, and fertilizer) required for rice farming. However, only 3.4 kg of rice seeds were obtained from the 2 plots of 121㎡. The satisfactorily results were not obtained in the NERICA trials mainly because of the following reasons:

- The seeds were broadcasted directly in the field which did not have a leveled surface. Hence the seeds which fell on the deeper locations did not germinate well.
- Some of the seeds which germinated were eaten by the birds.
- Since broadcasting was carried out, the weeds were randomly distributed, and hence the weeder could not be used. The farmers also lost their interest in weeding the NERICA fields.

b) Participation of Farmers

The participation of the farmers and the coordination between the farmers and the AVBs greatly influence on the farming activities. In the beginning of the trials, there were only 3-5 farmers

involved in the trials in P1, where as there were only 2-6 farmers in P2, and the farming activities did not progress well. However, through the constant explanation of the Study team, CNRADA and AVBs on the objectives and details of the verification trials, the farmers of P2 cooperative slowly understood the importance of the verification trials and hence started showing more interest in the trials through their participation. Hence good yield results were obtained in P2 area.

On the other hand, in P1 area, there was no close coordination between the AVB and the farmers' cooperative. Besides, the cooperative itself was not very active, and hence the participation of farmers in the trials was limited. Although the farmers were explained on the importance of trials similar to P2, their involvement in the farming activities were still limited. As a result, since they did not protect the field from the birds and animal attack, the trial plots were completely eaten by animals and birds.

c) Techniques Adopted in the Rice Cultivation Trials

- Nursery: Instead of following the usual method of soaking the rice seeds, dry rice seeds were planted in the nursery and transplanting was done after 3-4 weeks of planting.
- Transplanting : Instead of following the random planting, comparison of row planting and random planting was made
- Different fertilization quantities were tried
- Weeding was done using a rotary weeder
- Pests control and bird scaring were tried.
- Threshing was carried out by using a thresher.

The details of each of these techniques are mentioned in the Annex 2.

d) Problems of Implementation in the Verification Trials

While it is obvious that optimum amount of inputs (quantity of fertilizer) is to be used in order to obtain the maximum yield, it is also necessary to grow strong and healthy seedlings which are the basic technique of rice growing. During the verification trials, it was understood that the importance of healthy seedlings was not properly understood. In the case of nursery prepared by farmers, the seeding quantity was high (farmers – 300-500 g/m^2, experimental field – 170 g/m^2; Normal - 90-100g/m^2), and therefore the seedlings were too dense in farmers field. Even under the instruction of CNRADA, the planting density was closer. Besides, the transplanting was supposed to be carried out within one month after planting, where as it was carried out only after 40 days, because of the time requirement for land preparation. These are some of the factors which influenced on the rice yield.

In order to avoid the bird damages, the harvesting was carried slightly in advance than the normal harvesting period. There was damage by rats when the rice was kept in the field after the

harvest for drying. In the field, there were damages not only by the birds but also by the rats. There were also problems in the consciousness of the breeders.

The use of child labor is high in the project area. Especially during the trials, many children actively participated in the farming. Especially in P1, the number of children was even higher than that of the adults, and the necessity child labor in farming was felt. The child labors were seen not only in the trials plots but also in other areas. The involvement of children in farming results in improper work, which leads to poor yields.

e) Benefits of the Verification Trials

In the verification trials, the farmers were trained on improvements which need to be made on the nursery preparation, transplanting method, weeding and threshing methods. In the technical level, the farmers were already harvesting more than 3 t/ha through the recommended fertilization application by SONADER and CNRADA. In regard to nursery preparation, it was confirmed that the time and the quantity of seeds required are less by using the improved method. The foot operated thresher also received a high evaluation from AVB and the farmers, since the labor required for the operation is low.

(3) Results of Verification Trial and Apply for A/P

As a result of applying various recommended techniques while extending to the farmers, it was verified on the improvement of yield by optimum use of fertilizer, shortening of nursery period, and improvement of work efficiency by using farm machinery. In order to apply for A/P, it is necessary to improve productivity with extension of various suggested techniques.

4.5.2 Fruits

(1) Outline

Presently, fruits cultivation is not practiced in Foum Gleita project area. Through the hearing survey of the AVBs, and farmers, it was understood that banana cultivation was experimented once some years before, although it was not popularized. However, the fruit trees such as banana, mango, and citrus fruits are grown in the Lexeiba project area, which is located at about 50 km from Foum Gleita project area. Presently, there is totally no technical training given to the farmers on the cultivation of the fruit trees. Hence, it is

Banana in Fruiting Stage

considered that there is a potential to grow the fruit trees in the Foum Gleita Project area, where soil is suitable for cultivation, the fields and water can be secured, and marketing can be expected as well.

(2) Objectives of the Fruit Cultivation Trials

Through the verification trials, it is aimed that the fruit cultivation techniques suitable for the area shall be established and the extension of such techniques will be taken root by the farmers, and thereby a stable production will be secured with diversification of agricultural products and increasing cash income of the farm households.

(3) Study Areas

After the discussion of the Study team, SONADER, and CNRADA with the two cooperatives (P1:El Wihda, and P2 : Weltaré1, and Weltaré Bokki), and explanation of the details of the verification trials, the verification trial areas were selected. The details of fruit cultivation trials are shown in the following Table 4.1.6. More specific details of the trials are shown in the ANNEX2.

Table 4.5.3 Details of Fruits Cultivation Trials

Primary Canal : P-1; Secondary canal : S-2	Primary Canal : P-2; Secondary canal : S-25
Village : Sabbahalla	Village : D'Dakhla
Cooperative : El-Wihda (Ladies– 49) Women members	Cooperative : Weltaré1, Weltaré Bokki（Ladies - 265）Women members
Cultivation area : 0.5 ha	Cultivation area : 0.5 ha
Land right : SONADER	Land right : Private (currently unused)
Fruit trees : 5 types of fruit trees including banana(Petite naine and Williams), mango (ordinary variety (Improved Cameroun) and 4 improved varieties: Amélie, kent, keitt and brooks), guava(supreme), citrus Lemons (galet and eureka), orange Casamance, mandarins Clementine, pomelos (marsh and Shambar), and Jujube (India jujube (Rindiao).	
Inputs : Seedlings from CNRADA, fertilizers, and fence materials	
Materials Lent : wheelbarrow, hoe, axe, shovel, pickaxe, watering can etc.	

Each of the trial activity from the land preparation to harvest was carried by the farmers under the supervision of the Study team as per the instruction of advice of CNRADA to AVB and of AVB to farmers in the field.

4) Results

a) Growth of Fruit Trees

In June 2010, the trees including mango, citrus, banana, guava, and Indian jujube which were planted one year before in July 2009 are showing good growth in both P1, and P2 areas, and many of the trees of mango, citrus, and guava reached a height of a about 1m, and banana, and Indian jujube

reached a height of more than 2 m. Presently, 13 trees (11 trees of Petite naine variety and 2 Williams variety) in P2 area, and one banana tree (Petite naine variety) in P1 area have started to produce fruits. The first harvest is expected at the end of June 2010. Indian jujube is in the flowering stage in the two sites and some small fruits are noticeable. First harvest of Indian jujube is also expected in 1-2 months time.

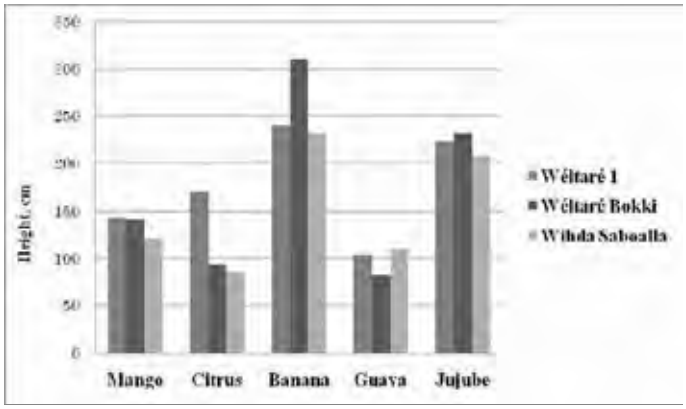


Figure 4.5.2 Comparison of Development of Fruit Trees in the 3 Cooperative Trial Areas (June, 2010)

The present vegetative development of fruit trees are shown in Fig.4.1.4 The fruit trees are developing very well. Brief comparisons of the two sites (P1 – one cooperative, P2- two cooperatives) are shown in the following figure. In general growth of fruit trees are better in P2 area (Weltaré 1 and Weltaré Bokki), than P1 (Wihda Sabahallah). The planting in P1 was carried out about two weeks later than P2. Besides, the soils of P1 area are more heavy, and stony, and hence the tree growth is slightly lower than P2.

b) Farmers Participation

In the beginning of the trials including preparation of seedlings for the fruits and transplanting of fruits etc., the participation of farmers was relatively high, such as about 20 farmers in P1 area, and about 40-50 farmers in the P2 area. However, from the end of August, starting from Ramadan, the participation of farmers was reduced to less than half. Especially, in P1 area, the participation was less intensive, and especially during the rainy season after Ramadan, the farmers did not turn up at the field, and hence the activities such as weeding and water management were not carried out. Therefore some fruit trees including banana, mango, and citrus trees wilted because of the shortage of water. In P2 area, there were flooding during the rainy season which discouraged the farmers in attending the field activities during the rainy season. However, during the dry season (October to February), the farmers were regularly involved in weeding and water management activities of the fruit trees. The farmers were also continuing the water management of fruit trees during the field survey in May to June 2010.

c) Expanding Fruit Cultivation in Foum Gleita Area

As mentioned "(2) Objectives of the Fruit Cultivation trials", fruit cultivation trials was conducted with the purpose of crop diversification and as an important source of income other than the

vegetable cultivation. The fruit cultivation was addressed that it is necessary initial investment properly such as seedlings preparation, a good fence, etc.

The possibility of introducing fruit trees is discussed below.

i) Cultivation Cost

At the present timing of the verification trial, it can be said that it is technical possible to grow fruit trees in the Foum Gleita area. However, the actual yield benefits can be verified only after a few years of time. In regard to cost for growing fruit trees, the cost of one fruit seedling range from 800 to 1,000 UM, and 25-30 seedlings were planted in the area of 0.5ha. Fertilization should also be carried out as recommended. Besides, initial investments such as fence and wind break trees are also required. Therefore, if the farmers or the cooperatives are interested to start the fruit farming, they need to prepare the initial investment for such purposes.

ii) Labor Required (Quantity of Work)

In regard to the labor work, the farmers have to make holes to plant fruit trees which also require labor especially in the heavy clayey soil. However if the group is formed for such activities, it can be carried out with less time. Besides, water management should also be carried out at regular interval. Since the fruit bearing will take a few years there is a possibility that the farmers might abandon the field in the middle; however, since the vegetable cultivation is carried out in the fruit area, it is considered that the maintenance of the fruit trees is possible in the dry season.

iii) Possibility of Expanding Fruit Trees

During the field surveys, it has been noted that the farmers, especially the ladies farmers who are involved in vegetable cultivation have a very high interest in fruits cultivation. While there is a necessity to analyze the economical cost-benefit of the trees, there are also other benefits to be considered.

Farmers Taking Break under Banana trees

At present, there are no shadow trees in the project area, and hence the farmers have to make small tents for taking breaks during their heavy work. Even though the banana trees are less than 2.5m height, the farmers are already taking a break under the shadows of the trees. More importantly, fruits are missing in the regular food of the people of the area. The fruits from the Foum Gleita project area in the future would also help to increase the nutritional balance of the population of Foum Gleita and the surrounding areas.

(5) Results of Verification Trial and Apply for A/P

It was confirmed that the fruits trees grow well with appropriate cultivation management. However, comparatively a high cost and labor input shall be required in the initial stage. In order to apply for A/P, there is a potential in the medium and long term, and it is also expected to provide additional effects such as providing shade of tree which is valuable in the area and improvement of nutrition. Therefore, there is a possibility to introduce fruits trees in the area.

4.5.3 Vegetables

(1) Outline

Since the irrigation scheme was established in Foum Gleita, some ladies'groups have grown vegetables mainly in the dry season. At the beginning, SONADER conducted some trainings to develop their cultivation skills and thereby, their livelihoods were improved. But, with the reduced function of SONADER, there have been no chances for such trainings, and hence they couldn't attain the new cultivation techniques and information. Additionally, the shortage of irrigation water with the degraded facilities and lack of input, and damage by pests & diseases result in significantly low productivity. In these circumstances, the improvement of the farming techniques to increase the vegetable production is considered by conducting verification trials in the FG Project Area.

(2) Objectives of the Vegetables Cultivation Trials

With the aim of introducing crop diversification, and to increase the cash income of the farm households, the main objective of the trials is to examine the improved vegetable farming techniques suitable for the area. Besides, the extension of such techniques will be made to the farmers, and thereby a stable production will be secured.

(3) Study Areas

After the discussion of the Study team, SONADER, and CNRADA with the three cooperatives (P1:El Wihda, and P2 : Weltare, Weltare Boki, Bedr), and explanation of the details of the verification trials, the verification trial areas were selected. The details of vegetables cultivation trials in the normal vegetable season of dry winter season (October to February) are shown in the following Table 4.1.7. More specific details of the dry winter season trials, and the complete details of rainy season vegetables (June to October) are shown in the Annex.

Table 4.5.4 Details of Vegetable Cultivation Trials in the Dry Winter Season and Input

Main Line	P-1; Secondary:S-2	P-2; Secondary:S-25	P-2 Secondary:S-19
Village	Sabbahalla	D'Dakhla	Foum Gleita
Cooperative:	El-Wihda (Ladies - 49)	Weltaré1 , Weltaré Bokki （Ladies - 265）	Bedr (Ladies - 40)
Area	0.5ha	1.0ha	0.5ha
Land cultivation rights:	SONADER	Communal Land	Personal
Vegetables: Tomato (Xina), Okra (Clemson Spineless and Pop 12), Eggplant (Black beauty), Sweet potato (local, and Ciam 80/30), Onion (violet de galmi), Cabbage (Marché de Copenhagen), and Carrot (Touchon)			
Input: Vegetable seeds, nursery, fertilizer(UREA,TSP,NPK), fence materials			
Materials Lent: Wheelbarrow, Ax, Hoe, Shovel, Watering can			

Each of the trial activity from the land preparation to harvest was carried by the farmers as per the instruction of SONADER, and advice of CNRADA under the supervision of the Study team.

(4) Results

a) Vegetable Yields

Vegetables yield results of the 4 cooperatives (Weltaré 1, Weltaré Bokki, El Wihda and Bedr) are summarized below.

Table 4.5.5 Vegetables Yield Results of the Verification Trials (t/ha)

Vegetables	Wéltaré 1	Wéltaré Bokki	El Wihda	Bedr	Average
Okra	14.18	9.37	12.75	18.13	13.61
Cabbage	14.14	24.23	10.23	1.59	12.55
Tomato	20.37	39.56	22.86	23.61	26.60
Carrot	28.99	37.97	12.27	10.93	22,54
Onion	12.60	9.62	9.88	2.38	8.62
Eggplant	24.54	24.26	29.45	16.78	23.76
Sweet potato	14.59	25.67	9.93	8.92	14.78

In comparison with the existing yield of 5-8 t/ha of vegetables in Foum Gleita, the yields obtained from the experimental trials were 3-4 times higher mainly because of adapting cultivation practices including row planting, using of suitable varieties of vegetable seeds, and strictly following the standard cultivation practices recommended by CNRADA including water management, fertilizer management and pest management.

Tomato and Carrot Harvest in Weltare Bokki

Not only the farmers of the participated cooperatives, but also the farmers of the surrounding areas visited the verification trial plots, and observed the better growth of vegetables. During the discussion with SONADER AVBs (extension agents), it was strongly advised to extend the cultivation

practices of verification trials to the other vegetable growing areas of Foum Gleita project area.

In case of Bedr cooperative, the project area was cultivated again, after a period of 10 years period. Hence the weed presence was a big problem throughout the growing season. Besides, the irrigation problem at some parts of the growing period also resulted in low yields in cabbage and onion. However, the ladies farmers of Bedr cooperative were fully satisfied that they could reclaim the field which has been unused for more than 10 years, and could obtain good yields in the vegetables including tomato, okra and eggplant.

b) Farmers Participation

There were some differences between the cooperatives in the farmers participation in various activities based on the relationship between AVB and the farmers. In general, the AVBs were more involved in the field activities in cold dry season compared to the rainy season, and they tried well to communicate to the farmers. Besides, the religious festival, preparation of one's own field, and water shortage due in the trial field due to broken the secondary canal (P2 site) also bad influenced on the farmers participation.

Since starting cold dry season, it was noted that the Wihda cooperative P1 which almost gave up the rainy vegetable season trial has improved significantly and they were involved strongly in the activities, although the number of participants were limited.

In P2, Weltaré bokki, and weltaré east were the two cooperatives working in two plots. Although, they have many members, they are also working in their own plots, and worked in the trial plot in rotation basis. Although they have shown interest to work in two plots, they took more time in the land preparation of the second plot, which also resulted in the delay of onion transplanting.

The cooperative Bedr is functioning more effectively among the 3cooperatives. The reasons are as follows: The president of the cooperative has a good commanding leadership, and the cooperative is organized well. They also have a man member, and in case of heavy works, the man was in charge of those heavy works, which the ladies could not manage by themselves. In some cases, some labors were hired by the cooperative. The plot selected by Bedr has been abandoned for a long time and though there was no farm road to the plot. Farmers created a new farm road cutting weeds, did the weeding work in the entire plot cleaning shrubs, and vegetable cultivation is practiced.

c) Introduction of New Techniques and Possibility of Expanding Vegetable Cultivation in FG Area

Vegetable cultivation trials were carried out with the purpose of crop diversification and as an important source of income for the farm households. The vegetables were introduced as per the requests of the farmers including tomato, okra, egg plant, cabbage, carrot, onion, and sweet potato.

The new techniques introduced in the trial cultivation are discussed below.

<Nursery Preparation and Transplanting>: The vegetable varieties used in this trial were selected in consideration of the soil conditions in this area, and the possibility of high yield. For eg. the sweet potato variety ciam 80/30 can be adapted throughout the year with the high yield in comparison with the local yield. In general, the farmers don't apply basal dressing, but manure and NPK were applied in the trial plots. Pest control was conducted by applying pesticides, if necessary. Land preparation had to be done by transplanting timing. It is necessary to have farmers understand the important of the making healthy nursery. The transplanting was done with enough spacing, where as farmers usually adapt the dense planting which creates problems of poor growth and weeding.

<Making ridge and furrows> : The ridge and furrow method applied in the trials in comparison with the normal flooding method has the following advantages i) To irrigate and to drain off water, ii) to improve airflow to earthing, iii) the roots grow roots well, iv) weeding will be much easier.

<Optimum fertilization>: Basal dressing (TSP) and Top dressing(UREA) were applied as optimum fertilization.

<Pest and disease control>: Pest and disease control were conducted in nursery period and after transplanting. Some pests attacked cabbage leaves, okra, eggplant. Sometimes, pesticides were sprayed in the nursery period and after transplanting.

The possibility of expanding vegetable cultivation in Foum Gleita Area is discussed below.

In Foum Gleita, vegetable cultivation is already practiced inside the project area, and outside the project area. The younger farmers have been using the techniques learned from the elder persons, and new techniques such as selection of right varieties and right cultivation techniques are not adapted. If such kinds of techniques are trained to the farmers by the research and extension organization such as CNRADA and SONADER, farmers can increase their yields by 3-5 times than their present yields.

During the field survey it was understood that the ladies farmers have a deep interest in growing vegetables, and presently it is one of the important income source in Foum Gleita. During the past 3 years, the vegetables are cultivated in Foum Gleita in almost equivalent area to the rice cultivation area. Therefore, if the farmers are trained with suitable cultivation and marketing techniques, it is highly possible to increase the vegetable cultivation area, and the vegetable crops such as okra, eggplant and sweet potato can be cultivated throughout the year in Foum Gleita.

(5) Results of Verification Trial and Apply for A/P

It was verified that the yield can be increased by 3-4 times by using the various suggested techniques. Mainly, it was a valuable income resource, and it was found out that more economic

impact could be expected by the extension of techniques. In order to apply for A/P, extension of various recommended techniques shall be carried out, which shall improve the productivity and living conditions of the area. Strengthening of marketing is also expected.

4.5.4 Construction of Multipurpose Shed

(1) Purpose of the Multipurpose Shed

The construction of the multipurpose shed was made because of the following reasons. Presently, there is no place near the project area where the farm products can be stored before transporting to the markets or bigger storage places. Further, the farmers in the Project area do not have a resting place after their hard field work conditions. Besides, there is also no common place for a cooperative meeting or discussion among the farmers. Hence, it was proposed to construct the multipurpose sheds in P1 and P2 sites with simple materials, and the farmers were also involved in the construction of multi-purpose shed. The farmers were also trained on the usage of local materials for constructing such sheds.

In addition, many farmers are growing onions in the project area which can be kept for a long time after harvesting, and thus more profit can be obtained by selling at a higher price. However, presently there is no storage in this area to keep onions after harvesting. If the farmers can dry the onion properly, it can be kept for a few months until they can sell them for a higher price. For this reason, removable shelves for storage of onion were planned as one of the components of the multipurpose shed.

(2) Construction Details of the Multipurpose Shed

A simple plan of the Multi-purpose Shed is shown below.

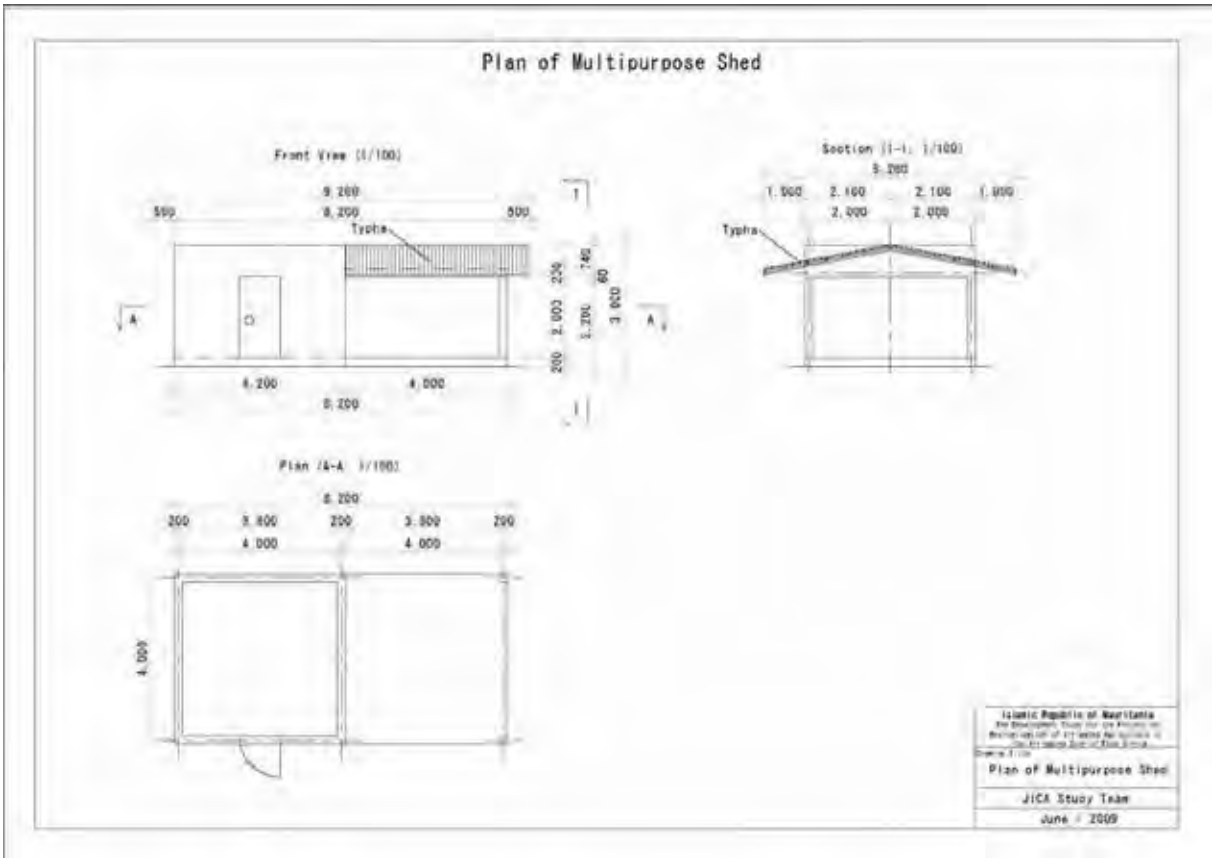


Figure 4.5.3 Plan of Multipurpose Shed

The construction of multipurpose shed was started on 2009, 9th of September. For each of the multi-purpose shed, the following labor and materials were used.

1. The materials used included cement, iron, iron mesh, gravel, sand, wooden doors, windows, and typha for the roof for the resting place.

2. One technician for bricks making worked with the 5 farmers. At the beginning, it was difficult for him to make the planned number of bricks because he was teaching the farmers simultaneously. But, after a few days, the farmers were able to make the bricks by themselves.

3. A qualified builder with 3 assistants (farmers) and 10 labors (farmers) constructed the shed. From the 3rd day, the farmers were able to make accurate task such as mixing of cement, and setting of iron frames. The assistants improved and reinforced their techniques such as using the right amount of cement and sand to make the concrete.

4. The construction of each multi-purpose shed of in P2 area (Bachat) took 25 days, and in P1 (Sabahallah), it took 23 days

5. Removable shelves for onion storage were fabricated in Kaedi, and was transported and installed in the storage room of the shed.

(3) Present Use of Multipurpose Shed

Within a week time after the construction of the multipurpose shed, the farmers started to use the multipurpose shed. At the Saballah village (P1), it is used by the ladies as a meeting place and a resting place. Even when the meeting was arranged by the JICA team, CNRADA, and the ladies farmers, it was held at the multipurpose shed.

During the harvesting of vegetables, the multipurpose shed was used for storage of vegetables. Since the onions were produced in a bigger area, the onion shelves were also used. Storing onions in the shed is profitable for the farmers, since they can sell them at a better price after a period of time, when the onions are not available in the market.

Cooperative, and CNRADA Meeting at Multipurpose Shed

Storage of Onion in the Multipurpose Shed

(4) Results of Verification Trial and Apply for A/P

It was verified that the multipurpose shed could be utilized by the farmers' meeting, rest, and storage. Onion was stored to delay the selling period in order to sell them at a high price. In order to apply for A/P, various diversified functions including marketing is expected. Maintenance of facility should be done properly.

4.5.5 Visit Advanced Site

In the context of strengthening farmers' groups, 33 Foum Gleita farmers and employees of SONADER visited the developed agricultural areas in Lexeiba, and Kaedi, January 13, 2010. (Details are mentioned in ANNEX 3).

Exchange of Opinion by the Farmers

On both the areas, the Foum Gleita farmers and the farmers of the area have engaged in lively

discussions on the subjects of organization and marketing. Since the Study team had selected the farmers who are likely to become the leaders in Foum Gleita project area, and they were eager to attend this study tour, the discussions were more animated than expected.

The study tour sites including Kaedi and Lexeiba are closer geographically and culturally to the participants of the Foum Gleita project and hence there was a strong impact, and it is necessary to continue such assistance in the future.

As results of verification trial, FG farmers have very limited opportunity to visit the farms of other area. By verification trials, it was confirmed that positive exchange of opinions could be made, which is an efficient way to strengthen their knowledge and information. In order to apply for A/P, it should be enforced for improvement of production techniques and to strengthen the ability of organization.

4.6 Strengthening of Farmers Organizations

Since the starting of the project in Foum Gleita, twenty years have been passed. Out of the total area of 1,950 ha, only 400 ha is presently cultivated, because of the problems of irrigation and drainage facilities, loss of functions of facilities, and loss of motivation & morale of the farmers. Moreover, the farmers relied on SONADER since it was equipped with equipment and personnel to manage the maintenance of primary and secondary canals, which provided water, and supported the operations and the structuring of agricultural organizations. When the government introduced its national policy of population settlement in 1980s, some of the newcomers, either nomads or farmers, moved to the project area to settle and started irrigated agriculture in Foum Gleita. The Government was supposed to ensure the livelihoods for those who had been displaced by the project.

Furthermore, the uncertainness of obtaining loan and un-transparent management fixed fee which was collected until 2000 led to distrust against the agencies such as SONADER or union (UCAF). In addition, the distrust of the farmers increased, since the repair of primary canal and secondary damaged by flood in 1999 was not carried out with the fund from the fixed fee. After exemption of fixed fee by the government, the fee collection has been stopped. The uncollected fee caused difficulty on maintenance of basic irrigation facilities and as a result, the areas could not be irrigated land or expanded and caused a vicious cycle such as decreasing of cultivated area and making the life harder for the farmers. While the cultivated area decreased, the number of cooperative members also became smaller, and the function of cooperatives was finally lost. Some farmers were engaged in farm management within their family or within their tribes.

Meanwhile the operations of SONADER in Foum Gleita also repeatedly shrunk in terms of its organization, staff and materials. As a result, SONADER could offer only a minimum service in this area such as emergency aid, which is provided by the external funds.

During the first field survey, the main causes of insufficient farmer's group management were identified as follows: 1. the environmental constraints of insufficient training on organization management by SONADER, 2. few farmers have leadership capabilities, 3.the UCAF which is upper level of cooperatives is still inactive, and 4. there is a low level of exchange of techniques with outside farmers. Therefore, four activities were selected as countermeasures to solve the above mentioned problems during verification trials as mentioned below.

Table 4.6.1 Details of Verification Trials for Strengthening of Farmers'Groups

Activity	Details	Note
3.1 Strengthening of support system of organizational management of SONADER	On the job training was offered to SONADER staff during the verification trials and was promoted to strengthen the support system of organization management.	The system of organization management was formulated in consideration of future expected structure after rehabilitation
3.2 Training of farmers leadership	By meeting and discussion with the farmers a consensus was built to manage their organizations, to market their products etc..	Training was provided on the division of responsibilities of the cooperative activities, management of the accounts, methods of disseminating information, conducting of regular meetings, review of internal regulations, mode of electing members, and to disseminate all the decisions (Details are in ANNEX 3)
3.3 Strengthening UCAF	Information campaigns were made to agricultural cooperatives to reconfirm the rationale of the UCAF, and reactivate as an organization working for farmers.	The division of responsibilities in the UCAF, activities of each agency, managing the accounts, methods of disseminating information, holding regular meetings, review the internal regulations and instructions for election of members were reexamined. Besides, a general meeting, which has not been conducted for a long period shall be conducted, and the new system to be introduced shall be published. (Detail are in ANNEX 3)

As results of verification trial, strengthening of support system for SONADER and revitalization of UCAF, self-reliant operation could not be achieved because of time limitation. However, it was found out that there is a need to ensure the transportation of SONADER staff, and they should improve the relationship with the farmers. Continuous improvement of ability of SONADER FG staffs and strengthening of office and organization of UCAF are expected.

The activities carried out in the verification trials are mentioned below.

4.6.1 Strengthening of SONADER

During the verification trials, on-the-job training (OJT) was given to SONADER staff in the fields of strengthening of cooperatives, formation and operation of UCAF. Specifically, strengthening of the five cooperatives which were involved in the demonstration plots and supports the reactivation of the UCAF was made. As a result, the SONADER which has not carried out farmers support activities again recognized the importance of supporting farm organizations, and its leaders have worked with great energy. The lively discussions were initiated even on agricultural issues at the regular weekly meetings, which at first were carried out between the Study Team and SONADER, and then drew the attention of the UCAF and other groups. Presently several representatives of agricultural organizations participated the weekly meeting.

Regular Weekly Meeting

Yet, UCAF and the cooperatives are not fully out of the lethargy into which they are succumbed for many years. This was mainly because of the fact that the farmers did not fully understand the benefits they could bring by forming an organization, because of the undeveloped irrigation system which was almost not improved, and also the farmers who were practicing agriculture continued to do the cultivation in the same way. In the future, it is also necessary to conduct such meetings with the farmers and to provide information to improve the situation.

As results of verification trial, as a result of instruction of OJT, it was verified that staffs became active, and provided support for farmers' organization more efficiently. However, limited transportation is a major obstacle on efficient support for organization in entire area. In order to apply for A/P, it t is expected to ensure transportation of staffs and improve their ability.

4.6.2 Training of Farmers Leaders

Since it is not possible to expect adequate support from SONADER, it is vital to strengthen the agricultural cooperatives, and it is crucial to train the leaders among the farmers. In order to train the leaders gradually stage by stage, at first the capacity of five cooperatives which participated in the verification trials was strengthened. In regard to the implementation of the training, the extension agent of SONADER who is in-charge of training and farmers organization was involved in analyzing the present conditions, extracting out the problems, finding out remedial measures, planning on training contents, and methods of implementation. Based on these methods, the implementation was

made as on-the-job-training.

During the workshop conducted in mid July, it was found out that the cooperatives P1 (Al Wahida for men and Al Wahida for women) and P2 (El Wai for men, Wartaré1 and Bokki women) were highly different. The cooperative in P1 side consisted of mostly family members, and was not functioning. The cooperatives in P2 side were functioning, but needed to be strengthened further. Thus, for cooperatives in P1, special training was provided to explain the foundations of an organization (see figure below)

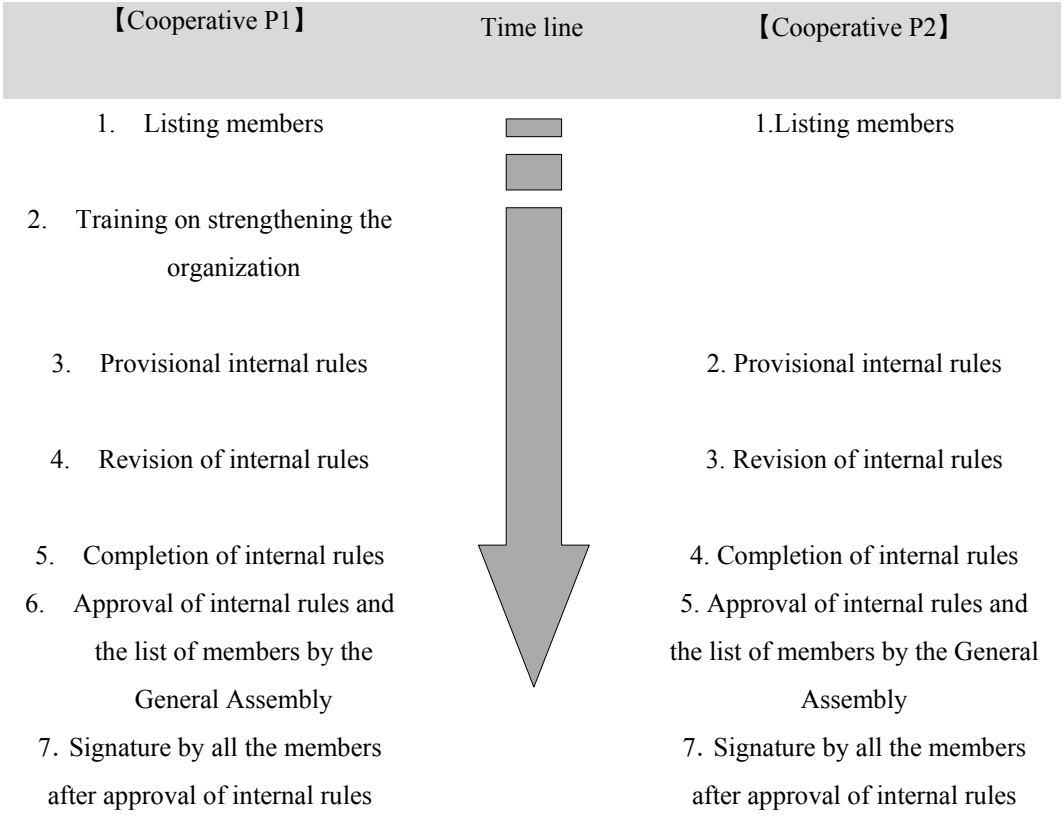


Figure 4.6.1 Procedure of Strengthening Targeted Farmers' Organization

For this purpose, the Study team and the extension agent of SONADER who is responsible for training and farmers organization conducted 14 workshops and three training courses for 550 people in July and August 2009. (Details are in ANNEX 3).

Normally the rules and the activities of an agricultural cooperative are defined at the time of its formation, but most of the cooperatives in Foum Gleita do not have this information until now, even though these cooperatives were setup nearly 20 years ago. Hence it was necessary to update the information of almost all the cooperatives, and in the verification fields, it was made as an opportunity for all the activities to be carried out including accumulation of the necessary information.

Because of the time limitation, the activity was focused on the five cooperatives of the

verification fields, but the same activity should be repeated to other cooperatives in Foum Gleita in the future.

As results of verification trial, it was verified that the organizational ability of leaders of 5 cooperatives who were engaged in the farm management of the verification trials was improved and their activities became more intensive. In order to apply for A/P, training of leaders of other cooperatives is needed in a similar way.

4.6.3 Strengthening of Union (UCAF)

Presently, it is difficult to say that union (UCAF), which is normally placed over the cooperatives, has so far fulfilled its role with the farmers or cooperatives. Therefore, the problems of the UCAF were highlighted including the internal problems of the union and to strengthen its capacity in order to reform itself in the right direction.

SONADER and UCAF Meeting

The real action was started in December 2009 with the confirmation of internal rules and by a series of meetings with cooperatives. The Study team had a significant impact on the resumption of activities of union, and the work for the recovery of UNCACEM loans between 2001 to 2007 was started, and it was possible to borrow loan in 2008. The details of activities in each month are mentioned below.

Table 4.6.2 Outline of Activities for Strengthening of UCAF

Month	Activities
Dec.2009	SONADER explained to a total about 430 farmers, 33 times about handling loan and future prospect and exchanged opinions with the members of the cooperatives. Preparation for the General Assembly was held on February 28, and agreements were made after active discussion as follows. 1. Executive officers of UCAF need to be selected again. 2. Some cooperatives are not functioning enough, and some cooperatives need to be restructured. 3. SONADER shall also support the restructuring of cooperatives and it should be done within 60 days. After that, the executive officers should be reelected in general assembly.
Jan,2010	
Feb.	
March	The vehicles and the fuel fee were provided by the head quarters of SONADER. It supported the strengthening of the organization for all cooperatives. Reelection of executive officers and representatives of the UCAF were done. Even though the general assembly was held on April 16, they could not agree on whether there should be one or two new unions. Therefore, the selection of executive officers of union was not made.
April	
May	Although the discussion among farmers was continued, since the situation has not improved, and hence the Study team proposed a compromise plan (To establish 2 independent coordinating committees under one union). The government including SONDER and most of the farmers' group agreed the plan, but a part of the farmers group showed reluctance to this proposal. It was decided to continue to organize the union by SONADER with the government support and a breakthrough of this situation is expected until August 2010.
June	

Since the main importance was placed on the sustainability of the activities, the Study team itself did not direct any activities towards making changes, but UCAF was carrying out those activities including organizing the farmers in the project area and the agricultural cooperatives with the indirect support of SONADER. The process was also important in a situation where there were extremely limited resources, and consensus took time and things were not progressing smoothly, as it was expected by the Study team. Since the process was also important, the Study team explained the situation to SONADER, and MDR, and it was expected that there would be a breakthrough until August 2010.

As results of verification trial, although the discussion of revitalization of UCAF was active, forming of a new organization could not be achieved. The main reasons were not only the time limitation, but also the deep-seated distrust of officers in UCAF and speculation of each group after reformation. In order to apply for A/P, it is necessary that they achieve a self-reliant organization management and take time for discussion among the farmers for mutual understanding. Strengthening of UCAF shall be continued.

4.7 Urgent Construction Measures

Although it was not included in the component of verification trial, urgent construction measures were planned with SONADER in order to strengthen the irrigation facilities to avoid the stopping of irrigation water supply by expected defect of the facility, and to support the farm management activities in the rainy season of 2009, and the work was executed by re-consignment. The details of the urgent construction measures were to excavate the drainage canal on the left bank of OA and to strengthen the dike of right bank at the downstream of AD and canal bridge. The works were completed in July 2009. Right after the construction, the largest recorded flood brought unexpected sediment discharge, but the collapsing of AD could be prevented through the construction measures.

4.7.1 Removing of Sediments of Drainage Canal at the Left Bank of OA

(1) Objectives

OA primary canal (3.8km length) supplies irrigation water for all the irrigation area starting from the dam. The objective was to complete removing of the sediment of drainage channel which is placed parallel to left bank of the canal for 450m length from the starting point well before the rainy season. This work was implemented by reconsignment to a local contractor under the supervision of SONADER Foum Gleita and the Study team (See Fig.4.2.1 Verification Trial Sites).

(2) Background

During the first year study, it was requested by SONADER that the urgent measures should be done in the canal sections which were expected to overflow or break in the rainy season of 2009.

The existing drainage channel was a rectangular canal with 3.0m base width, but almost all the sections were buried by the sediments. Therefore, it was feared that the rain water and sediments in the left bank just at the downstream of dam might be flow directly into OA canal. In addition, there was also concern that the accumulated rain water and sediment might decline the ability of supplying water in the upstream and it would result in overflow and break at the downstream side of the irrigation system by increasing the amount of water flow at the downstream of the canal.

In the rainy season 2008, downstream of right bank of AD and left bank of AG were broken, and it was reported that the flow of rain water at OA might be the cause of this problem. Flow of rain water and sediments into the primary canals were influencing on the safety of the entire system. Especially, it was possible to break at the right bank dike at the downstream of AD right aqueduct, even after the emergency measure was done in 2008 at the left bank at upstream of inverted siphon of AG. It was proposed to take urgent countermeasures by SONADER Foum Gleita due to decrease of rain water and sediments and to improve safety before the rainy season in this year.

(3) Details of Implementation

The activities which were jointly implemented by SONADER Foum Gleita and the Study team are as follows:

① Confirmation and measurement of rain water flowing area (used surveying tool of FG)
② Discussion and getting consent of the neighboring local farmers before starting construction.
③ Confirmation of downstream box culvert (PK900) and sediments situation.
④ Planning and design
⑤ Explanation at the site
⑥ Management of the construction
⑦ Completion inspection

Description of works is as follows.

- Drainage extension： 450m
- Depth of excavation： Maximum 140cm
- Base width： 3.0m
- Reinforcement of left embankment of OA canal by excavation and using existing the soil.

(4) Evaluation

The construction of drainage canal was completed in 7days although there were interruptions for 3days by rainfall and breakage of construction machine. During the construction, the contractor

acted immediately on instructions given by the Study team such as excavation method, the construction process and extension of width of the drainage canal. After the construction in September, there was the largest recorded flood since 1984, and sediments were deposited more than the expectation at OA principal canal, but invasion of sediments to the canal could be avoided. In future, it is necessary to implement removing of sediments in the drainage canals every year, and to construct a new box culvert of drainage during the major rehabilitation works.

Before construction (June, 2009)	Under construction (early July, 2009)	Sand accumulation after completion (Oct. 2009)
		

Excavation of Drainage Canal on the Left Bank of OA Primary Canal

4.7.2 Strengthening of Dike at the Downstream of Aqueduct of Principal Canal AD

(1) Objectives

At the end of the principal canal OA, there is a diversion structure which divides the water flow to primary canal AG (left bank), and the primary canal AD (right bank). The targeted location of urgent construction measure is located at the midway of the AD principal canal (1.8 km length). There is a road combined with aqueduct at the crossing point of the principal canal and Gorgol river, and the main aim was to strengthen dike of the downstream side. Apart from strengthening of OA primary canal, the other works should also be completed before the rainy season, and the work was implemented by reconsignment to local contractor under the supervision of SONADER Foum Gleita office and the Study team (See Fig.4.1.1 the construction site).

(2) Background

In the first year of the study, request was made by SONADER for the assistance of urgent construction measures at the canal sections which were expected to overflow or break in the rainy season 2009. Since the quantities of the construction were many, it was proposed to be postponed the construction until the main rehabilitation works. However, the particular area was repaired almost every year by urgent measures. Therefore, it does not function as a dike road and the local people are going through the drainage as temporary diversion. However, the backwater of Gorgol river blocked traffic and created inconvenience to the people. The users of this road include the people living in the northern beneficiary area and a part of the people living in scattering villages of a few thousands km^2 around the left bank of White Gorgol river in the southern part. Since the dike road is playing an

important role of transporting goods and there was a strong request from SONADER, it was determined to execute the work with high urgency.

(3) Details of Implementation

The activities which were jointly implemented by SONADER FG and the Study team are as follows:

① Confirmation and measuring of reinforcement zone (using surveying tool of SONADER, Foum Gleita)
② Securing the consent of the local population for the construction
③ Planning and design
④ Explanation at the site
⑤ Management of the construction
⑥ Completion inspection

Description of work is as follows;

- Reinforcement zone extension： 60m
- Width of top of Dike : 8.0m（Including 2m width of participatory fence）
- Protection（Gabion, macadam pavement）

(4) Evaluation

Reinforcement of dike was completed in 10 days in spite of heavy disturbance by rainfall and breakage of construction machine. The width of dike road was extended to 8m, which could improve the safety of the canal and the dike. Even the largest recorded flood in September did not create any problem.

Regarding verification and strengthening of future ability and techniques of operation and maintenance, the measurement and construction management exercises were carried out to the technical service department of SONADER Foum Gleita by the Study team, and the training was provided from contracting to completion of construction in a short term and the initial objective was achieved.

Before construction (June 2009)

Under construction (early July 2009)

Sand accumulation (October, 2009)

Strengthening of Dike at the Downstream of Aqueduct of Principal Canal AD