

Report No. 1682-NIR

# Appraisal of an Irrigation Project Niger

September 11, 1978

Agriculture Projects Department  
Western Africa Regional Office

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W/IDA/R78-110 9/21/78  
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### CURRENCY EQUIVALENTS

Currency Unit	=	CFAF Franc
US\$1	=	CFAF 245
CFAF 1	=	US\$0.00408

### WEIGHTS AND MEASURES

1 kilometer (km)	=	0.6215 mile
1 centimeter (cm)	=	0.033 feet
1 hectare (ha)	=	2.47 acres
1 metric ton (t)	=	2,207 lbs
1 kilogram (kg)	=	2.207 lbs

### ABBREVIATIONS

ADF	African Development Fund
BADEA	Banque Arabe pour le Developpement en Afrique
CNCA	Caisse National de Credit Agricole
FAC	Fonds d'Aide et de Cooperation
FNI	Fonds National d'Investissement
GR	Service du Genie Rural
IRAT	Institut de Recherches d'Agriculture Tropicale
MRD	Ministry of Rural Development
ONAHA	Office National des Amenagements Hydroagricoles
OM	Operation and Maintenance
OPVN	Office des Produits Vivriers du Niger
SOGREAH	Societe Grenobloise d'Hydraulique Agricole
UNCC	Union Nigerienne de Credit et de Cooperation

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MAPS



## NIGER

### IRRIGATION PROJECT

#### SUMMARY AND CONCLUSIONS

- (i) The Government of Niger has asked IDA to help finance the development of the country's irrigation subsector. A major component of the project would be the development of a 1,550 ha scheme at Namarigoungou. The project is based on a feasibility study by SOGREAH, and on the findings of an appraisal mission which visited Niger in February 1977.
- (ii) Because of the increasing demand for food the country is no longer self-sufficient, even in normal years, and is unlikely to become so in the next decade, even assuming that all planned rainfed improvement projects and all irrigation projects (some 1,300 ha annually) for the period 1977-1983 are realized. While rainfed projects are necessary to help the great majority of the rural community, Government believes that equal priority should be given to investments in irrigation schemes. IDA endorses Government's policy of a balanced development of the agricultural sector. IDA is financing a productivity improvement project for the Department of Maradi; is assisting in the preparation of another productivity improvement project for the Department of Dosso; and considers financing a forestry and a livestock project. The proposed irrigation project would be the first major irrigation project. In addition to its objective of food production, it would assist Government in its goal of creating the necessary institutional framework to build and develop some 1,300 ha of irrigated schemes annually through the creation of the "Office National des Amenagements Hydroagricoles" (ONAHA).
- (iii) The relatively high cost of the project, estimated at US\$6,300/ha for investment (in constant terms) and at US\$500/ha/year for annual development expenses during the development period, is due (a) to the fact that the country is landlocked which increases the cost of imported goods; (b) the lack of local expertise; and (c) the absence of effective competition in the contracting and supply industries.
- (iv) The project would comprise (a) constructing the Namarigoungou polder; 1/ (b) providing services to the farmers who would take up cultivation at Namarigoungou and to the farmers already cultivating on the schemes presently under irrigation; (c) improving health services; (d) training farmers in modern agricultural techniques; and (e) preparing a feasibility study for a nearby polder north of Namarigoungou.

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1/ Polders are land reclaimed from the sea or any other body of water by constructing dikes and drying out the land so empoldered. Thereafter, the water runoff is controlled by sluicing or pumping. A "cuvette" is part of the flood plain of the Niger River and is usually submerged at the time of the high flood level.

(v) Project costs are estimated to total CFAF 5.1 billion (US\$21 million) of which the foreign exchange component would be US\$14.8 million, or 70%. Principal components are irrigation works construction (US\$8.6 million); management of the project and administrative and financial services (US\$2.6 million); agricultural development services and support unit (US\$2.5 million); other (US\$1.8 million); and contingencies (US\$5.5 million). Other costs include the financing over a three year period of a financial coordinator for the IDA-financed agricultural projects (US\$0.3 million). Except for the financial coordinator, who would be financed 100% by IDA, all other project items would be financed jointly by IDA and Kreditanstalt für Wiederaufbau (KfW). It is proposed that IDA make a credit of US\$15.0 million. KfW would make a credit of DM 12.5 million (US\$6.0 million). The IDA credit and the KfW credit would be disbursed on a pari-passu basis (70% for IDA; 30% for KfW).

(vi) Analysis of the construction costs for several irrigation schemes in Niger indicates that contractor costs are unusually high reflecting partly a lack of effective competition. To stimulate competition, it is necessary to build up the capabilities of the smaller local contractors and to develop Government capability to construct the irrigation schemes by force account. The project would give ONAHA the capability to construct the Namarigoungou works by force account. This would result in cost savings of some 40% compared to contractor costs and give practical training to a number of local technicians and engineers. Another advantage of the force account approach would be the greater flexibility in project implementation. The only civil works to be built by contractor (US\$0.5 million) would be the pumping stations.

(vii) The following procurement procedures would be used: Orders or contracts for equipment, vehicles, the electrical line from Tillabery to Namarigoungou, supplies for construction, agricultural equipment and inputs with a value of more than US\$50,000 would be through international competitive bidding (ICB), in accordance with IDA guidelines. Such procurement is estimated to have a value of US\$4.0 million. Contracts of less than US\$50,000, and construction of the civil works for the Namarigoungou pumping stations, of houses, storage areas and offices, which are too small to attract foreign contractors, would be procured on the basis of competitive bidding advertised locally and in accordance with local procedures satisfactory to IDA. However items of less than US\$15,000 each could be purchased directly from local suppliers. Contracts procured under local competitive bidding would not exceed US\$1.5 million. Consultants would be recruited according to IDA guidelines (US\$4.3 million). Some US\$5.3 million would be for operating expenses and local staff salaries.

(viii) The project would be carried out by ONAHA, which would be established prior to presentation of the Credit to the Executive Directors. The organization of ONAHA would be based on the recommendations of consultants financed through a project preparation facility of US\$8,500. The Regional Director of ONAHA at Tillabery would be responsible for day-to-day implementation of the project.



(ix) Organization of farmers on the schemes would evolve, with ONAHA's directive involvement being progressively replaced by farmers' cooperatives. Until such time as the latter are ready to assume management activities, ONAHA would assure farmers supply of water and basic services. Farmers would be organized into the smallest groups compatible with management of the schemes, comprising about 10 farming units. The group would establish the basis for financial solidarity for credit repayment.

(x) The procedures for land allocation in the irrigation schemes have been proven through past testing along the Niger River and are known to be acceptable to the present land owners and to the new settlers. Under the project land would be allocated on the basis of no more than 1 ha per farming unit.

(xi) Project induced annual production would be as follows: In the Namarigoungou polder under irrigation: 12,500 tons of rice paddy, 400 tons of sorghum and 950 tons of various vegetables; on the rainfed holdings of the Namarigoungou farmers: 1,600 tons of cereals. Production increases on the existing schemes are estimated at 900 tons for rice paddy in the polders, and 700 tons for cereals under rainfed cultivation.

(xii) Without the project the farmer taking up cultivation on the Namarigoungou polder would continue to have an annual net income of about CFAF 115,900 (US\$473). With the project and assuming that he is given 0.5 ha to cultivate, his net income would increase to CFAF 251,600 (US\$1,027). His per capita net income would increase from US\$90 to US\$197. At the proposed level of water charges, Government's cost recovery index from farmers would be about 37%.

(xiii) The project's direct benefits would be the increased production it would generate for the 3,000 farming units (16,000 people) who would take up cultivation on the Namarigoungou polder. The economic rate of return is estimated at 12.5% for the project components whose benefits have been quantified. The project would have a number of secondary benefits not included in the rate of return calculations, namely: (a) increase in the agricultural production of farmers cultivating in other schemes in the project area; (b) creation of farm employment (some 400,000 man-days), 70% of which for the riparian populations.

(xiv) The risks attached to the project have been considered from several angles: financial, technical, institutional and social. The financial risk has been reduced by having the detailed engineering study completed prior to this draft green cover report. The technical risk is mainly in the achievement of the production increases contemplated. The sensitivity analysis indicates that even if the production of paddy were 25% lower, the rate of return would still be acceptable, at 8%. The institutional risk will be overcome through the creation of ONAHA, which would be adequately staffed and equipped to carry out the project. The social risk involved in land allocation will be reduced by the use of well-established land allocation procedures.

(xv) On the basis of the assurances set out in Chapter IX, the project is suitable for an IDA credit of US\$15 million.



NIGER  
IRRIGATION PROJECT

I. INTRODUCTION

1.01 The Republic of Niger has asked IDA for assistance in financing the development of the country's irrigation subsector mainly in the "Arrondissements" of Tillabery and Tera. A major component of the project would be the development of a 1,550 ha scheme at Namarigoungou. A feasibility study of the Namarigoungou scheme was prepared by Consultants SOGREAH in 1974. This report is based on the findings of an IDA appraisal mission which visited Niger in February 1977. The appraisal mission consisted of Messrs. Ropiteau and Park (IDA), Boumendil, Chateau, and Reynders (Consultants).

1.02 The proposed project would be the fifth in Niger's agricultural sector to be financed by IDA. Summary statements on the implementation of the other projects are in Annex 1, including that on the Agricultural Credit Project (Credit 207-NIR) for which a completion report and an audit report are being circulated to Government for comments.

II. BACKGROUND

A. General

2.01 Niger is one of the largest landlocked countries in Africa, covering about 1.3 million km<sup>2</sup>, between latitudes 10° and 25° (map). Rainfall decreases from between 700 and 800 mm annually in the south, to less than 350 mm 150-200 km further north. About 10% of the area is suitable for crop production, but of very low potential. About 2% of the land area is cultivated. Drought to one degree or other is a common occurrence and in 1968-1973 drought reached catastrophic proportions.

2.02 About half of the country's some 4.7 million people live between the southern border and the 500 mm isohyet, where population pressure averages only about 20/km<sup>2</sup>, although in valleys it may be as high as 100 km<sup>2</sup>. Population growth rate is high at 2.7% per annum.

2.03 The per capita GNP increased between 1972-75 to US\$130, owing to greater mining activities. Uranium mining began in 1971. The present production of 1,600 tons should increase to 3,500-4,000 tons in 1979, making Niger the fourth largest producer of uranium in the world. The earnings resulting from increased uranium production and quadrupling of its price make it possible for Government to allocate greater local resources for productive investments. The "Fonds National d'Investissement" (FNI) is the vehicle for such investments. Government's allocation to the FNI was CFAF 10 billion in 1976/77 (US\$40 million) compared to CFAF 4.5 billion in 1975/76.

## B. The Agricultural Sector

2.04 The agricultural sector directly supports about 90% of Niger's population. It contributes about 47% to GDP. Prior to 1973 Niger used to be self-sufficient in food, but it was obliged to import some 500,000 tons of cereals over the period 1973-1975. Because of the increasing demand for food the country is no longer self-sufficient, even in normal years, and is unlikely to become so in the next decade, even assuming that all planned rainfed improvement projects and all irrigation projects (some 1,300 ha annually) are realized.

2.05 As far as rainfed farming is concerned, there is a limit to the level of increases that productivity improvement projects can generate. Income levels in the rainfed areas of Niger are less than US\$70 per capita and with present technology these can be increased by perhaps 50%, but the beneficiaries of such projects will continue to remain very poor, and the food base of the country will continue to depend upon unreliable rainfall which from time to time fails catastrophically. Nevertheless, Government intends to improve productivity and farm incomes as much as economically justified. It intends to develop the general use of farm inputs through the development of agricultural credit and the strengthening of agricultural extension services; and over the next few years plans productivity improvement projects throughout the southern tier of the country where rainfed cultivation is possible.

2.06 While rainfed projects are necessary to help the great majority of the rural community, Government correctly believes that equal priority should be given to investments in irrigation schemes. At present, some 8,000 ha of modern irrigation schemes have been developed: 3,700 ha along the Niger river valley. This compares to a total irrigation potential of about 200,000 ha (Annex 1): 100,000 ha along the Niger River. The latter, however, cannot be fully developed for double cropping irrigation until the flow of the Niger River is regulated by a dam to be built at the site of Kandadji (1985). Still, there are some 16,000 ha that could be developed for double cropping irrigation along the Niger River prior to the construction of the dam. At the present rhythm of development of 1,300 ha per year, this would take more than 10 years.

2.07 IDA endorses Government's policy of a balanced development of the agricultural sector: IDA is financing a productivity improvement project for the Department of Maradi whose content and organization is intended as a model for future similar projects, and is assisting in the preparation of another productivity improvement project for the Department of Dosso. The two Departments comprise about one-third the area of the southern tier of Niger. IDA also intends to finance a pilot forestry project and a livestock project which would include 30% of all cattle in Niger.

2.08 The proposed irrigation project is a necessary complement to these various projects. It would be the first major irrigation project in Niger, and in addition to its objective of food production, it would have a number of other benefits:

- (a) It would assist Government in its goal of creating the necessary institutional framework to build and develop some 1,300 ha of irrigated schemes annually, through the creation of the "Office National des Amenagements Hydroagricoles" (ONAHA), which would integrate and strengthen the activities of construction and management of the irrigation schemes hitherto carried out by the "Service du Genie Rural" (GR) and the "Union Nigerienne de Credit et de Cooperation" (UNCC), respectively.
- (b) It would not only produce rice, which is increasingly becoming a staple food for the populations along the Niger River and the city dwellers, but also a variety of vegetables, and it would provide the means for a better utilization of the local livestock resources. Irrigated fodder and crop by-products and residues would be used for finishing stock for sale, and this would help reduce the long cattle migrations, often to Nigeria, during the dry season.
- (c) It would allow the use of modern agricultural technology on the schemes, and to some extent, the use of improved methods on the rainfed holdings of project participants.

2.09 The relatively high cost of the project, estimated at US\$6,300/ha for investment (in constant terms) and at US\$500/ha/year for annual development expenses during the development period, is due to a number of factors, including (a) the fact that the country is landlocked which increases the cost of imported goods, (b) the lack of local expertise, (c) the small scale of the project and (d) the absence of effective competition in the contracting and supply industries. Cheaper alternatives to the proposed technical design (full water control) were studied and rejected because they were less economical or impractical, namely: improved flood recession, which will no longer be possible once the Kandadji dam is built (para 2.06), limited water control, which is less economical, and development through wells, which is impossible. The project would be built by force account, which would result in savings of about 40% compared to the contractor costs, would make possible a transfer of expertise in the construction of irrigation works to the local technicians, and would introduce some competition in the contracting and supply industries.

### III. THE PROJECT AREA

3.01 Location. The project area is the "Arrondissements" of Tillabery and Tera (see map). There are a number of existing irrigation schemes (1,200 ha) described in Annex 3, and one new scheme to be built in 1978, Lossa third phase (162 ha), with financing from Fonds d'Aide et de Coopération (FAC).

3.02 Access. The major town in the project area is Tillabery, 130 km northwest of Niamey (see map) by tar-surfaced road. The Namarigoungou scheme would be linked by a 30 km dirt road to Tillabery, and the other schemes are within a 60 km radius of Tillabery.

3.03 Climate. The climate is Sahelian, characterized by high day time temperatures, sharp intra-day variations, and a long dry season, from October through June. Average annual rainfall is about 430 mm (Annex 4), which is only adequate for the production of low yielding crops of drought resistant plants such as millet.

3.04 Hydrology. The discharge of the Niger River is monitored through 5 water gauges along the 550 km of the Niger River. The average flow in Niamey is 985 m<sup>3</sup>/sec. Highest floods occur in the period September through March, and lowest floods in June. Considering the period of reference as 1964-1974, the dry season monthly discharge would exceed 15 m<sup>3</sup>/sec nine years out of ten. This figure limits double cropping irrigation from the Niger River north of the town of Say to around 12,000 ha (Annex 1, Table 3). South of the town of Say the river benefits from a number of tributaries and the dry season flow is rarely below 50-60 m<sup>3</sup>/sec.

3.05 Soils. The soils of the polders along the Niger River are usually clay and are suitable for rice cultivation. The soils classification map for the Namarigoungou polder (scale 1/10,000) and the soils analyses indicate that soils are clay (60%) and sandy/silty soils (10%) and that the remaining 30% are unsuitable for cultivation. Double cropping of rice is possible on the clay soils, and double cropping of sorghum and vegetables on the sandy/silty soils.

3.06 Population. The main beneficiaries of the project would be the 3,000 farming units (16,000 people), who would take up cultivation on the Namarigoungou polder. Other beneficiaries would include the 2,200 farming units already cultivating on the existing schemes. At least 75% of participants would belong to the Wogo tribe, who are traditionally good at farming. The rest would belong to the Kado tribe. (Annex 5). The average farming unit size of about 5.25, with 1.50 male adults, is the same for both ethnic groups. The present per capita income of farmers likely to participate in the project is about US\$79, or some 25% above the absolute per capita poverty level of US\$63 for Niger.

3.07 Farm Size and Land Tenure. Socio-economic surveys conducted during project preparation indicate that the average Wogo farm comprises

4.10 ha under cultivation: millet and cowpeas (rainfed, 2.60 ha); rice (traditional irrigation, 1.15 ha); sorghum (flood recession, 0.15 ha); tobacco and gardens (0.20 ha) (Annex 6); the study also showed that farmers do not give up traditional cultivation when they participate in modern irrigation schemes. The Wogos rent about 20% of the land they cultivate from the Kados. The land in the schemes becomes property of the nation, and previous owners are given priority for land allocation.

3.08 Health. There are no reliable statistics on the health situation in the area. Waterborne diseases (malaria and bilharzia) are the most frequent, especially affecting the young children, but the proposed project would not exacerbate the present situation, and it includes a limited health component (para 4.22).

#### IV. THE PROJECT

##### A. Objectives and Components

4.01 The project (1978-1982) would seek (i) to increase Niger's production of rice through the development of irrigated agriculture and (ii) to improve the income of participating farmers from their holdings in the irrigation schemes and in rainfed areas. The project would comprise:

- (a) Constructing the Namarigoungou polder (dike, irrigation and drainage systems and on-farm works);
- (b) Providing services to the farmers who would take up cultivation on the Namarigoungou polder (1,550 ha of net area) and on the Lossa III scheme (162 ha of net area); and to the farmers already cultivating on 1,215 ha presently under irrigation development. Such services would include: delivery of irrigation water, assistance in organization, extension, applied research and seed multiplication, procurement of inputs, agricultural credit and crop marketing;
- (c) Improving health services;
- (d) Training project staff, farmers and artisans;
- (e) Providing the necessary physical infrastructure and equipment to carry out project activities; and
- (f) Preparing the feasibility study for a nearby polder (3,300 ha net area) north of Namarigoungou.

The project would be carried out by ONAHA (para 2.08).

## B. Detailed Features

### Development of the Namarigoungou Polder

4.02 Works to be built in the Namarigoungou polder include (Annex 7):

- (i) a dike some 12 km long and 3.0 m high to protect the polder against the maximum flood levels occurring in a one to one hundred year frequency;
- (ii) two pumping stations, each serving a separate district, designed to allow gravity irrigation as often as possible, with the lowest pumping station serving during floods to drain water back to the river. The pumps would be vertical axial flow type, and the power would be supplied by a 20 KV power line drawn from Tillabery.
- (iii) an irrigation network, including some 30 km of primary and 40 km of secondary canals, and a tertiary network; and
- (iv) a drainage network, using as much as possible the existing streams.

4.03 Concrete Lining of Canals. The cost and financing plan of the project are based on the assumptions that primary and secondary canals would be concrete lined. Since concrete lining cannot always be economically justified, assurances were obtained at negotiations that this would be done when criteria agreed upon between Government and the Association are met. The criteria proposed by the Association were that the canals be lined where (i) the soil permeability measured in situ was equal to or greater than 0.4 m/day, and (ii) necessary as protection upstream and downstream of canal structures and connections. Additional criteria could be submitted by the Borrower for the co-lenders' review and acceptance no later than one month prior to the commencement of canal construction.

4.04 Namarigoungou Irrigation System Design and Capacity. The capacity of the main canals is designed for 2.8 l/s/ha (Annex 8). Farmers would irrigate 16 hours per day. The secondary canals irrigating mixed cropping areas are designed for 2 l/s/ha. The perimeter would be divided into two irrigation units. Based on a discharge for the tertiaries designed at between 20 l/sec and 40 l/sec, the size of the irrigation blocks would vary between 7 and 14 ha. The average size of the individual farms would be 0.5 ha. They would be irrigated by rotation.

4.05 Namarigoungou Drainage System Design and Capacity. Drains would have a design capacity of 1.2 l/s/ha. During the normal flows of the river drainage would be assured by gravity through flap gates at the southernmost tip of the scheme; during the flood season drainage waters would be pumped out at the pumping station SP<sub>2</sub>.



4.06 Water Demand and Supply. At full development (by year 1982) total yearly requirements for the Namarigoungou scheme (1,550 ha of net area) would be some 48 million m<sup>3</sup> at the source, based on requirements on the existing irrigation schemes. Its requirements in June when the water level is lowest in the Niger River would amount to 16% of the minimum flow occurring in a one to ten year frequency (Annexes 1 and 2).

4.07 Water Quality. The waters of the Niger River are excellent for irrigation and can be classified C<sub>1</sub> S<sub>1</sub> on the USBR classification.

4.08 Status of Engineering. Maps of the Namarigoungou polder (scale 1:2,000) and semi-detailed soil classification (scale 1:10,000) have been completed. The detailed design of the works and the update of the costs as well as the bidding documents for procurement were terminated in February 1978. This was done by SOGREAH under Government financing. The project would be executed with the assistance of consultants to be retained under the procedure described in para 6.04.

4.09 The construction schedule (Annex 14) shows procurement of equipment in 1978, and the works starting in February 1979 with the construction of the dike, being completed by mid-year 1981.

#### Provision of Services to Farmers

4.10 Beneficiaries. The project would finance the provision of services to all farmers cultivating on the irrigation schemes in the "Arrondissements" of Tillabery and Tera, including the existing schemes where the services are presently inadequate (Annex 2).

4.11 Until such time as farmers are ready to assume management activities (para 6.08), ONAHA would manage the main infrastructures, provide irrigation water, assist in the creation of farmers' cooperatives, evaluate farmers' equipment requirements, organize the provision of agricultural credit for equipment and improved seeds, and importantly, provide them with effective extension advice for their holdings in the irrigation schemes and in the rainfed areas. A number of blocks in the Namarigoungou polder would be used for applied research tests and seed multiplication. Assurances were obtained at negotiations that the design of the research trials and the seed multiplication program would be acceptable to IDA.

4.12 Details of the production packages are given in Annex 6. The techniques advocated for rice cultivation and mixed cropping under irrigation are proven through past testing in the project area and known to be acceptable to reasonably receptive farmers. They include: ox-drawn plowing, transplanting, fertilizer applications, proper weeding, hand harvesting and threshing using a thresher with paddles. There is no evidence that the improved measures advocated for rainfed cultivation have been thoroughly tested in the project area under farmers' conditions (new varieties, pure stand planting, fertilizer applications). There is some indication, however, that increases in yields are possible. In any case, improved techniques would be introduced progressively, and it is not assumed that the complete package would be adopted by more than 10% of all farmers.

4.13 The area under cultivation in the Namarigoungou scheme would be divided according to soil suitability between: rice (1,350 ha), mixed cropping (150 ha) and fodder crops (25 ha); in addition 25 ha of eucalyptus would be planted. Double cropping would be practiced for all annual crops. Mixed cropping would consist of one crop of sorghum during the rainy season and a variety of vegetables during the dry season. The fodder crops would enable some 500 head of cattle to be fattened annually. The eucalyptus would be cut every 3 years. In addition, project services would be extended to the 9,000 ha that Namarigoungou farmers would continue to cultivate under rainfed conditions.

4.14 The area under cultivation in the other schemes (1,180 ha total net area) would comprise 740 ha of rice in double cropping, 140 ha of rice single cropping and 300 ha of mixed cropping. In addition, project services would be extended to the 5,000 ha cultivated under rainfed conditions by the farmers participating in these other schemes.

4.15 Farm Inputs and Equipment, Procurement and Credit Procedures. Assurances were obtained at negotiations that the project would be granted a license to import inputs and agricultural equipment. Although the local manufacturer of agricultural equipment, SONIFAME, has recently received a line of credit to expand its facilities, it may not be able to meet the emerging demand for agricultural equipment in the country. Some 500 sets of agricultural equipment, comprising a plow and a hoe, would be financed under the project.

4.16 Caisse Nationale de Credit Agricole (CNCA) has been vested with overall responsibility for agricultural credit in the country, and all project funds for credit as well as for other costs would be channelled through CNCA. However day-to-day administration of farmers credit under the project would be carried out by the project staff. Farmers would be eligible for seasonal credit for fertilizer, insecticides and livestock to be fattened under the livestock subproject; and for medium term credit (3 years) for agricultural equipment, oxen and carts; blacksmiths, for 5 years' equipment credit. Prices for inputs include interest at the rate prevailing for agricultural credit; this rate is currently 8%. Farmers' and blacksmiths' repayments would be kept in a revolving fund administered by CNCA for the sole use of project participants. This fund would be established no later than 1979.

4.17 Niger follows a policy of subsidization of agricultural equipment and inputs: agricultural equipment (between 32% and 73%), insecticides (25%), and fertilizers (43%). For fertilizer the policy is consistent with existing agreements in the Maradi Rural Development Project that subsidies be reduced to 50% of cost by year-end 1977. This policy is justified at the present time by the low use of equipment and inputs; but it should be reconsidered when that use increases. Assurances were obtained at negotiations that government policy regarding subsidies for agricultural equipment and inputs would be discussed annually by Government and IDA.

### Improvement in Health Services

4.18 The project would finance a health training program, to be carried out under the supervision of the Ministry of Health (MOH). Assurances were obtained at negotiations that MOH would organize this training component, including post-training supervision and refresher courses; in addition, volunteer first aid assistants would be selected from among project farmers for training in basic skills. A total of some 80 first aid assistants would be trained under the program. Each person trained would be provided with a basic kit financed under the project. Renewal of the kit would be paid for by the community. The project would also provide proper water supply facilities for the two villages to be established around the Namarigoungou scheme. Assurances were obtained that Government would conduct a limited epidemiological desk study of the area and that the results of the study would be reviewed by Government and IDA to determine whether an additional epidemiological field survey to collect basic health information is warranted.

### Training Programs

4.19 The project would provide for the training of its own extension staff (about 30) and for farmer leaders, blacksmiths and other artisans (paras 6.07-6.10 and Annex 11). The project includes the subsistence costs of the trainees, the teaching equipment and the rehabilitation of a vocational school in Tillabery.

### Physical Infrastructure and Vehicles

4.20 The project includes the construction in Tillabery of 8 senior staff houses, project offices, a garage, and in Namarigoungou, 2 stores (1,000 m<sup>2</sup> total area). The capacity of the Tillabery rice mill would be doubled to 10,000 tons. A total of 9 light vehicles and 3 trucks would be purchased, in addition to the heavy vehicles required for construction of the works.

### Feasibility Study for a Future Irrigation Project

4.21 The project would finance the preparation of the feasibility study for the Gabou-Bonfeba polder (3,300 ha), which is adjacent to Namarigoungou and shows good potential. Assurances were obtained at negotiations that the consultants to carry out the study would have qualifications and experience satisfactory to IDA, and that they would be employed under terms and conditions satisfactory to IDA.

### The Project's Impact on Ecology

4.22 It is unlikely that the project would have any undue adverse impact upon the ecology and the health of the population, since, except in the dry season, no additional area would be permanently under water. On the contrary, the concrete lining of primary and secondary canals of the Namarigoungou

scheme would increase the speed of the flow, thereby reducing the snail population, which is the vector of schistosomiasis. The project also includes a limited health improvement component.

V. COST ESTIMATES AND FINANCIAL ARRANGEMENTS

A. Project Costs

5.01 Project costs are estimated to Total CFAF 5.1 billion (US\$21 million), of which the foreign exchange component would be US\$14.8 million or 70%.

5.02 Government will exempt the project from import duties and direct taxes. Project costs are therefore net of duties and taxes. They are detailed in Annex 9 and summarized below:

	<u>Local Cost</u>	<u>Foreign Exchange</u>	<u>Total</u>	<u>Local Cost</u>	<u>Foreign Exchange</u>	<u>Total</u>	<u>% Foreign Exchange</u>
	----- CFAF Million -----			----- US\$ Thousand -----			
Irrigation Works							
Construction	419	1,677	2,096	1,710	6,840	8,550	80%
Direction "Office National des Amenagements Hydroagricoles"	101	100	201	410	410	820	50%
Administrative and Financial Services	266	178	444	1,090	720	1,810	40%
Agricultural Development Services	178	179	357	720	730	1,450	50%
Support Unit	103	155	258	420	640	1,060	60%
Health Component and Training	9	22	31	40	90	130	70%
Agricultural Equipment and Incremental Inputs	34	137	171	140	560	700	80%
Other	-	221	221	-	900	900	100%
Base Cost Estimate	1,110	2,669	3,779	4,530	10,890	15,420	70%
Physical Contingencies	145	337	482	590	1,380	1,970	70%
Price Increases	267	617	884	1,090	2,520	3,610	70%
Total Expected Cost of Project	1,522	3,623	5,145	6,210	14,790	21,000	70%

5.03 The cost of the project is based on the detailed engineering study carried out by SOGREAH. Expatriate staff salaries would be equivalent to those

paid in other projects in Niger. Technical assistance for the construction of the Namarigoungou works would amount to 15 1/2 man-years over the period 1978-1981 for a total cost of CFAF 356 million (US\$1.5 million), averaging US\$97,000 per man-year. Technical assistance for ONAHA management and agricultural development would amount to 22 man-years over the period 1978-1982 for a total cost of CFAF 506 million (US\$2.1 million), averaging US\$95,000 per man-year. Salaries would account for about 50% of the total expatriate costs. Project costs include a physical contingency of 15% of the cost of the irrigation works and of 10% on all other items, and in addition a contingency to cover expected inflation amounting to 25% of base costs over the disbursement period.

5.04 Other costs comprise the feasibility study of the Gabou-Bonfeba polder and the financing over a three year period of a financial coordinator for the IDA-financed agricultural projects. The financial coordinator would provide technical assistance to the various projects in accounting and financial management, coordinate processing of disbursement applications and monitor financial reporting and auditing.

#### B. Proposed Financing

5.05 It is proposed that IDA make a credit of US\$15 million. Kreditanstalt fur Wiederaufbau (KFW) would make a credit of DM 12.5 million (US\$6.0 million). 1/ Except for the financial coordinator (para 5.04), who would be financed 100% by IDA, 100% of the other project expenditures would be financed jointly by IDA and KFW. The IDA and the KFW credits would be disbursed on a pari-passu basis. The financing plan is summarized below:

	<u>IDA</u>	<u>KFW</u>	<u>Total</u>	<u>%</u>
	<u>-----US\$ '000-----</u>			
Irrigation works construction	5,990	2,560	8,550	40
Direction "Office National des Amenagements Hydroagricoles"	580	240	820	4
Administrative and financial services	1,270	540	1,810	9
Agricultural development services	1,020	430	1,450	7
Support unit	740	320	1,060	5
Health component and training	90	40	130	1
Agricultural equipment and incremental inputs	490	210	700	3
Other	720	180	900	4
Base cost estimate	10,900	4,520	15,420	73
Physical contingencies	1,390	580	1,970	9
Price increases	2,710	900	3,610	18
Total expected cost of project	15,000	6,000	21,000	100
% of total	71%	29%	100%	

1/ The terms of the KFW credit would be similar to those of IDA excepted for a commitment of 0.25% on the undisbursed amount.

5.06 To ensure the efficient and timely execution of the project, assurances were obtained from Government that it would: (a) ensure that an account in the name of the project be established with "Caisse Nationale de Credit Agricole" (CNCA); (b) deposit an initial amount of CFAF 250 million (US\$1.0 million) into the account; (c) replenish the account quarterly on the basis of the project cash forecasts in order to provide the project with sufficient funds to meet project expenditures for the following three months; and (d) ensure that seasonal and short term credit, repayment for farm inputs, seeds, equipment, blacksmith kits and vaccines would be made to revolving fund accounts administered by the project and deposited with CNCA. The establishment of the revolving fund account with an initial deposit of CFAF 250 million is a condition of credit effectiveness.

5.07 Retroactive financing by IDA of up to US\$210,000 (70% of total cost) from January 1, 1978 is proposed to finance three scrapers necessary for the construction of the dike. KFW would finance its share or up to US\$90,000 (30% of total cost).

### C. Procurement

5.08 The analysis of the construction costs for several irrigation schemes in Niger (Annex 10) indicates that contractor costs are unusually high, reflecting a lack of effective competition. To stimulate competition, it is necessary to build up the capabilities of the smaller local contractors, and to develop Government capability to construct the irrigation schemes by force account. The project would give ONAHA the capability to construct the Namarigoungou irrigation works by force account. This would result in cost savings of some 40% and give practical training to a number of local technicians and engineers, who would be able to apply their expertise to the construction of future irrigation schemes. Other advantages to the force account approach would be greater flexibility in implementation and better phasing of the agricultural development of the polder. Works built on force account would amount to US\$8.1 million. Only the civil works of the pumping stations would be built by contractor (US\$0.5 million). ONAHA would call in small work gangs paid on a piece work basis whenever feasible.

5.09 The following procurement procedures would be used: Orders or contracts for equipment, vehicles, the electrical line from Tillabery to Namarigoungou, supplies for construction, agricultural equipment and inputs with a value of more than US\$50,000 would be through international competitive bidding (ICB), in accordance with IDA guidelines. Such procurement is estimated to have a value of US\$4.0 million. Contracts of less than US\$50,000, and construction of the civil works for the Namarigoungou pumping stations, of houses, storage areas and offices, which are too small to attract foreign contractors, would be procured on the basis of competitive bidding advertised locally and in accordance with local procedures satisfactory to IDA. However items of less than US\$15,000 each could be purchased directly from local suppliers. Contracts procured under local competitive bidding would not exceed US\$1.5 million. Consultants would be recruited according to IDA guidelines (US\$4.3 million). Some US\$5.3 million would be for operating expenses and local staff salaries.

D. Disbursements

5.10 The proceeds of the proposed IDA credit (US\$15 million) would be disbursed over five years (1978-1982) as follows:

		<u>US\$</u>	
Category I:	Civil Works		
	a) Primary and secondary canals	1,400,000	70%
	b) Other	400,000	70%
Category II:	Equipment, Vehicles, Cement, Chemicals	2,700,000	70%
Category III:	Tillabery-Namarigoungou Electric Line	360,000	70%
Category IV:	Pumping Station	470,000	70%
Category V:	Operating Expenses Including Salaries	4,820,000	70%
Category VI:	Agricultural Projects Coordinator	300,000	100%
Category VII:	Audit, Studies	400,000	70%
Category VIII:	Reimbursement of Project Prepara- tion Facility	8,500	100% of amount not reim- bursed at the date of effec- tiveness
Category IX:	Unallocated	<u>4,141,500</u>	
	TOTAL	15,000,000	

5.11 Disbursements of the IDA credit would be against import documenta-  
tion and certified records of expenditures. For disbursements made against  
certified records of expenditures documentation would not be submitted for  
review as a matter of course, but would be retained by ONAHA for scrutiny by  
IDA missions. The estimated schedule of disbursement of the IDA credit is  
in Annex 9, Table 10.

#### E. Accounts and Audit

5.12 Accounts for the project would be kept under acceptable commercial accounting practices. The cost of concrete lining the primary and secondary canals would be recorded separately, and savings realized by not lining 100% of the canals would be cancelled from the credit (para. 4.03 and para 5.10). The project accounts and revolving fund kept by CNCA for farmers' agricultural credit (para 4.16) would be audited annually by independent auditors acceptable to IDA. The auditors' opinion on the disbursement applications made against certified records of expenditures would be submitted to IDA every six months. Audited annual accounts would be submitted to IDA within six months of the closing of the financial year. Assurances to the foregoing were obtained at negotiations.

### VI. ORGANIZATION AND MANAGEMENT

#### A. Organization

6.01 The project would be carried out by ONAHA through its regional offices at Tillabery. ONAHA would be created prior to the presentation of the credit to the Executive Directors. Its organization would be based on the recommendations of consultants financed through a project preparation facility of US\$8,500, approved as part of the proposed credit. ONAHA would be an autonomous public agency under the overall responsibility of the Minister of Rural Development. ONAHA's policy decisions would be taken by a Board of Directors and implemented by a General Director. ONAHA's central services would include:

- General Directorate: The General Director would be accountable to the Board of Directors for ONAHA's operations. He would be assisted by a deputy responsible for technical operations and by planning staff;
- Engineering Services: responsible for topographical surveys, detailed engineering and construction of irrigation works;
- Agricultural Development Services: responsible for assistance in the management of the schemes, definition of agricultural development programs and development of cooperatives;
- Equipment Services: responsible for management and maintenance of the equipment of ONAHA (pumping stations and water gates, earthmoving and transport equipment, agricultural equipment and central garage);
- Administrative Services: responsible for personnel and general administration;



- Accounting Services: responsible for general accounting and analytical accounting.

The central services would backstop ONAHA's regional offices established where justified by the number of irrigation schemes and the distance to headquarters in Niamey.

6.02 There would be a regional office at Tillabery. The regional director at Tillabery would report to the General Director. He would be responsible for day-to-day implementation of the project and all other ONAHA activities in his region, and would be responsible for the interface of ONAHA with the other public agencies in his region. The organization of the services at the Tillabery office would be similar to those at the central level: engineering, agricultural development, equipment, administration and accounting. The agricultural development services would include a technical assistance support unit responsible for assistance in grouping the farmers on the schemes; training of extension staff, farmer leaders, herdsmen and a number of technicians including blacksmiths; and for evaluation of project results.

6.03 Project Evaluation. The support unit of the project's agricultural development services would be responsible for evaluation of the project. It would produce quarterly progress reports and an annual report giving the information outlined in Annex 11. Assurances were obtained that the unit would prepare the project completion report.

#### B. Staffing

6.04 The lack of experienced local staff is a major constraint to the implementation of agricultural projects in Niger. Government is aware of this and agrees that the shortage of local expertise can only be alleviated in the short term by technical assistance. The Regional Director at Tillabery would be assisted by an expatriate technical adviser and a team of as many as ten other expatriate specialists. The relatively large number of expatriates reflects the fact that (a) the Namarigoungou works would be built by force account requiring technical skills that even contractors would import; and (b) the project would include a number of training programs requiring special training skills. The staff recruited internationally would be provided by a company with recognized expertise to carry out irrigation projects, including construction of works by force account and agricultural development. Government has pre-selected four consulting firms with relevant qualifications and knowledge of Niger. Assurances were obtained at negotiations that the company, the terms and conditions of its employment and the qualifications and experience of the technical adviser to the Regional Director at Tillabery would be mutually acceptable to Government and IDA. Selection of the company and nomination of the technical adviser to the Regional Director are conditions of Board presentation. Signature of the technical assistance contract is a condition of the credit becoming effective.

6.05 High and medium level local staff would belong to one of the following specialties: agricultural engineer or ITA ("Ingenieur des travaux agricoles"), rural engineer or ITR ("Ingenieur des travaux ruraux"), accountant. There are a limited number of these specialists in the country, but some are being trained under various scholarships overseas and are expected to return to Niger after 1980. After that date recruitment of high and medium level local staff would become easier. Such staff would be seconded to the project as government employees on full pensionable service, and with posting allowances commensurate with their new responsibilities.

6.06 The ratio of extension staff to farmers would be one to 200 farming families. They would work with the delegates of the farmers' groups, who in turn would be expected to serve as the relay with the other farmers. A delegate would represent 10 farming units, demonstrate irrigation techniques, organize procurement and distribution of inputs and equipment within the group, and control the use of water for irrigation. The extension staff would report to the heads of the irrigation units.

### C. Training

6.07 High and medium level staff would receive on-the-job training so as to be in a position to replace expatriate staff after the project development period. Extension staff who do not receive any specialization in irrigation techniques at the agricultural school in Niger (Kolo) would be given one month courses in irrigation application upon joining the project. Such training would be provided by the consultants providing technical assistance to ONAHA. Their contract would make specific provision for training programs, and assurances were obtained at negotiations that these programs would be reviewed and approved by IDA.

6.08 Farmers' training would be performed by project staff and would concern: (i) farmers' group delegates, who would receive technical training in cultivation, irrigation, network maintenance and work organization over a 5 month's period on their own plots; (ii) farmer accountants: who would be taught basic bookkeeping over a 5 month period, spent partly in the villages and the training center built under the project; (iii) herdsmen: their courses would be essentially technical in nature and taught over a 5 month period, alternating between the villages and the training center. Some 366 delegates, 82 farmer accountants and 82 herdsmen would be trained.

6.09 Village first aid volunteers would be chosen by the village and trained in emergency help situations over a 2 week period at the Tillabery dispensary. Some 82 first aid volunteers would be trained.

6.10 The project staff member responsible for the blacksmith training component would himself have participated either in Niger or in other countries in a blacksmith training program for a period of about 6 months, after which he would be able to provide courses to advanced blacksmiths in the use of blacksmith's equipment, fabrication of improved tools, metal

brazing, tampering, and fabrication of parts. The courses would last a total of 40 days broken up into a number of periods. About 25 blacksmiths would be trained.

#### D. Farmers' Settlement and Organization

6.11 The procedures for land allocation in the irrigation schemes have been proven through past testing along the Niger River and are known to be acceptable to the present owners and to the new settlers (Annex 2). They are based on Law No. 60-28 of May 25, 1960 and entail: (a) ascertaining present land use rights through a series of interviews with the local population; (b) giving priority for land allocation to the farmers whose rights can be established; (c) selecting farmers according to a number of criteria including: proximity to the schemes, size of the family, farming experience, and existing assets, including ownership of bullocks; and (d) allocating no more than 0.25 ha per male adult. Some flexibility should be shown in the application of these procedures. Land allocation would be handled jointly by the "Comite Technique d'Arrondissement," (the advisory body to the Sous-Prefet of Tillabery, the population, and the Nigerien head of the project's agricultural development services. To ensure that the Namarigoungou scheme would benefit as many farmers as possible, assurances were received that IDA would be consulted before farmers would be allotted more than 1 ha per farming unit.

6.12 The organization of farmers on the schemes would evolve with ONAHA's directive involvement being progressively replaced by farmers' cooperatives (para. 4.11). Until such time as the latter are ready to assume management activities, ONAHA would assure farmers supply of water and basic services. Farmers would pay for operating and maintenance costs incurred by ONAHA and a capital recovery charge (para. 7.11), but not for extension services. If farmers do not comply with their obligations, their lands could be repossessed. The decision to repossess holdings or to impose other disciplinary action would be made by ONAHA, but advice would be sought from the irrigation unit councils. Unit councils would be created for each irrigation unit (para. 4.04) and would include representatives of farmers and the extension staff assigned to the unit.

6.13 Farmers would be organized into the smallest groups compatible with the management of the schemes comprising about 10 farming units each. The group would establish the basis for financial solidarity for credit repayment.

VII. YIELDS AND PRODUCTION, DEMAND, PRICES, MARKETING ARRANGEMENTS, FARMERS' BENEFITS AND COST RECOVERY

A. Yields and Production

7.01 The yields for the crops grown on the Namarigoungou polder have been estimated at full development (1982) as follows: paddy (4,800 kg/ha per season), sorghum (2,500 kg/ha), cowpeas (1,200 kg/ha); eucalyptus (20 m<sup>3</sup>/ha year). In addition, the millet yields under rainfed conditions would increase from 310 kg/ha to 390 kg/ha. The paddy yield is lower than the 5,200 kg/ha actually obtained on the comparable Toula scheme (Annex 6, Table 5). The yields for mixed cropping are those currently obtained where mixed cropping is practiced.

7.02 The yield increases are estimated to result in the following annual production increments (1982): In the Namarigoungou polder under irrigation: 12,500 tons of rice paddy, 400 tons of sorghum and 950 tons of various vegetables; on the rainfed holdings of the Namarigoungou farmers: 1,600 tons of cereals. In addition, wood pole production would have an annual value of some CFAF 16 million, and the livestock subproject would gross some CFAF 6 million annually.

7.03 Production increases on the existing schemes are estimated at 900 tons for rice paddy cultivated in the polders, and 700 tons for cereals under rainfed cultivation.

B. Demand, Prices, and Marketing Arrangements

7.04 Rice. Local demand for rice has been increasing over the past few years and is expected to continue to increase as a result of the population growth and the rapid urbanization. (Annex 1, Tables 1 and 2). There is at present a deficit of some 6,000 tons of rice between local production and consumption.

7.05 The official producer price for paddy at CFAF 45/kg gives farmers working on the irrigation schemes adequate incentives. Assurances were obtained that the official paddy price would be reviewed annually to determine its adequacy, taking into account the necessity to maintain economic incentives for farmers and the overall supply and demand situation. The financial price of CFAF 45/kg of paddy was used for the farm budgets, and the farm gate economic price of CFAF 53/ kg for the economic rate of return calculations.

7.06 Rice produced on the Government schemes is sold by "Office des Produits Vivriers du Niger" (OPVN) at CFAF 105/kg, which is about the import substitution price, (Annex 12, Table 1). It is estimated that OPVN makes a profit of CFAF 5/kg of rice.

7.07 ONAHA would organize the transport of the paddy produced under the project (para. 6.12) for delivery to the government mill at Tillabery. The mill's processing capacity would be doubled to 10,000 tons of paddy with relatively small investments in equipment.

7.08 The demand for the project's other products (cereals, vegetables, wood and meat) is strong given the proximity of Niamey. They would be marketed through the traditional network of private traders. The prices used for farm budgets and in the economic rate of return calculations are: millet, CFAF 40/kg, sorghum, CFAF 35/kg; cowpeas CFAF 45/kg; onions, CFAF 196/kg; tomatoes, CFAF 38/kg; gombos, CFAF 340/kg; trees, CFAF 1,600/tree; liveweight meat, CFAF 180/kg.

### C. Farmers' Benefits

7.09 Benefits of the project have been quantified only for the farmers taking up cultivation on the Namarigoungou polder. Farmers on the other schemes would increase their present income level slightly. It is assumed that the average farming unit would comprise two male adults; would be given 0.5 ha of the Namarigoungou polder, and would keep its present holdings under rainfed cultivation and traditional irrigation. Since prospective project participants are presently self-sufficient in terms of food, it is assumed that they would sell all their production under the scheme, and would not increase their family consumption.

7.10 Without the project the farmer taking up cultivation in the Namarigoungou polder would continue to have an annual net income of CFAF 115,900 (US\$473) (Annex 6, Table 7). With the project, and assuming that he is given 0.5 ha to cultivate, his net income would increase to CFAF 251,600 (US\$1,027) (Annex 6, Table 8). His per capita net income would increase from US\$90 to US\$197. In addition, the family cultivating 0.1 ha of mixed cropping would increase its net income by an additional CFAF 57,200 (US\$233). While incomes would increase substantially, the amount of work required would also increase: family labor from 343 man-days to 440 man-days and hired labor from 40 man-days to 121 man-days for the family cultivating 0.5 ha of rice. Net income per man-day would increase from CFAF 339 to CFAF 1,399.

7.11 The net income figures have been calculated after deducting direct production costs (seed, fertilizer, debt service on credit received, payments for hired labor, etc.), the operation and maintenance cost of the irrigation system (O.M.) and a capital recovery charge. The governmental policy has been that farmers be charged for all O.M. expenses, but that they should not be asked to pay for extension services or to contribute to the amortization of the investment in the schemes. As a major improvement upon this policy and to ensure some degree of financial viability and replicability of the investment, assurances were obtained at negotiations that farmers on the Namarigoungou scheme would pay water charges including a capital recovery charge. These water charges would initially be set at CFAF 100,000/ha/year, starting June 30, 1980, and would be maintained at a level acceptable to the Government and the Association which would be the maximum allowed under the

Government's regulations at any one time. ONAHA would maintain separate accounts for the water charges recovered from farmers. Since O.M. expenses in the Namarigoungou scheme would be about CFAF 34,000/ha/year in 1978 terms, the capital recovery charge would be about double at CFAF 66,000/ha/year. This relatively high level of capital recovery charges compared to O.M. expenses and past practice is justified given the high cost of the project and the substantial benefits expected for project participants.

#### D. Cost Recovery and Impact on Government Revenues

7.12 At a discount rate of 10% per annum the present value of Government's initial and recurrent investment in the Namarigoungou scheme is CFAF 3.7 billion (Annex 12, Table 2). At the agreed level of water charges of CFAF 100,000 per ha per year, the cost recovery index of these water charges (totalling CFAF 155 million annually) discounted at 10% compared to Government investment in the scheme is 37%. The rent recovery index or ratio of total direct charges to farmers' rent would be 33%.

#### Impact on Government Revenues

7.13 Government revenues from the project would consist of direct charges paid by farmers, indirect taxation induced by the increase in farm production and trading profits made by OPVN. Government outflows would be operating and maintenance expenses, extension and administrative expenses after project, and service charges and amortization of the IDA credit. The cash flow (Annex 12, Table 3) shows a surplus from 1980 onwards.

### VIII. ECONOMIC BENEFITS AND JUSTIFICATION

8.01 The project's direct benefits would be the increased production it would generate for the 3,000 farming units (16,000 people), who would take up cultivation on the Namarigoungou polder. The economic rate of return is estimated at 12.5% for the project components whose benefits have been quantified. These components account for 95% of project costs. This return excludes the health component, the technical training programs and the studies, for which no meaningful rate of return could be estimated because of the predominance of non-quantifiable effects.

8.02 The main assumptions for the economic rate of return calculations at Annex 13 include:

- (a) incremental production from the Namarigoungou scheme only (para. 7.02);
- (b) economic farm gate prices in constant prices as shown in paras. 7.05 and 7.08;

- (c) inclusion in the cost streams of all on-farm production costs, including hired labor costed at the prevailing wage rate (about CFAF 200/day) throughout the year and family labor costed for the periods of the year when it is fully employed (estimated at 55%) at the wage rate of CFAF 200/day and for the other periods of the year (45%) at CFAF 100/day; and
- (d) based on a standard conversion factor of 0.86, foreign exchange costs and benefits have been converted to the rate of exchange of CFAF 285 = US\$1. (16% lower than the present official rate of CFAF 245 = US\$1).

8.03 A number of sensitivity tests have been run and indicate that the project would be equally sensitive to variations in benefits and costs. A variation of benefits or costs of 10% would result in an absolute change of about 2 percentage points in the project's rate of return. Other tests indicate that:

- Without an increase in production on the rainfed holdings of the Namarigoungou farmers the rate of return would be 1 percentage point lower (11.55%);
- Keeping the technical assistance five years after project completion would decrease the rate of return about 1 percentage point (12.15%); and
- Reducing the cropping intensity from 200% to 175% would lower the rate of return 1.5 percentage points (10.45%).

8.04 The project would have a number of secondary benefits which have not been included in the economic rate of return calculations:

- (a) an increase in the agricultural production of farmers cultivating in other schemes of the project area outside Namarigoungou.
- (b) the creation of farm employment, estimated at some 400,000 man-days, about 70% of which for the riparian populations which otherwise would continue migrating to the south; and 30% for casual laborers, mostly from the "Ouallam Arrondissement," one of the poorest in Niger.
- (c) it would help reduce the income disparities between the local tribes and between the rural and urban populations.
- (d) it would provide a reliable source of cereals which could soften the impact of drought.

- (e) it would provide the demonstrative effect of an integrated approach to provide farmers with comprehensive extension and marketing services, not only for their holdings on the modern irrigation schemes, but also for those cultivated under rainfed conditions, and it would establish the proper institutional framework for Government to meet its goal of developing some 1,000-2,000 ha of irrigated land annually over the next five years.
- (f) it would have other secondary benefits including the impact of the health and training programs, the expansion of non-farm rural employment, for example in blacksmithing and at the Tillabery rice mill, and the improvement of nutrition and health.

8.05 The risks attached to the project have been considered from several angles: financial, technical, institutional and social. The financial risk has been reduced by having the detailed engineering study completed prior to this draft green cover report. The technical risk is mainly in the achievement of the production increases contemplated. The sensitivity analysis indicates that even if the production of paddy were 25% lower, the rate of return would still be acceptable, at 8%. The institutional risk will be overcome through the creation of ONAHA, which would be adequately staffed and equipped to carry out the project. The social risk involved in land allocation will be reduced by the use of well-established land allocation procedures.

## IX. RECOMMENDATIONS

- 9.01 Conditions of Board presentation are receipt of evidence that:
  - (a) ONAHA would have been established (para 6.01);
  - (b) A company would have been selected to provide the internationally recruited staff; and the Technical Adviser to the Regional Director at Tillabery would have been nominated (para 6.04).
- 9.02 Assurances were obtained at negotiations that:
  - (a) The primary and secondary canals would be concrete lined only if agreed upon technical criteria were met (para 4.03).
  - (b) The design of the applied research trials and of the seed multiplication program on the Namarigoungou polder would be acceptable to IDA (para 4.11).
  - (c) ONAHA would be granted a license to import agricultural equipment and inputs (para 4.15).



- (d) Government policy regarding subsidies for agricultural equipment would be discussed annually by Government and IDA (para 4.17).
- (e) The Ministry of Health would organize the training of first aid volunteers including post-training supervision and refresher courses (para 4.18).
- (f) Government would conduct a limited epidemiological desk study of the area; and the results of the study would be reviewed by Government and IDA (para 4.18).
- (g) The consultants who would carry out the study for the development of a second irrigation project would have qualifications and experience satisfactory to IDA, and they would be employed under terms and conditions satisfactory to IDA (para 4.21).
- (h) Government would:
  - (i) ensure that an account in the name of ONAHA would be established with "Caisse Nationale de Credit Agricole";
  - (ii) deposit an initial amount of CFAF 250 million into the account;
  - (iii) replenish the account quarterly to provide ONAHA with sufficient funds to meet project expenditures for the following three months; and
  - (iv) ensure that seasonal and short term credit repayments for farm inputs, seeds, equipment, blacksmith kits and vaccines would be made to revolving fund accounts administered by ONAHA and deposited with CNCA (para 5.06).
- (i) The project accounts and revolving fund kept by CNCA for farmers' agricultural credit would be audited by independent auditors acceptable to IDA. The auditor's opinion on the disbursement made against certified records of expenditures would be submitted to IDA every six months (para 5.12).
- (j) The support unit would prepare the project completion report (para 6.03);
- (k) The company providing the internationally recruited staff, the terms and conditions of its employment and the qualifications of the Project Manager would be mutually acceptable to Government and IDA (para 6.04).

- (l) The contract of the company providing internationally recruited staff would make specific provision for training programs, and these programs would be reviewed and approved by IDA (para 6.07).
- (m) IDA would be consulted before farmers would be allotted more than 1 ha per farming unit (para 6.11).
- (n) The official paddy price would be reviewed annually to determine its adequacy, taking into account the necessity to maintain economic incentives for farmers and the overall supply and demand situation (para 7.05).
- (o) Farmers on the Namarigoungou scheme would pay a capital recovery charge at a level mutually acceptable to Government and IDA, and this level would be reviewed from time to time (para 7.11).

9.03 Conditions of effectiveness of the IDA credit are (a) the establishment of a revolving fund with an initial deposit of CFAF 250 million (para 5.06); and (b) signature of the contract with the company providing technical assistance for the project (para 6.04).

9.04 With the above assurances and recommendations the project is suitable for an IDA credit of US\$15 million to the Republic of Niger.

NIGER

IRRIGATION PROJECT

IDA Financed Projects in the Agricultural Sector,  
Niger Food Self-Sufficiency and the Irrigated Sector

A. IDA Financed Projects in the Agricultural Sector

1. There have been four IDA agricultural projects in Niger as follows:

- (i) Agricultural Credit (207-NIR) for US\$0.6 million made in 1970 for the financing of agricultural credit, technical assistance to Caisse Nationale de Credit et de Cooperation (CNCA) and extension staff training. Although the technical assistance and training components were completed satisfactorily, the agricultural credit component lagged considerably. One reason was that it coincided with the worst drought of the century. An equally, and probably, more significant constraint was Niger's poorly developed credit, input and extension delivery systems. Disbursements for agricultural credit were about 23% of the appraisal estimate. Credit 207-NIR was closed with an amount of US\$44,000 remaining undisbursed.
- (ii) Drought Relief Fund (441-NIR) for US\$2 million made in 1973 to help people in drought affected areas to re-establish as far as possible, their self-sufficiency through assisting them to redevelop and improve their farms and herds. The fund financed a range of subprojects. The project is nearing satisfactory completion.
- (iii) Maradi Rural Development Project (608-NIR) for US\$10.7 million made in 1976 to provide production improvement packages to farmers grouped in 15 cooperatives ("Associations Locales de Cooperatives") in the "Departement de Maradi" together with 80 km of agricultural tracks, planting of 500 ha of wood fuel plantations, study of the irrigation potential of the area and improvements of livestock services. The project is progressing satisfactorily.
- (iv) Forestry Project (800-NIR) for US\$4.5 million, made in 1978. This project will assist Government in its efforts to establish 400 ha of pilot irrigated plantations and 700 ha of pilot rainfed tree plantations; improve the rural forestry activities of the Forestry Department; finance a training program in extension services; provide assistance to research and a workshop maintenance unit. A project unit will be established within the Forestry Department to assist in coordinating and monitoring the various project activities, plan rural forestry programs and prepare a second phase suitable for Bank support.

## B. Niger Food Self-Sufficiency

### Millet and Sorghum

2. Table 1 shows the total production for millet and sorghum at 1.3 million tons in 1976, and Table 2 the total consumption for these staple foods at about 1.1 million tons, leaving a surplus of some 11,000 tons in 1976/77 after seed requirements and losses have been deducted. The slight 1976 surplus is due to better than average rainfalls in 1976. During the recent series of drought years Niger imported a total of about 500,000 tons (1973-1975).

3. Projections at Table 2 are based on the expected population growth rate of 2.7% per year and the historical consumption of 220 kg/capita/year of coarse grains. Even under normal rainfall, and assuming that all productivity improvement projects until 1983 are implemented, there would likely be an increasing deficit of millet and sorghum starting in 1977/78.

### Rice

4. Paddy production was estimated at 29,000 tons in 1976, with 20,000 tons produced traditionally, and 9,000 tons on the development schemes. All paddy comes from the Niger valley. Corresponding rice quantities after deduction of losses and seed requirements totalled 17,000 tons, with 11,000 tons produced traditionally and 6,000 tons coming from the modern irrigation schemes.

5. The government investment program to develop a total of some 4,000 ha between 1977 and 1980 would increase rice production from 17,000 to 37,000 tons by 1982/83. The rice consumption forecast at table 2 takes into account (i) the country's overall population growth (2.7% per year); (ii) the migration towards the towns (Niamey's growth is estimated at 7.7% per year and that of the other towns at 5.5%); and (iii) the growth of consumers' real income (estimated at 2% per year).

### Overall Food Self-Sufficiency

6. The analysis at Table 2 shows that (i) even under normal rainfall, and assuming that all productivity improvement projects for the rainfed area are implemented, there would likely be an important millet and sorghum deficit in years to come, (ii) that the present rice deficit will be offset only if the irrigation program embarked upon by Government is implemented without delay, and (iii) that irrigation is unlikely to help reduce the deficit in millet and sorghum unless more investments in irrigation schemes are made beyond those proposed over the period 1977-1982.

7. Since the problem stems from the very high rate of population growth, little can be done in the short term to improve the situation. The Government welcomes the Bank's assistance to help in establishing the institutional framework necessary to carry out the various productivity improvement projects for the rainfed area and achieve its goal of building some 1,000-2,000 ha of irrigated schemes annually.

B. The Irrigated Sector

8. The area of the country under irrigation development totals some 8,000 ha, 3,700 ha along the Niger River (Table 4), 3,000 ha in the Konni scheme, and the rest distributed throughout the country.

9. The total potential for irrigation development in Niger is estimated as follows:

Niger River valley - "polders"	22,000 ha
- terraces	80,000 ha
Maggia River - valley	5,000 ha
- hillside retaining basins	5,000 ha
Komadougou River	5,000 ha
Lake Chad	35,000 ha
Dry valleys ("dallols," "goulbi")	50,000 ha
Telak/Errazer	<u>15,000 ha</u>
	217,000 ha

Of the 217,000 ha, about 50% are along the Niger River, and the rest located throughout the country, mostly in areas of low population density. Because of its comparatively large potential and its high population pressure, the valley of the Niger River is the priority area for irrigation. (The assessment of the potential for "polders" and terraces development is based on a 1976 study by consultants SOGREAH.) However, as can be seen below, the total potential of about 100,000 ha for irrigation development could only be obtained after the flow of the Niger River has been regulated; until that time only 16,000 ha can be developed.

10. The potential for further development of double cropping irrigation along the valley of the Niger River north of Say (see Annex 4) is limited by the river minimal flow of 15 m<sup>3</sup>/sec ( 9 years out of 10). This limit does not apply to single cropping done during the rainy season when the Niger River flow is more than adequate to provide the complement of water that cultivation requires, but since double cropping is essential to economically justify investment in modern irrigation schemes, the 15 m<sup>3</sup>/sec flow should be considered the limit for irrigation development north of Say at the present time. Table 3 indicates that this corresponds to a total area of 12,000 ha under double cropping irrigation. South of Say, where the Niger River receives a number of local tributaries, and the minimum flows rarely drop below

50 m<sup>3</sup>/sec, there is a potential 8,000 ha of "cuvettes." All told there is a 16,000 ha potential for double cropping irrigation before the flow of the Niger River needs to be regulated.

11. Such a regulation would be obtained through the construction of the Kandadji dam, likely to be built starting in 1985 with Arab financing. The dam would cost an estimated US\$100 million and would be multipurpose, providing Niger with its own source of energy, and regulating the river for agricultural and transportation purposes.

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Niger Food Self-Sufficiency and the Irrigated Sector/Autosuffisance alimentaire du Niger et le secteur d'irrigation

Main Crops/Cultures principales

		<u>1976</u>	<u>1975</u>	<u>1974</u>	<u>1973</u>	<u>1972</u>		
<u>Millet</u>	- Area ('000 ha)	2,531	1,693	2,230	2,008	2,195	<u>Mil</u>	- Surface ('000 ha)
	- Production ('000 tons)	1,091	581	883	627	919		- Production ('000 tonnes)
	- Yield (kg/ha)	431	343	395	312	391		- Rendement (kg/ha)
<u>Sorghum</u>	- Area ('000 ha)	856	893	919	823	920	<u>Sorgho</u>	- Surface ('000 ha)
	- Production ('000 tons)	257	254	219	126	208		- Production ('000 tonnes)
	- Yield (kg/ha)	406	320	404	282	344		- Rendement (kg/ha)
<u>Cowpeas</u>	- Area ('000 ha)	856	893	919	823	920	<u>Niébé</u>	- Surface ('000 ha)
	- Production ('000 tons)	236	219	133	92	144		- Production ('000 tonnes)
	- Yield (kg/ha)	276	260	144	112	136		- Rendement (kg/ha)
<u>Rice</u>	- Traditional Area ('000 ha)	20	16	15	18	17	<u>Riz</u>	- Surface en culture traditionnelle ('000 ha)
(Paddy)	- Production ('000 tons)	29	29	30	46	32	(Paddy)	- Production ('000 tonnes)
	- Yield (kg/ha)	1,381	1,812	2,000	2,555	1,882		- Rendement (kg/ha)
<u>Groundnuts</u>	- Area ('000 ha)	178	320	256	365	419	<u>Arachides</u>	- Surface ('000 ha)
	- Production ('000 tons)	96	42	129	77	260		- Production ('000 tonnes)
	- Yield (kg/ha)	539	130	504	211	385		- Rendement (kg/ha)

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Niger Food Self-Sufficiency and the Irrigated Sector/Autosuffisance alimentaire du Niger et le secteur d'irrigation

Forecast of Food Supply and Demand/Prévisions de la production et des besoins alimentaires

('000 tons/'000 tonnes)

	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	
<u>Millet and Sorghum</u>								<u>Mil et sorgho</u>
<b>A. Production</b>								<b>A. Production</b>
1. Base year production /1	1,268	1,268	1,268	1,268	1,268	1,268	1,268	1. Production de l'année de référence /1
2. Incremental production of productivity improvement projects		18	40	68	104	143	153	2. Production supplémentaire des projets de productivité
3. Seed requirements and losses	(190)	(193)	(196)	(200)	(206)	(212)	(213)	3. Besoins en semences et pertes
4. Total production	1,078	1,093	1,112	1,136	1,166	1,199	1,208	4. Production totale
<b>B. Consumption</b>								<b>B. Consommation des familles</b>
1. Population ('000) /2	4,850	4,986	5,126	5,272	5,421	5,577	5,737	1. Population ('000) /2
2. Consumption /3	1,067	1,097	1,128	1,160	1,193	1,227	1,262	2. Consommation /3
<b>C. Millet-Sorghum Surplus (Deficit)</b>	<b>11</b>	<b>(4)</b>	<b>(16)</b>	<b>(24)</b>	<b>(27)</b>	<b>(28)</b>	<b>(54)</b>	<b>C. Surplus ou déficit en mil et sorgho</b>
<u>Rice</u>								<u>Riz</u>
<b>A. Production /4</b>								<b>A. Production /4</b>
1. Traditional	11	11	11	11	11	11	11	1. Traditionnelle
2. Incremental production of irrigation schemes	6	7	11	15	20	23	26	2. Production supplémentaire des projets d'irrigation
3. Total production	17	18	22	26	31	34	37	3. Production totale
<b>B. Consumption</b>								<b>B. Consommation</b>
Average forecast /5	23	25	27	28	30	33	35	Projection moyenne /5
<b>C. Rice Surplus (Deficit)</b>	<b>(6)</b>	<b>(7)</b>	<b>(5)</b>	<b>(2)</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>C. Surplus de riz (déficit)</b>
<b>Overall Food Surplus (Deficit)</b>	<b>5</b>	<b>(11)</b>	<b>(21)</b>	<b>(26)</b>	<b>(26)</b>	<b>(27)</b>	<b>(52)</b>	<b>Surplus global (déficit)</b>

/1 1976 actual production was reduced by 40,000 tons under the assumption that some 250,000 ha would not have been planted in cereals in 1976 if farmers had been able to get enough groundnut seeds.

/2 Assumes a 2.7% annual increase.

/3 220 kg/capita corresponding to 1,687 calories per day.

/4 Net of seed requirements and losses.

/5 Between projections based on total population growth and average national consumption of 5.21 kg/capita, and projections based on urban growth with an average consumption of 50 kg/capita.

/1 La production de 1976 a été réduite de 40.000 tonnes dans l'hypothèse que 250.000 ha de céréales n'auraient pas été plantés en 1976 si les fermiers avaient été capables d'obtenir assez de graines d'arachide.

/2 Hypothèse de 2,7 % par an.

/3 220 kg par tête correspondant à 1.687 calories par jour.

/4 Net des besoins en semences et des pertes.

/5 Entre des projections basées sur une croissance de la population entière et une consommation moyenne de 5,21 kg par tête et des projections basées sur la croissance urbaine et une consommation de 50 kg par tête.



NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Niger Food Self-Sufficiency and the Irrigated Sector/Autosuffisance alimentaire du Niger et le secteur d'irrigation

Maximum Area to be Irrigated Under Double Cropping Without Regulation of the Niger River/  
Surfaces maximas qui peuvent être irriguées en double culture sans régularisation du Fleuve Niger

	Existing Schemes	Possible Schemes	Requirements in June at the Pumping Station/ Besoins au mois de juin à la station de pompage		Water Losses Returned to the River (% of pumped flow)/ Pertes d'eau revenant à la rivière (% du débit)	Net Requirements/ Besoins en eau nets (m <sup>3</sup> /sec)	
			l/sec/ha Continuus/ Continu	m <sup>3</sup> /sec Continuus/ Continu			
<u>1. Irrigation Schemes North of the Town of Say</u>							
"Cuvettes"							Cuvettes
Rice	3,490	8,900	1.6	14.2	15 /1	12.1	Riz
"Polyculture"		300	0.7	0.2	30 /2	0.2	Polyculture
Total "Cuvettes"	3,490	9,200		14.4		12.3	Total des cuvettes
"Terrasses"							Terrasses
Sugar Cane	240	2,500	1.0	2.5	20 /3	2.0	Canne à sucre
"Polyculture"		500	0.5	0.4	30	0.3	Polyculture
Total "Terrasses"	240	3,000		2.9		2.3	Total des terrasses
Grand Total	3,730	12,200		17.3		14.6	Total global
<u>2. Urban and Industrial Requirements</u>				1.0 /4	80	0.8	<u>2. Besoins urbains et industriels</u>
						15.4	
<u>3. Possible Schemes South of the Town of Say</u>		6,760	1.6	10.8			<u>3. Ouvrages possibles au sud de Say</u>

- /1 2/3 of water losses (25% of pumped water) are returned to the river and likely to be reused by the schemes downstream.  
/2 3/4 of water losses (40% of pumped water) are returned to the river.  
/3 2/3 of water losses (30% of pumped water) are returned to the river.  
/4 Niamey urban requirements were only 0.23 m<sup>3</sup>/sec in 1974.  
/5 The minimum Niger River flow in June at that location is 50 m<sup>3</sup>/sec because of the numerous tributaries flowing into the Niger.

- /1 2/3 des pertes d'eau (25 % de l'eau pompée) sont retournés à la rivière et utilisés en aval.  
/2 3/4 des pertes d'eau (40 % de l'eau pompée) sont retournés à la rivière.  
/3 2/3 des pertes d'eau (30 % de l'eau pompée) sont retournés à la rivière.  
/4 Les besoins de la ville de Niamey étaient de 0,23 m<sup>3</sup>/sec en 1974.  
/5 L'étiage minimum en juin du Niger est de 50 m<sup>3</sup>/sec à cause de l'apport des nombreux affluents du Niger sur cette portion du parcours.

NIGER

IRRIGATION PROJECT

Irrigation Schemes Present Organization

A. General

1. Although the activities of construction and management of the irrigation schemes are the overall responsibility of the "Ministere du Developpement Rural," these activities have been carried out separately, without much cohesion by two government agencies: the "Service du Genie Rural," which constructs the schemes, and the "Union Nigerienne de Credit et de Cooperation" (UNCC), which manages them. Furthermore, there is a great deal of confusion in the management of the schemes between the central staff of UNCC and the UNCC representatives in the various "departements" (Niamey, Tahoua, Dosso, etc.). Although the local UNCC representatives are nominally responsible for management of the schemes within their jurisdiction, they usually do not have the required technical capability, and the unit which is responsible for backstopping them at the central level is under-equipped, understaffed and usually does not have enough authority over the local representatives to implement a cohesive policy. For these reasons Government has decided to create a new "Office National des Amenagements Hydroagricoles", which would assume the functions until now entrusted to the "Service du Genie Rural" and UNCC. ONAHA is discussed at Annex 11.

2. The "Service du Genie Rural" is one of the four directorates of the "Ministere du Developpement Rural." It is subdivided into the four divisions listed below with their main activities:

- (1) "Hydraulique Agricole" (Agricultural Hydraulics) - Use of surface and ground waters applied to the rural world. Irrigation, drainage, construction of dams, pumping stations and bottomland improvement.
- (2) "Hydraulique Pastorale" (Livestock Hydraulics) - Construction of dams on intermittent streams for livestock use.
- (3) "Equipement Rural" (Rural Equipment) - Construction of rural tracks, rural buildings (houses, laboratories, classrooms, sheds for storage).
- (4) "Hydrologie des Eaux de Surface" (Surface Water Hydrology) - Control of high floods, construction of dikes, measurement of the river flows and depths, anti-erosion measures.

Of particular relevance to the construction of irrigation schemes along the Niger River is the division of "Hydraulique Agricole" (Agricultural Hydraulics). This division would be transferred to ONAHA.

3. "Union Nigerienne de Credit et de Cooperation" (UNCC) was created by Law 62/37 of September 1962 and includes two main departments, listed below with their main responsibilities:

- (1) "Service de la Cooperation" - to promote the cooperative movement; train cooperative agents; to organize, inform and train farmers; provide them with agricultural credit and market their production.
- (2) "Service de la Production" has three divisions:
  - "Division des Operations" (Operations Division) - to supervise the production improvement projects entrusted to UNCC;
  - "Division des Artisans Ruraux et Machinisme Agricole" (Rural Artisans and Agricultural Equipment Division);
  - "Division de la Gestion des Amenagements "Hydroagricoles" (Management of Irrigation Schemes Division).

The latter is responsible for managing the irrigation schemes. This division would be transferred to ONAHA.

4. Terms and conditions of the management of the irrigation schemes are set out in Law No. 60-28 of May 25, 1960, and their application is the object of Decree No. 69-149 MER/CGD of October 19, 1969. These legal instruments specify:

the ownership. The land in the schemes obligatorily belongs to the State.

the farming system. The schemes should be allocated to individual families, although industrial farming is possible in the case of an agro-industry.

the organization to be set up along cooperative lines, with Government replacing cooperatives only in the case of failure of the cooperatives.

These legal instruments have not been translated into any formal procedures: land registration, management contract for the scheme, or individual contract for the farmers. Under the proposed project farmers would receive individual leases giving them adequate security of tenure. This may induce them to reduce their rainfed holdings, or their traditional rice fields, and eventually assume larger holdings on the schemes.

5. The first schemes built in Niger were managed by the "Service de l'Agriculture," a directorate of the "Ministere du Developpement Rural." UNCC started taking over from the "Service de l'Agriculture" in 1967. In 1977 all existing schemes are under UNCC.

6. Present Organization of the Schemes in the Department of Niamey. In the six "Arrondissements" which comprise the Department of Niamey, there are irrigation schemes in only two: Niamey and Tillabery. The UNCC staff situation in these "Arrondissements" in the summer of 1976 was as follows:

"Direction" - 1 Chief of Division "Amenagements Hydroagricoles"  
(Technical Assistant)

Niamey - "Delegation Departementale"

1 "Delegue departemental" + supporting staff

1 Training Assistant

1 Assistant for Management of the Schemes  
(Technical Assistant)

1 Procurement Officer and 1 Accountant

1 Mechanic

On the schemes, 1 extension agent for 50 ha.

Extension agents on the schemes are seconded by the "Ministere du Developpement Rural." Because of the overall shortage of agricultural technicians and the priority given to staffing the various branches of the "Ministere," the ratio of extension agents is rather low. Furthermore, these agents are not formally trained in the management of irrigation schemes since the Kolo agricultural school, which supplies all agricultural technical agents, does not specialize in water management, and since UNCC does not provide in-service training.

7. Farmers' Organization. The models of land allocation, organization of farmers, extension techniques and training activities presently applied on the schemes along the Niger River were first designed in 1970 for the schemes of the Adder Douchi Maggia. The system was supposed to rely on a low ratio of agricultural technicians being assisted in extension work by farmer leaders. Because of the limited number of technicians and of their poor qualifications, and because there were no programs for the training of farmer leaders, extension services on the schemes lagged considerably. In 1975 "Projet Fleuve," financed by USAID, started training farmer leaders for the Toula scheme.

8. The Toula Case. The FED-financed Toula scheme was built in 1974. Farmers are organized in pre-cooperatives, "Groupements Mutualistes de Progres" (GMP), covering 50 ha each and comprising 100 farmers, usually from

the same village. The GMPs are integrated in a formal vertical structure and linked by a number of committees. The farmers trained under the "Projet Fleuve" have become the key staff in this organization and are perceived by the other farmers to represent the organization. In fact, because of the multiplicity of committees (8) and the great number of paid farmer staff (65 leaders and 15 accountants) for 250 ha under cultivation, the cooperative framework is no longer thought to represent the interests of the land users, and it is feared that the traditional chieftains will take over the actual management of the scheme, leaving only the appearance of a cooperative. In addition, this structure hides the sociological and other problems which exist between farmers on the same scheme.

9. To draw from the Toula experience: (i) priority should be given to the in-depth training of as many farmers as possible, with training taking place in the field prior to the first cultivation season; (ii) paid farmer leaders should be avoided; (iii) the cooperative structure should be kept as simple as possible, i.e., for Namarigoungou only one committee where the representatives of the GMPs would meet should suffice; (iv) joint financial responsibility should be introduced at the GMP level or even within smaller groups where farmers have chosen to cooperate on the basis of inter-individual affinities; and lastly (v) the management of a scheme should conduct a constant analysis of the sociological problems on the schemes. The proposed project intends to apply these principles.

NIGER

IRRIGATION PROJECT

Summary Description of Existing Schemes and Schemes to Be Built in the "Arrondissements" of Tillabery and Tera

Existing Schemes

Fergoun (300 ha)

1. Development of the "polder" in 1955 included construction of a protection dike, with flood control gates. Because the control of the water level is not guaranteed, only the lower parts of the "polder" are cultivated (132 ha in 1976 in the rainy season with an average yield of 3 tons of paddy per ha).
2. The reconditioning of Fergoun in a scheme with full control of the water level and land levelling is being considered. A number of donors have been approached. Fergoun would be submerged if the Kandadji dam 35 km downstream is built.

Toula (260 ha)

3. This "polder" downstream adjacent to Tillabery was developed in 1974/1975 under FED financing. The full water control is obtained with a dike, a pumping station for irrigation and drainage, concrete lined primary and secondary canals, tertiaries every 200 m limiting 7 ha plots. The design of the scheme is excellent, and explains in a large part the yields obtained (more than 5 tons/ha per cropping season, with two crops per year).
4. To ensure that yields are maintained, it will be necessary to introduce better maintenance practices and reorganize farmers' cooperative arrangements (Annex 11).

Lossa-Sona (402 ha) (First and second phase)

5. This "polder" was developed in several phases. This scheme has full water control and land levelling, but the transport of water from the pumping station is by concrete pipes under low pressure. This method allowed savings in investments, but because of the considerable loss of head pressure in the pipes, the pumping costs are almost three times as much as in Toula (between CFAF 2.6 and CFAF 2.9/m<sup>3</sup>, versus CFAF 1/m<sup>3</sup>). In addition, there have been many repairs and incidents in operations, such as malfunctions of the gates and breaks in the pipes.

Schemes Planned for the Period 1977-1980

Yelewani and Daibery (120 ha and 357 ha)

6. The feasibility studies and detailed engineering for the two schemes were done by consultants "Agrar und Hydrotechnik" in 1975. The works are similar to those of Toula and Namarigoungou.

Lossa (162 ha, third phase)

7. The third phase will be the development of a terrace with pumping station and concrete lined canals. It will be financed by FAC. Crops intended are legumes and cowpeas during the dry season, and sorghum during the rainy season.

Other Possible Schemes in the Project Area

Gabou-Bonfeba (3,270 ha)

8. This "polder" is just downstream of the site of the future Kandadji dam, and upstream of Namarigoungou. Its southern part, and, if Kandadji is built, all the "polder" area, could be irrigated without pumping.

9. The feasibility study for this scheme is included in the proposed project. The study should examine the possibility of gravity irrigation of Namarigoungou from Gabou-Bonfeba, after the Kandadji dam is built. The pumping stations included in the proposed Namarigoungou project would for the most part have been depreciated by that time, but would still be necessary for drainage during high floods.

NIGER

IRRIGATION PROJECT

Climate and Hydrology of the Niger River

A. Climate

Rainfall

1. Along the 550 km of the Niger River in the Republic of Niger (from Ayorou, in the north at the Malian border, to Dole in the south at the Nigerian border), the climate evolves progressively from Sahelian to tropical-Sudanian. Average rainfall and periods of rainfall registered are shown below:

	<u>Number of Years Registered</u>	<u>Annual average Rainfall (mm)</u>	<u>Period of Rainfall</u>	<u>Average monthly peaks</u>
Ayorou	15	370	June to September	August 150 mm
Tillabery	30	509	May to September	August 200 mm
Niamey	30	566	May to September	August 200 mm
Say	30	685	May to October	August 230 mm
Gaya	30	871	April to Oct/Nov.	August 280 mm

2. As is well known, in the Sahelian zone rainfalls vary greatly from year to year as shown below:

Variations of Average Monthly Rainfall at Tillabery (mm)

	<u>J</u>	<u>F</u>	<u>M</u>	<u>A</u>	<u>M</u>	<u>J</u>	<u>J</u>	<u>A</u>	<u>S</u>	<u>O</u>	<u>N</u>	<u>D</u>	<u>Total</u>
Average (1960-1974)	-	-	3.1	6.8	19.2	54.7	100.6	166.4	70.0	9.8	0.6	0.3	431
Maximum monthly rainfall	-	0.6	35.7	67.4	63.2	98.5	189	358.7	170.6	46.8	9.7	4.2	
Minimum monthly rainfall	-	-	-	-	-	32	50.1	65	23.5	-	-	-	
Monthly rainfall with probability > 0.8	-	-	-	-	-	35	65	95	30	-	-	-	

3. The maximum daily rainfall, on which the drainage works are calculated, is estimated at 85 mm day for the 1 to 5 year frequency (f=0.2).



4. Temperature. Recorded temperatures at Tillabery were as follows: (C°).

	<u>J</u>	<u>F</u>	<u>M</u>	<u>A</u>	<u>M</u>	<u>J</u>	<u>J</u>	<u>A</u>	<u>S</u>	<u>O</u>	<u>N</u>	<u>D</u>
Average temperature	25.0	27.5	30.1	32.3	34.0	32.0	29.6	27.5	29.0	30.5	27.5	24.8
Minimum temperature												
Record	10.2	10.4	14.1	17.0	18.0	18.5	18.4	19.4	17.5	15.4	11.7	8.6
Average	16.6	18.7	21.6	24.1	27.0	25.8	24.4	22.9	23.0	22.0	18.6	16.1
Maximum temperature												
Record	39.6	41.9	43.6	44.8	45.2	44.6	41.3	37.8	39.6	41.2	40.4	39.5
Average	33.3	36.2	38.6	40.5	40.9	38.1	34.8	32.1	34.4	38.2	36.4	33.5

5. Evapotranspiration

Potential evapotranspiration has not been measured in Niger. Best estimates are as follows based on Penmant formula:

Monthly Average Evapotranspiration Over Free Water in the Tillabery Area  
(mm per month)

<u>J</u>	<u>F</u>	<u>M</u>	<u>A</u>	<u>M</u>	<u>J</u>	<u>J</u>	<u>A</u>	<u>S</u>	<u>O</u>	<u>N</u>	<u>D</u>	<u>Total</u>
166	155	177	204	222	237	198	140	159	200	180	160	2,200

B. Hydrology

6. General. Except for the area around Gaya near the southern border with Nigeria, no sizeable tributaries enter the Niger River between Tossoye (Mali) and the border with Nigeria, and the upstream flow is not augmented. High flood level at Niamey occurs four to five months after the Segou-Mopti area, i.e., in January/February. It makes traditional irrigation possible during the dry season.

7. Average Flows. There are five gauges that are read regularly at Ayorou, Tillabery, Niamey, Say and Gaya. The discharges calculated from gauge rating curves show a very good correlation. The average monthly flows at Niamey and Malanville (in Benin) opposite Gaya are as follows:

Average Monthly Flows at Niamey and Malanville (m<sup>3</sup>/sec)

	<u>J</u>	<u>A</u>	<u>S</u>	<u>O</u>	<u>N</u>	<u>D</u>	<u>J</u>	<u>F</u>	<u>M</u>	<u>A</u>	<u>M</u>	<u>J</u>	<u>Mean</u>
Niamey (1928-1967)	125	503	1085	1262	1422	1605	1745	1750	1434	854	340	125	985
Malanville (1952-1967)	215	791	1705	1638	1442	1599	1871	2074	1890	1220	523	237	1262

### High Water Level

8. The preceding table indicates that the water level in Niamey increases progressively from July until January-February and decreases progressively thereafter. On the other hand in Malanville the water level rises in September because of rainfall occurring in June-July in the catchment areas of the local tributaries, then recedes and rises again at the onset of the Niger's own flood levels. This observation shows that any development upstream would have limited impact on the development of irrigation in the Gaya-Malanville area.

9. As indicated in the same table, the maximum flow in Niamey occurs in January-February. Since 1928 it has varied from 1,430 m<sup>3</sup>/sec (1943) to 2,150 m<sup>3</sup> (1956). Until 1962-1964 the one/hundred year frequency flood was estimated at 2,200 m<sup>3</sup>/sec. Until that time there was a very good correlation between the flood in Dire (Mali) and that in Niamey. Since 1962 this correlation has been modified. The floods in Niamey are higher (the one/hundred year frequency flood is now estimated at 2,800 m<sup>3</sup>/sec). They occur earlier and decrease faster. The minimum flows are more pronounced and occur earlier. The likely explanation could be a deepening of the channels of the internal Niger delta in Mali, with lower evaporation losses and an increase in the speed of the flow; besides overgrazing has probably resulted in an increase in the flow coefficient.

10. The increase in the one to one hundred year maximum flow would result in a higher water level in Niamey of 75 cm. Offsetting this, the dam to be built at Kandadji (70 km upstream of Tillabery) would reduce the height of the average flood by some 0.5 m at Tillabery. The reduction for the 1 to 20 year and for the 1 to 50 year flows, which are the measures used in the construction of the dikes that protect the schemes along the Niger River, would be smaller.

11. A study of the evolution of the maximum flows of the Niger River since 1962 is being financed by FAC and carried out by ORSTOM.

12. Lowest Flows. The flows occur in June-July; monthly values varied between 13 m<sup>3</sup>/sec and 200 m<sup>3</sup>/sec until 1965-1966, and reached 5 m<sup>3</sup>/sec with a minimum daily low of 0.4 m<sup>3</sup>/sec during the period 1972-1974. Based on the last 40 years' data, the monthly lowest flows at Niamey corresponding to a return period of 1/10 year frequency would be as follows: (m<sup>3</sup>/sec)

<u>J</u>	<u>A</u>	<u>S</u>	<u>O</u>	<u>N</u>	<u>D</u>	<u>J</u>	<u>F</u>	<u>M</u>	<u>A</u>	<u>M</u>	<u>J</u>
40	350	820	1170	1275	1490	1400	1200	570	160	45	25

Considering only the 1964-1974 period, the minimum flow in June would decrease from 25 m<sup>3</sup>/sec to 15 m<sup>3</sup>/sec. The 15 m<sup>3</sup>/sec can be considered the limiting natural flow to irrigation development upstream. On the other hand, further downstream in the Gaya-Malanville area, the dry season flow rarely decreases below 50-60 m<sup>3</sup>/sec and a storage dam is no longer as necessary for large irrigation development as it would be for the upstream areas where the 15 m<sup>3</sup>/sec discharge is fully committed.

14. Profile of the Riverbed between Ayorou and Dole. The slopes of the free water surface at the highest floods are as follows:

	<u>Ayorou</u>	<u>Tillabery</u>	<u>Niamey</u>	<u>Say</u>	<u>Gaya</u>	<u>Dole</u>
Cumulated distance (km)	-	100	218	280	516	554
Average slope (cm/km)	27	16	7.5	7	7	-

There are great variations in these average slopes because of rock formations in the riverbed. In the Namarigoungou polder the average slope is 10 cm/km.

#### Turbidity and Water Quality

15. There have been no turbidity analyses. However, because of the sedimentation which occurs in Mali, the waters between Gao (Mali) and Say have very little turbidity.

16. Waters are excellent for irrigation and can be classified C1-S1 in the USBR classification.

NIGER

IRRIGATION PROJECT

Population

1. Project Area

1.01 The main beneficiaries of the project would be the 3,000 farming units (16,000 people), who would take up cultivation on the Namarigoungou polder. Other beneficiaries would include the 2,200 farming units already cultivating on the existing irrigation schemes, and the 300 farming units who would take up cultivation on the Lossa scheme. Therefore, some 5,500 farming units (or about 30,000) people would benefit from the project to one degree or another. This is 60% of the population in the project area, which is estimated at 50,000 people.

1.02 A number of studies of the population in the "Arrondissement" of Tillabery indicate that the average farming unit is comprised of 5.25 people, including 1.54 adult males (Table 1), and that this is fairly constant within the various ethnic groups.

1.03 Allocation of Land in the Namarigoungou Irrigation Scheme. It is proposed that 0.50 ha be allocated to each farming unit, giving preference to the people already cultivating the polder. Since the scheme would cover 1,550 ha, some 3,000 farming units (16,000 people) would be given land on the Namarigoungou scheme. The population of the various villages around the Namarigoungou polder is as follows:

1st group: (less than 1 km)

Namarigoungou	1,870 people
Diamballa	2,722
Gari (I) 1/	1,103
Darbani (I)	591
	<u>6,286</u>

2nd group: (1 to 5 km - 2 hours maximum of travel per day)

Noranda	279 people
Bonfeba	710
Sawani (I)	1,118
Soudani (I)	2,485
Sinder-Boura (I)	953
M'Bida (I)	854
Wissili (I)	2,178
Fala (I)	1,357
Sinder-Tiendadji (I)	255
Sayani (I)	546
	<u>12,735</u>

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1/ I = from the islands.

3rd group: (5 to 8 km - 3 hours of travel per day)

Tessa (I)	960 people
Dionte Niargou (I)	1,912
Dangala (I)	655
	<u>3,527</u>

4th group: (beyond 8 km - Anzouron "Canton")

Doukou Dindje	390 people
Doukou Makani	328
Doukou Saro	831
	<u>1,549</u>

1.04 Assuming that 75% of the population in the villages of groups 1 and 2 participate, giving 2,700 farming units (14,300 people), only 30% of group 3 villages (200 farming units or 1,000 people) and 34% of group 4 villages (100 farming units or 1,600 people) need participate. Farmers from group 3 villages would need to cultivate their rainfed crops closer to the scheme, and farmers from group 4 villages may need to relocate. Establishment of two new villages would be planned under the proposed project. 75% of farmers in groups 1 and 2 are Wogos from the islands.

1.05 Since there is no way to ascertain at the present time whether farmers belonging to the various villages will participate in the proportions indicated at para 1.03, project management should use flexibility in allocating land in the scheme, and may even try out mechanized cultivation on a limited scale.

1.06 Allocation of Land in the Lossa Scheme. Study of the population in the villages within 1 km of the Lossa scheme indicates that no farmers from outside the project area would be required.

Scheme net area	160 ha
Number of farming units	320 ha
Number of people	1,700
% of the population of surrounding villages	30%

## 2. Sociological Characteristics of the Population

2.01 The Kados belonged to the Songhai Empire, which spread from the source of the Niger to Say (500 km downstream from Tillabery), and are considered the first settlers of the area with the Gourmantches. At the end of the 18th century the Gourmantches disappeared from the islands and were replaced by the Kourthey. The Wogos, whose origin is unknown, appeared around 1810. They live in the islands between the Kourthey chiefdoms of Dessa in the north and Sonsonni in the south. All these ethnic groups share the same characteristics of the Songhai civilization: language (Zerma), socioeconomic organization and political structure, but differ markedly in their agricultural practices. The Kados cultivate essentially in the rainfed areas and practice little rice cultivation. The Wogos practice traditional rice irrigation and flood recession cultivation. The Wogos lack land and are expanding into Kado territory. The Wogos would constitute 75% of project farmers.

2.02 Sociological Characteristics. Originally the various racial groups were fairly autonomous. The groups themselves were organized into micro-groups corresponding to the villages. The villages were made up of one extended family or several related families. In the extended family the chief had under his jurisdiction several households integrated into the same economic unit. The power of the chiefs was backed by a regime of slavery in which the slaves were assimilated into the family as perpetual junior members. The abolition of slavery transformed the social structure and led to a splitting of the families into smaller farming units. The heads of families as well as the traditional chiefs lost power. The remaining chieftains at the village or "canton" levels, although theoretically backed by the central administration, today have only powers of representation. They can no longer levy taxes, and their lands belong to those who cultivate them. The various groups remain cohesive, especially the Wogos. In 1968 in Tessa, 99 of the 100 marriages involved 2 Wogos, and 66 were between persons of related families.

2.03 The Basic Social Units: Compound, Family, Farming Unit. Originally the compound was the basic unit for habitat, production and consumption, and in more than 80% of the cases corresponded to one family group; in the other 20% compounds comprised 2 family groups. Compounds are still the basic unit for habitat and they can still house from 9 to 11 people, but today only the unmarried children are under the direct authority of the head of the family. When married, children set up their own production and consumption units.

### 3. Labor Situation

3.01 As can be seen at Annex 6, even under traditional cultivation farmers use hired labor at the time of peak labor requirements such as for seeding and weeding millet, and for land preparation of the rice fields and planting of rice. It is estimated that between 30 and 50% of farming units use hired labor under traditional cultivation conditions. Laborers are either young Kados without land or prospective emigrants, seeking to acquire some cash for the journey, or are Djermas coming from the "Arrondissement" of Ouallam, which is considered one of the poorest in Niger. Laborers are organized into groups of 2 to 5 and are hired as a group for periods not exceeding 3 days. Wages vary between CFAF 200 and CFAF 300 per man-day. Kado farmers use more hired labor than Wogos.

3.02 The "bogu" is another form of hired labor. It is the organization of Wogo farmers into an association of 6 to 15 members to cultivate each others plots at specific times. The "bogu" covers every detail of the association: working hours, salaries and fines. Although somewhat disappearing, the "bogu" is still very much alive in the "Canton" of Sinder.

3.03 It is proposed that the project consider the "bogu" as an important step in the organization of the farmers on the scheme. The "bogu" main advantages are that it is a spontaneous organization of farmers and that it is neither too small (like the family compound) nor too large to be effectively controlled by the traditional chieftains.

NIGER

IRRIGATION PROJECT  
PROJET D'IRRIGATION

Traditional Cultivation  
Culture traditionnelle

Composition of Farming Unit  
Composition familiale des exploitations

<u>Sources</u>	<u>Number of farming units studied</u>	<u>Average number of people per farming unit</u>	<u>Average number of male adults per farming unit (man &gt; 14 years old)</u>
<u>Sources citees</u>	<u>Nombre d'exploitations etudiees</u>	<u>Nombre moyen de personnes par exploitation</u>	<u>Nombre moyen d'actifs par exploitation (hommes &gt; 14 ans)</u>
Olivier de Sardan	62	5.30	1.52
AHT	325	6.23	1.92
Enquete agricole S/Prefecture	100	5.56	1.53
Tillabery	2,800	5.11	1.50

NIGER

IRRIGATION PROJECT

Agricultural Development

1. Present Situation in the Project Area

1.01 Average Farming Unit. Annex 5 defines the average farming unit as composed of 5.25 people, including 1.54 adult males.

1.02 Average Farm Size. A recent study conducted in the "Arrondissement" of Tillabery with 325 farming units indicated that on the average the traditional farm comprises 4.10 ha under cultivation, 1.0 ha under fallow in the rainfed area, and 0.20 ha under fallow in the flood plain (Table 1). The area under cultivation would on the average be distributed as follows:

- Millet and cowpeas (rainfed)	2.60 ha
- Rice (traditional irrigation)	1.15 ha
- Sorghum (flood recession)	0.15 ha
- Tobacco and gardens	<u>0.20</u> ha
Total	4.10 ha

1.03 Cowpeas are grown in association with millet over 50% of the millet area. Traditional yields are:

Millet: 312 kg/ha

Cowpeas: 118 kg/ha

Sorghum: 450 kg/ha

Traditional Cultivation Methods

1.04 Rainfed crops (millet, cowpeas, sorghum, sesame) are sown in June after a slight scarifying of the soil. Millet is weeded twice during the season. Cowpeas and at times groundnuts are planted between the rows of millet. No fertilizers are used. Cultivation is carried out almost exclusively by men.



1.05 In the flood plain farmers practice traditional flood submersion. For rice, the soil is turned over by hoe in July after the first rains, and the plants are weeded a couple of times after submersion starts. Paddy is harvested from pirogues in December when the "polders" are still underwater. After being dried from 10-20 days, paddy is threshed collectively. The difficult harvesting conditions result in a product of inferior quality suitable only for home consumption or the traditional market. Varieties used are floating or semi-floating rice and are progressively being replaced by the D 52-37 variety, which is produced on the modern schemes. There are also some traditional varieties (*oryza glaberrima*) used as early maturing types and harvested in September. The latter must be transplanted. Yields vary from 800 kg/ha for the traditional variety to 1,200 kg/ha for the D 52-37.

1.06 Sorghum is sown in March, in border strips where it is watered by hand for about three weeks. It is then transplanted following the flood receding line. Sorghum requires a very long cycle (7 months) and four to five weedings. For these reasons sorghum cultivation is regressing, the Wogos starting to cultivate millet instead.

1.07 Tobacco is grown exclusively by the Wogos, in the terraces bordering the flood plain. Its cycle is from November to February. Cassava is at times grown in association with tobacco, and unearthed as the need arises. The gardens belong to the men and women, and produce vegetables of local and European origin. The cultivation of a local pimiento is especially important, and it is done by women.

1.08 Livestock. The various studies show that 75% of the farms own cattle, and some sheep and goats (5.1 animals per compound). The average income per animal is estimated at CFAF 6,000 for cattle and CFAF 1,000 for sheep and goats.

1.09 Existing Irrigation Schemes. The technical characteristics of the main irrigation schemes of the project area are described at Annex 4. The schemes are the following:

	<u>Scheme Gross Area (ha)</u>	
	<u>Polder</u>	<u>Terrace</u>
Fergoun	300	-
Sakoira	-	42
Tillakeina	-	101
Toula	260	-
Daikena	110	-
Sona	212	-
Lossa	190	-
Total	1,072	143

1.10 Table 2 shows the production of the schemes in 1975 and 1976. Some 736 ha were under rice in the rainy season of 1976 with a production which averaged 4.5 tons/ha for the season.

1.11 The new schemes for which financing is being sought include:

Namarigoungou	1,550 ha
Yelewani	120 ha
Daibery	357 ha
Lossa Terraces	<u>162 ha</u>
Total	2,189 ha

## 2. Agricultural Research

2.01 Agricultural research in Niger is the responsibility of INRAN. Rice research under irrigated conditions started in 1953 under IRAT management and was transferred to INRAN when the latter was created in 1975. Tests for applied rice research are conducted in three schemes, none of which can duplicate proper irrigation conditions.

2.02 The inadequate infrastructure for applied research under irrigation explains why there is not much difference between the yields obtained by farmers and those obtained under research conditions. Still, the comparisons made by the research staff are useful since their tests are made under similar conditions for all varieties tested. The results of research for the two cropping seasons 1975/1976 dry season and 1976 rainy season were:

- (a) Irrigated rice with full water control. The tests comprised preliminary tests for new varieties, and comparison tests for varieties already selected and tested during preceding two years. The new varieties were provided by ADRAO. It is unlikely that any of the varieties introduced in 1976 would be retained. The two highest yielding varieties were eliminated because their vegetative cycles were too long (140-145 days). Among the varieties already selected and tested the short cycled varieties IR 28 and IR 30 (90-115 days) confirmed their high yielding potential. Furthermore they are resistant to disease and lodging. The middle-length cycled varieties (120-130 days), IR 269-26-333 and IR 1529-680-3, confirmed their high yielding potential. The latter should replace IR 22 now distributed to farmers.

- (b) Deep submersion rice. For this type of rice cultivation without full water control the variety D-52-37 is still the best suited because of the length of its vegetative cycle and its adaptability to the various levels of submersion.
- (c) Floating rice. Under traditional cultivation the varieties Nang-Kiew, Khao-baew and Mali-Sawn remain, as in Mali, the best varieties recommended.

2.03 Fertilizer trials concerned the two varieties used on the irrigation schemes, IR 22 and D-52-37. For the D-52-37 the most economic yields are obtained with 45 kg of nitrogen at seeding and 45 kg at tillering; for IR 22 it takes 135 kg of nitrogen, either applied all at once or in two applications: 90 kg at seeding and 45 kg at tillering. The study of the soils under permanent cultivation does not show a lack of  $P_2O_5$  or  $K_2O$  after 8 years of cultivation.

2.04 For rainfed cultivation. The varieties recommended for millet are: P<sub>3</sub> Kolo where rainfall is greater than 400 mm, and HKP between 300 and 400 mm. The cowpea variety recommended is the TN 88-63, which is better yielding, has a shorter cycle and is more drought-resistant than the local varieties. Fertilizer trials conducted between 1967 and 1973 show that for a groundnut/millet rotation the best applications are 66 kg/ha of triple phosphate on groundnuts and 50 kg/ha of urea on millet. For a millet/millet rotation applications would be 35 kg/ha of triple phosphate and 50 kg/ha of urea for each crop of millet.

2.05 Future research programs. The emphasis put by Government on the development of the modern irrigation sector requires that rice research be strengthened and given adequate physical infrastructure: in this context it has been proposed that all comparison and fertilizer tests be regrouped on one scheme: Saadia-South, and that new varieties be tested at Gabougoura. It is also proposed that a limited number of plots in the Namarigoungou "polder" be dedicated to applied research to test new techniques (row seeding) and study the problems which might arise on the polder itself (disease, pests, fertility).

### 3. Rice Development

3.01 Improved cultivation methods recommended by the agricultural research service and already tested on a number of schemes include:

#### Nursery:

- Allow 0.7 ha for each 1.0 ha cultivated;
- Broadcast seeding of 8 kg of already-dressed seeds per 0.10 ha;

- Fertilizer applications (per 0.1 ha)
  - 2 kg of urea
  - 2 kg of triple superphosphate
  - 2 kg of potassium chloride;
- Amount of time plants are left in the nursery:
  - 25 days during the rainy season
  - 35 days during the dry season.

Fields:

- Ox-drawn plowing;
- Submersion of fields with 10 cm - 15 cm of water and levelling;
- Transplanting, four seedlings every 20 cm x 20 cm;
- Fertilization: (200 kg of urea)
  - 100 kg after transplanting
  - 100 kg one month later;
- Weeding:
  - 1st weeding - 8-10 days after transplanting
  - 2nd weeding - 20 days later;
- Maintain 10-20 cm of water in the field up to 25 days before harvesting;
- Harvesting with a sickle, and drying of paddy in small stacks before
- Threshing with a thresher with paddles.

When farmers have mastered the techniques of rice cultivation, they would be introduced to row seeding, which would replace transplanting.

3.02 Introduction of Row Seeding. Transplanting has a number of advantages, among which, regularity of planting, optimum density, better resistance against weeds and better use of seeds (30% less than direct seeding).

However, transplanting requires extra labor and is more expensive than the modern method of direct seeding. There is a new seeder with four bins (Nodet-Gougis) which has been successfully tested in Mali, where 150 units were placed in 1976. Since the seeder has a capacity of 2 ha per day and requires 2 men and 2 oxen, planting with the seeder requires 1 man-day per ha, while transplanting requires 25-30 man-days per ha. The seeder costs CFAF 175,000, and assuming a life of 5 years and the use over 100 ha per year (25 days in January - February and 25 days in July), the per ha cost of the seeder is CFAF 350/ha, which is cheaper than hiring extra help at 25 x CFAF 200 = CFAF 5,000/ha. From an agronomic standpoint, a number of tests have shown that the yields obtained with both methods (row seeding and transplanting) are equivalent when there has been land levelling and there is full water control. <sup>1/</sup>

3.03 Labor Availability: Experience in Niger has shown that farmers participating in modern irrigation schemes do not give up cultivation of their traditional farms and often give priority to cultivation of their rainfed holdings. Consequently, the time they can spend on the schemes, and therefore the size of the lots they should be allocated, must take into account what time they have left after cultivating their traditional farms.

3.04 Labor requirements for traditional cultivation have been calculated for an average farm size as defined at para 1.02, assuming the following per ha requirements for the various crops:

	Man-days			
	<u>Traditional Rice</u>	<u>Flood Recession Sorghum</u>	<u>Millet and Cowpeas</u>	<u>Tobacco and Gardens</u>
Nursery		5		5
Hoeing		5		
Hoeing and Transplanting		15		20
Land Preparation	15		12	
Direct Seeding	1		4	
Weeding	35	50	25	
Irrigation				5
Harvesting	20	15	18	15 (tobacco)
Garden Work				14
Threshing - Transport	<u>15</u>	<u>10</u>	<u>12</u>	—
Total	86	100	71	59

<sup>1/</sup> Cf. B. A. Stout in Etude FAO No. 84 (1966); A. Alim, "Effect of Direct Sowing and Transplantation on the Yield," in Agric. Pakistan (1960); M. Vaugh in IRC Newsletter (1954); R. F. Chandler, "An Analysis of Factors Affecting Rice Yields" in IRC Newsletter (1963).

Table 3 indicates that on the average the farm under traditional cultivation would require some 341 man-days throughout the year, and that family labor is supplemented by hired labor in the period from most of July through December.

3.05 Labor Requirements for Rice Cultivation. The following table is based on actual time studies made on the Toula scheme:

	<u>Man-days Required per ha</u>	
	<u>With Transplanting</u>	<u>Direct Seeding</u>
Nursery /1	-	-
Land Preparation	6	6
Submersion	10	-
Planing	-	2
Transplanting	25	-
Direct Seeding	-	1
Fertilizer Application	2	2
Weeding	20	20
Irrigation	5	5
Harvesting and Stacking	15	15
Threshing (with paddle thresher)	10	10
Transport	<u>4</u>	<u>4</u>
	97	65

/1 By the scheme management.

Draft animals are used 3 days in the case of cultivation with transplanting (land preparation) and 5.5 days in the case of direct seeding (land preparation, planing and direct seeding). Farms equipped for direct seeding could also use the Arara toolbar for weeding. Weeding in this case would take 2 days with two men per ha. It would reduce the time required for weeding from 20 man-days to 8 man-days, and total labor requirements from 65 man-days to 53 man-days. The timing of labor requirements for irrigation cultivation with transplanting is in Table 4.

3.06 For an average farming unit of 1.54 adult males family labor available is estimated at  $1.54 \times 25 \times 12 = 461$  man-days. Table 3 indicates that the average farming unit requires hired labor even under traditional cultivation conditions during the rainy season (July) when the rice fields are prepared and the rainfed crops need weeding, and in the dry season (October) when millet is harvested. While in October the harvested crop is unlikely to be spoiled since there is no rainfall, the conflict exists in July, and farmers usually give priority to millet over rice. For this reason it is proposed to limit land allocations in the Namarigoungou scheme to 0.50 ha per farming unit (the same as in Toula). A smaller plot would be unattractive to farmers and would not be consistent with past practice on the other schemes. In addition, there may not be enough people to work on the schemes (Annex 6) if (say) only 0.25 ha were allocated to each farming unit.

3.07 Rice Paddy Production. Paddy production for the project area is at Table 6. Total paddy production would increase from 6,000 tons in 1976 to 20,400 tons by 1982. Production from the Namarigoungou scheme alone would start in 1980 (2,700 tons) and reach 13,000 tons by 1982.

#### 4. Mixed Cropping Development

4.01 Project farmers would practice mixed cropping on the irrigation schemes where rice cultivation is not possible: soils being too sandy, too slopy or impossible to land-plane. There are already two schemes Sakoirra (42 ha) and Tillakeina (36 ha) established on the terraces where mixed cropping is practiced. Another terrace, Lossa (162 ha), should be completed in 1977, and in the Namarigoungou scheme there are an estimated 300 ha unsuitable for rice cultivation, of which 150 ha would be allocated to mixed cropping.

4.02 The other 50 ha would be divided into 25 ha for wood plantations and 25 ha for fodder crops. Wood plantations would belong to the farmers' cooperative units, while fodder crops and mixed cropping plots would be allotted to interested farmers. On the mixed cropping plots several crop rotations are possible. It is proposed here:

rainy season: sorghum;

dry season: cowpeas, onions, tomatoes, gombos.

4.03 Mixed cropping cultivation assumes (a) no irrigation in the rainy season, or only complementary irrigation, and (b) full irrigation during the dry season. Water requirements 1/ would be:

##### Rainy season

- Sorghum complementary irrigation 4,500 m<sup>3</sup>/ha

##### Dry season

- Cowpeas 9,500 m<sup>3</sup>/ha

- Vegetables 12,000 m<sup>3</sup>/ha

During the dry season the 200 ha would be divided as follows:

- Cowpeas	120 ha
- Onions	10 ha
- Tomatoes	25 ha
- Gombos	25 ha
- Other	<u>20 ha</u>

TOTAL 200 ha

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1/ Based on volumes used at Sakoirra and Tillakeina.

4.04 Plots under mixed cropping as well as those under rice irrigation would be supervised by the extension staff. Modern agricultural techniques would be taught to achieve the following yields:

Estimated Yields

Cowpeas	1,200 kg/ha
Sorghum	2,500 kg/ha
Tomatoes	25,000 kg/ha
Gombos	700 kg/ha (dry)

4.05 Tree Plantations. Following the success of the tree plantations in the Toula scheme, some 50 ha in the Namarigoungou scheme would be allocated to tree plantations. Soils selected would be those least adapted to crop cultivation, but where watering would still be possible. Plantations would also serve to protect the perimeter against wind erosion. Eucalyptus varieties would be used. Planting density would be 1,200 trees per ha, assuming that 1,000 trees emerge. Felling would take place in the third year. At least three crops would be grown on the same plot.

5. Rainfed Development

Project services would be extended to the holdings that farmers participating in the schemes would continue to cultivate under rainfed conditions.

5.01 Improved cultivation methods would be introduced progressively, and adopted by a minority of farmers.

- Millet:
- Abandoning cultivation of cowpeas between two rows of millet. Cowpeas would be cultivated in pure stand at the start of the crop rotation;
  - Scarifying the soil with an ox-drawn hoe;
  - Using improved varieties P3 Kolo or HKP;
  - Seeding after the first useful rains at a density of 10,000 seeds/ha;
  - Dressing seeds with 2 g of Thioral per kg of seeds;
  - Thinning to 3 plants per hole between 15 and 21 days after emergence;
  - Weeding 10 days after emergence and again 20 days after the first weeding;



- Applying 35 kg/ha of triple phosphate during soil preparation and 35 kg of urea after the first weeding.

Cowpeas: - Scarifying the soil;

- Using improved variety TN 88-63;
- Applying 75 kg/ha of superphosphate at the time of soil preparation;
- Seeding at a density of 60,000 seeds/ha;
- Weeding 10 days after emergence and again 20 days after the first weeding.

Sorghum (on the dunes):

- Planting in the crop rotation after millet;
- Scarifying the soil;
- Seeding at 10,000 plants/ha;
- Applying 35 kg/ha of triple superphosphate before soil preparation, and 50 kg/ha of urea at thinning before the second weeding;
- Thinning early (20 days after emergence);
- Weeding twice, 8 days after emergence and 15 days later.

5.02 The application of these improved techniques would result in the following yield increases:

	Stages of Adoption of Improved Techniques	Improved Techniques	Yield Increases	Yields under improved Conditions
<u>Millet</u>				
(yield under traditional cultivation 312 kg/ha)	1	Proper seeding density; correct thinning and weeding	25%	400 kg/ha
	2	Preceding methods + improved seeds	45%	450 kg/ha
	3	Preceding methods + fertilizer application ox-drawn cultivation	110%	650 kg/ha
<u>Cowpeas</u>				
(Yield under traditional cultivation 118 kg/ha)	1	Pure stand, at head of rotation Proper seeding density; correct thinning and weeding	40%	165 kg/ha
	2	Preceding methods + improved seeds + insecticides treatment	85%	220 kg/ha
	3	Preceding methods + fertilizer application + ox-drawn cultivation	150%	300 kg/ha
<u>Sorghum</u>				
(Yield under traditional cultivation 450 kg/ha)	1	Proper seeding density Early weeding	30%	585 kg/ha
	2	Preceding methods + Improved seeds	45%	650 kg/ha
	3	Preceding methods + fertilizer application + ox-drawn cultivation	100%	900 kg/ha

5.03 Adoption of improved cultivation methods could be as follows (% of total farming units):

	<u>Stages of Improved Methods</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>
Millet	1	15	20	30
	2		15	25
	3		5	10
Cowpeas	1	5	15	20
	2		10	15
	3		5	10
Sorghum	1	10	15	20
	2		10	20
	3		5	10

5.04 Rainfed Production. The incremental production under this component is estimated at about 2,400 tons by 1982 (Table 6).

5.05 The equipment for rice cultivation was calculated at the ratio of one basic unit per 5 ha, which would leave sufficient time for work on the rainfed holdings since it is generally estimated that one unit should be used on 6 ha per year. Some specific attachments would, however, be required for scarifying (estimated at 340 units). No additional labor would be required.

## 6. Livestock

6.01 The favorable elements for a livestock development program are:

- present ownership of cattle estimated at 5.06 head per compound;
- production of rice by-products at Tillabery rice mill (12-16% of tonnage of paddy) with high nutrient:  
1 kg = 0.29 UF;
- proposed production of fodder crops under irrigation in Namarigoungou (25 ha with yields of 30 to 40 tons per ha).

6.02 The proposed development program is limited to stall fattening of 3-4 year old cattle (live weight 225-275 kg) for 3 months, with green fodder and rice by-products for a daily gain of 600/700 grams.

6.03 The problem with stall fattening is the purchase of lean animals at a reasonable cost. No purchases should be made between July and November because at that time the animals are in demand and cost too much. Purchases

would start in December. Sheds would be built with local materials, and no more than 2 or 3 head of cattle would be fattened at the same time. Fattening would last 90 days and would be done twice a year.

6.04 Daily ration by animal would be:

Green fodder	20 kg
Rice by-products	4 kg
Salt	0.3 kg

6.05 Fodder varieties would be any of the following: *Andropogon gayanus*, *Panicum maximum*, *Brachiaria mutica* and *Cynodon dactylon*. All varieties were tested in a pilot program over the period 1970-1973 at Kirkessoye. <sup>1/</sup> Yields on the scheme were estimated at 40 tons per hectare of green fodder. Fodder is cut 5 to 6 times a year, and fertilizer is applied after each cut (for a total of 300 kg/ha).

6.06 Assuming that a family unit fattens on the average 3 head of cattle during 90 days and has 2 fattening cycles per year, total green fodder consumption would be 10.8 tons per farming unit (rounded to 12 tons with losses). If yields of 40 tons per ha are obtained, each farming unit participating in this project component should receive 0.30 ha. Assuming that the area under fodder crops in Namarigoungou is 25 ha, some 83 farmers could participate (some 3% of all farmers). The number of animals fattened would be 250 per cycle, or 500 per year.

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<sup>1/</sup> The pilot program was technically successful, but farmers were unable to sell their animals once fattened. Today marketing arrangements are better, and there should not be any problem selling the project production.

NIGER

IRRIGATION PROJECT  
PROJET D'IRRIGATION

Agricultural Development  
Developpement agricole

Area under Cultivation in 11 Villages of the Tillabery Area  
Superficie cultivee des exploitations de 11 villages de la region de Tillabery

Villages	Number of Farming units surveyed	<u>Area cultivated per farming unit</u>				Total area cultivated per farming unit
		Millet	Rice	Sorghum	Tobacco (ha)	
Villages	Nombre d'exploitations enquetees	<u>Surfaces cultivees par exploitation</u>				Surface totale cultivee par exploitation
		Mil	Riz	Sorgho	Tabac (ha)	
Maloumbery	6	1.06	1.12	-	-	2.18
Kiekietondo	8	2.93	1.49	-	-	4.42
Diadia Kado	53	2.38	1.06	-	-	3.44
Darbey Goumbia	10	1.78	0.84	-	-	2.62
Daibery	104	2.57	0.94	0.01	-	3.52
Toulame	12	4.76	0.85	1.63	0.06	7.30
Yelewani Kado	15	4.32	0.13	0.09	-	4.54
Yelewani Goungou	33	3.60	1.58	0.29	0.12	5.59
Neyni I	22	1.11	1.12	1.20	0.10	3.53
Neyni II	42	2.02	1.62	0.40	0.08	4.12
Neyni III	20	3.56	2.12	0.59	0.13	6.40
Total	325					

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IRRIGATION PROJECT/PROJET D'IRRIGATION

Project Area/Zone du projet

A. Existing Schemes/Aménagements existants	Farming Units/ Exploitations	Total Population/ Population totale	Area Under Irrigation/ Surface aménagée en irrigation moderne (ha)	Area Cultivated in 1975 (ha)		Area Under Rainfed Cultivation/ Surface en culture pluviale			
				Surface cultivée en 1975 (ha)		Millet/Mil		Sorghum/Sorgho	
				Rainy Season Saison des pluies	Dry Season Saison sèche	Millet/Mil	Sorghum/Sorgho		
Fergoun	202	1,060	300	132	42	500	100		
Sakoira	275	1,444	36		36	700	100		
Tillakeina	124	651	42			300	100		
Toula	450	2,363	260	242	240	1,100	200		
Daikena	361	1,895	110	100	110	900	200		
Sona	470	2,468	212	149	115	1,150	200		
Lossa	288	1,512	190	115	113	700	100		
Total	2,170	11,393	1,150	738	656	5,350	1,000		
B. New Schemes/Nouveaux aménagements									
Namarigoungou	3,000	15,750	1,550			7,400	1,400		
Yelewani	240	1,260	120			600	100		
Daibery	720	3,760	360			1,700	300		
Lossa - Terrasses	320	1,700	160			800	200		
Total	4,280	22,470	2,190			10,500	2,000		
Grand Total	6,450	33,863	3,340			15,850 /1	3,000		

/1 Of the 15,850 ha under millet cultivation, 9,350 ha (or 59%) are mixed with cowpeas.

/2 Sur les 15,850 ha où se cultivent le mil, le mil est planté avec du niébé sur 9,350 ha (59 %).

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IRRIGATION PROJECT/PROJET D'IRRIGATION

Agricultural Development/Développement agricole

Monthly Allocation of Time Requirements/Répartition mensuelle des temps de travaux

	January Janvier	February Février	March Mars	April Avril	May Mai	June Juin	July Juillet	August Août	September Septembre	October Octobre	November Novembre	December Décembre	Total Total	
<b>A. Culture traditionnelle</b>														<b>A. Traditional Cultivation</b>
Hommes/jour/mois	39.00	36.00	39.00	36.00	39.00	36.00	39.00	39.00	38.00	39.00	38.00	39.00	461.00	Man-days/month
<u>Riz traditionnel</u>														<u>Traditional Rice</u>
Houage							17.25						17.25	Hoeing
Semis							1.15						1.15	Seeding
Désherbages									20.00	20.25			40.25	Weeding
Récolte												23.00	23.00	Harvesting
Battage	17.25												17.25	Threshing
<u>Sorgho de décrue</u>														<u>Flood Recession Sorghum</u>
Semis en pépinières			0.75										0.75	Nursery
Houage et repiquage				3.00									3.00	Hoeing and transplanting
Sarclages					1.50	1.50	1.50	1.50	1.50				7.50	Weeding
Récolte - battage										3.75			3.75	Harvesting-threshing
<u>Mil et niébé dunaire</u>														<u>Millet and Cowpeas</u>
Préparation du sol					31.20								31.20	Soil preparation
Semis						10.4							10.40	Seeding
Sarclages							30.00	35.00					65.00	Weeding
Récoltes									20.00	26.80			46.80	Harvesting
Battage -transport											15.60	15.60	31.20	Threshing-transport
<u>Tabac et jardins</u>														<u>Tobacco - Gardens</u>
Pépinières											1.00		1.00	Nurseries
Houage et repiquage												4.00	4.00	Hoeing and transplanting
Irrigation	1.00												1.00	Irrigation
Récolte tabac		3.00											3.00	Tobacco harvest
Travail sur jardins		0.75	1.00	1.00									2.75	Work in gardens
<b>Total traditionnel</b>	18.25	3.75	1.75	4.00	32.70	11.90	49.90	36.50	41.50	50.80	47.80	42.60	341.45	<b>Total Traditional</b>
Main d'oeuvre familiale disponible (déficit)	20.75	32.25	37.25	34.00	6.30	26.10	(10.90)	2.50	(7.50)	(11.80)	(9.80)	(3.60)	119.55	Family Labor
<b>B. Temps de travail (0.5 ha riz repiqué)</b>	3.00	19.00	6.00	5.50	8.00	10.00	19.00	6.00	5.50	0.50	7.50	7.00	97.00	<b>B. Labor Requirements (0.5 ha of transplanted rice)</b>
Main d'oeuvre familiale restant disponible (déficit)	17.75	13.25	31.25	28.50	(1.70)	16.10	(29.90)	(3.50)	(9.00)	(12.30)	(17.30)	(10.60)	22.55	Family Labor Left Over (Deficit)

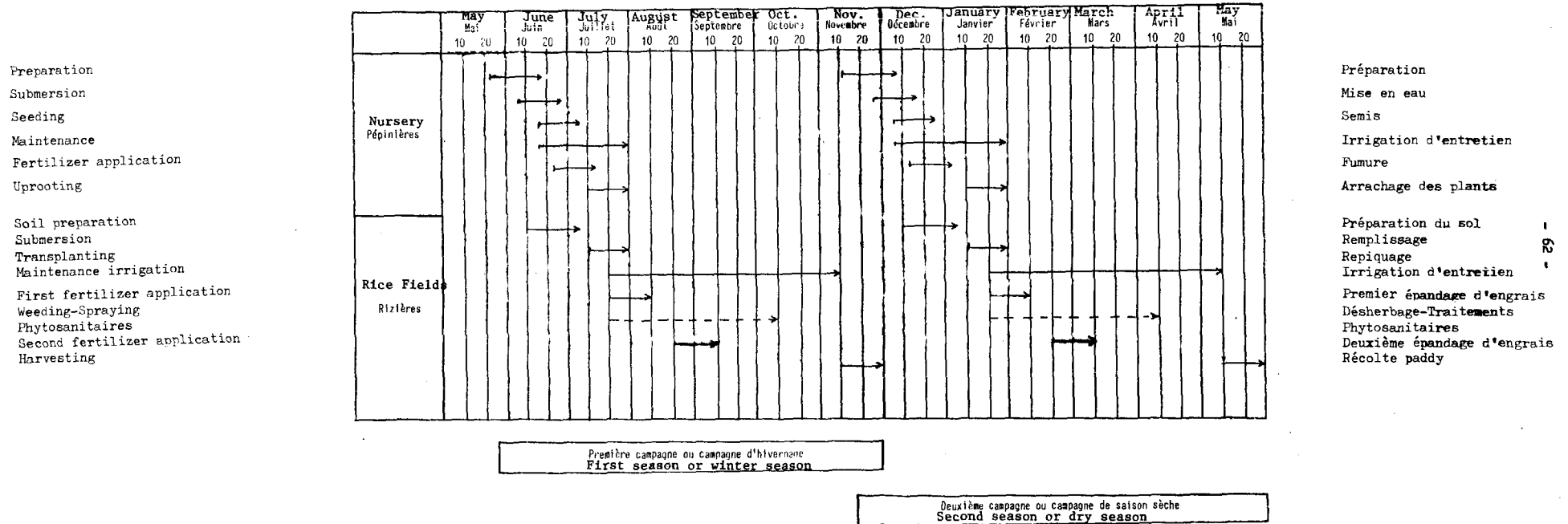
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IRRIGATION PROJECT - PROJET D'IRRIGATION

Agricultural Development - Développement agricole

Rice Cultivation Under Modern Irrigation With Transplanting - Culture du riz sur aménagement avec repiquage

Timing of Cultivation - Calendrier Cultural





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IRRIGATION PROJECT - PROJET D'IRRIGATION

Agricultural Development - Développement Agricole

Area Cultivated and Production on Schemes in the Project Area - Surfaces cultivées et production sur aménagement dans la zone du projet

		Rainy Season 1975/Campagne SP 1975			Dry Season 1975-76/Campagne SS 1975-76			Rainy Season 1976/Campagne SP 1976			No. of farmers/ Nombre d'ex- ploitants	Average area cultivated/ Surface moy. cultivée
		Area/ Surface (ha)	Yield/ Rendement (kg/ha)	Production/ Production (tons/tonnes)	Area/ Surface (ha)	Yield/ Rendement (kg/ha)	Production/ Production (tons/tonnes)	Area/ Surface (ha)	Yield/ Rendement (kg/ha)	Production/ Production (tons/tonnes)		
Fergoun	Paddy/Riz	132	3,500	456	-	-	-	132	3,500	462	202	0.65
Sakoira /1	Onions/Oignons	-	-	-	19.5	30,000	585	-	-	-	275	0.07
	Cowpeas/Niébés	-	-	-	22.5	1,500	34	-	-	-	275	0.08
Tillakeina /1	Cowpeas/Niébés	-	-	-	36.4	1,300	47	-	-	-	124	0.29
Toula	Paddy/Riz	242	4,600	1,113	240	5,200	1,248	240	5,200	1,248	450	0.53
Daikena	Paddy/Riz	100	4,000	400	110	4,150	456	105	4,000	420	361	0.29
Sona	Paddy/Riz	149	4,000	596	115	4,660	536	124	4,000	496	470	0.26
Lossa	Paddy/Riz	115	4,400	504	113	3,600	407	135	5,100	688	288	0.47
Total cultivated/total cultivé		738	-	-	656.4	-	-	736	-	-	-	-
Total paddy/total riz		738	-	-	578	-	-	736	-	-	-	-
Paddy production/Production riz		-	-	3,069	-	-	2,647	-	-	3,314	-	-
Paddy yield/Rendement riz		-	4,160	-	-	4,580	-	-	4,500	-	-	-
Total project beneficiaries/total attributaires		-	-	-	-	-	-	-	-	-	2,170	-

/1 Schemes where sorghum is cultivated without irrigation during winter season.  
Aménagements cultivés en sorgho pendant l'hivernage sans irrigation.

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## IRRIGATION PROJECT/PROJET D'IRRIGATION

## Agricultural Development/Développement agricole

## Agricultural Production With Project/Production agricole avec le projet

A. Production of paddy	Area Cultivated (ha)/1		Yields (kg/ha)		Production (tons)		A. Production de paddy
	Without Project	With Project	Without Project	With Project	Without Project	With Project	
<u>Existing Schemes</u>	Superficies cultivées (ha) /1		Rendements (kg/ha)		Production (tonnes)		<u>Aménagements existants</u>
Fergoun	140	140	3,500	3,500	500	500	Fergoun
Toula	480	520 /2	5,000	5,000	2,400	2,600	Toula
Daikena	200	220	4,000	4,500	800	1,000	Daikena
Sona	350 /3	380	4,300	4,500	1,500	1,700	Sona
Lossa	300 /3	360	4,400	4,500	1,300	1,600	Lossa
Total Area (ha)/Superficie totale (ha)	1,470	1,620	Total Production (tons)		6,500	7,400	Production totale (tonnes)
			Incremental Production (tons)			900	Production supplémentaire (tonnes)
<u>New Scheme /6</u>	Area Cultivated (ha) /1		Yields (kg/ha)		Production (tons)		<u>Aménagement nouveau /6</u>
	Superficies cultivées (ha) /1		Rendements (kg/ha)		Production (tonnes)		
	1980	1982	1980	1982	1980	1982	
Namarigoungou	300	2,700	4,500	4,800	1,400	13,000	Namarigoungou
Total Area (ha)/Superficie totale (ha)	300	2,700	Total Production (tons)		1,400	13,000	Production totale (tonnes)
			Incremental Production (tons)				
<u>Mixed Cropping /4</u>	Area Cultivated (ha)		Yields (kg/ha)		Production (tons)		<u>B. Polyculture /4</u>
	Superficies cultivées (ha)		Rendements (kg/ha)		Production (tonnes)		
<u>New Schemes</u>	1980	1982	1980	1982	1980	1982	<u>Nouveaux aménagements</u>
Lossa	162	162	2,200	2,500	360	400	Lossa
- Sorghum	98	98	1,100	1,200	110	120	- Niébé
- Cowpeas	8	8	27,000	30,000	210	240	- Oignons
- Onions	20	20	22,500	25,000	450	500	- Tomates
- Tomatoes	36	36	900	1,000	30	40	- Autres légumes
- Other Vegetables	324	324			1,160	1,300	
Namarigoungou	50	150	2,200	2,500	110	400	Namarigoungou
- Sorghum	30	90	1,100	1,200	30	120	- Niébé
- Cowpeas	3	10	27,000	30,000	80	300	- Oignons
- Onions	6	20	22,500	25,000	140	500	- Tomates
- Tomatoes	11	30	900	1,000	10	30	- Autres légumes
- Other Vegetables	100	300			370	1,350	
<u>C. Wood Plantations and Livestock on Namarigoungou</u>	Area Cultivated (ha)		Production (CFAF millions)		Production (en millions de FCFA)		<u>C. Plantations et élevage à Namarigoungou</u>
	Superficies cultivées (ha)		Production (CFAF millions)		Production (en millions de FCFA)		
Wood Plantations	10	25				24	Plantations
Livestock	-	25				13	Élevage
<u>D. Rainfed (Incremental Production on Rainfed Holdings of Scheme Participants) (tons)</u>	1980	1981	1982				<u>D. Cultures sèches (production supplémentaire des cultures sèches des participants du projet)</u>
<u>Existing Schemes /5</u>				<u>Aménagements existants /5</u>			
Millet	120	400	680	Mil			
Sorghum	20	70	130	Sorgho			
(Cowpeas)	(30)	(50)	(130)	(Niébé)			
Total	110	420	680	Total			
<u>Lossa Scheme</u>				<u>Lossa</u>			
Millet	20	80	130	Mil			
Sorghum	10	20	30	Sorgho			
(Cowpeas)	(10)	(10)	(20)	(Niébé)			
Total	20	90	140	Total			
<u>Namarigoungou</u>				<u>Namarigoungou</u>			
Millet	260	860	1,460	Mil			
Sorghum	50	160	280	Sorgho			
(Cowpeas)	(60)	(120)	(160)	(Niébé)			
Total	250	890	1,580	Total			

/1 Double cropping except for Fergoun.

/2 Area reclaimed from nurseries.

/3 Investments to expand these two schemes are not included in project cost.

/4 No production increase contemplated on the 2 existing schemes where mixed cropping is practiced (Sakoirra, Tillakeina).

/5 Includes Sakoirra - Daikena.

/6 Production without project (500 tons).

/1 Deux récoltes, Fergoun excepté.

/2 Superficie gagnée sur les plantations.

/3 Les investissements pour renforcer ces ouvrages ne sont pas compris dans le coût du projet.

/4 Pas d'augmentation de production prévue dans les deux aménagements existants où la polyculture est pratiquée (Sakoirra, Tillakeina).

/5 Comprend Sakoirra, Tillakeina.

/6 Production sans le projet (500 tonnes).

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IRRIGATION PROJECT - PROJET D'IRRIGATION

Agricultural Development - Développement agricole

Farm Budget/Budget de ferme

	<u>Area/ Surface (ha)</u>	<u>Yield/ Rendement (kg/ha)</u>	<u>Farm Price/ Prix au producteur (CFAF/kg/FCFA/kg)</u>	<u>Total/ Total (CFAF/FCFA)</u>
<b>A. Without Project</b>				
<u>Crop Production Gross Income</u>				
Paddy	1.15	1,200	45	62,100
Millet	2.60	312	40	32,450
Cowpeas <sup>/1</sup>	1.05	118	45	5,580
Gardens <b>and Sorghum (net income)</b>				<u>18,000</u>
Total Crop Production Gross Income				118,130
<u>Crop Production Expenses</u>				
Seeds:				
Rice	1.15	80	45	4,140
Millet	2.60	15	40	1,560
Cowpeas	1.05	12	45	570
Total Seeds				<u>6,270</u>
Hired Labor 39.6 man-days at CFAF 200/man-day				7,920
Land Rent: <sup>/2</sup>				
Rice 25% at 10% of gross income				1,550
Millet 18% at 5% of gross income				290
Total Rent				<u>1,840</u>
Total Crop Production Expenses				16,030
<u>Crop Production Net Income</u>				<u>102,100</u>
<u>Livestock Net Income</u>				13,800
<u>Total Farming Unit Gross Income</u>				131,930
<u>Total Farming Unit Net Income</u>				115,900
Labor Requirements (341.45 man-days)				
Farmers' Gross Income per Man-day				386
Farmers' Net Income per Man-day				339
Farmers' Gross Income per Capita (5.25 people in farming unit)				25,130
Farmers' Net Income per Capita				22,080

<sup>/1</sup> Grown with Millet.  
<sup>/2</sup> This is the farm budget (without the project) of a Wogo farmer who rents an estimated 25% of the land cultivated in rice, and an estimated 18% of the land cultivated under rainfed conditions from Kado owners.

**A. Sans le projet**

Revenu brut de la production agricole

Riz	
Mil	
Nièbé <sup>/1</sup>	
Jardins <b>et sorgho (revenu net)</b>	
Revenu total brut de la production agricole	

Frais de production

Semences:	
Riz	
Mil	
Nièbé	
Total semences	

Main-d'oeuvre salariée 39,6 hommes-jours à FCFA 200 par homme-jour

Location des terres: <sup>/2</sup>  
 Riz - 25 % à 10 % du revenu brut  
 Mil - 18 % à 5 % du revenu brut  
 Total location des terres

Total frais de production

Revenu net de production agricole

Revenu net de l'élevage

Revenu brut par exploitation

Revenu net par exploitation

Besoins en main-d'oeuvre (341,45 hommes-jours):  
 Revenu brut des fermiers par jour de travail  
 Revenu net des fermiers par jour de travail  
 Revenu brut des fermiers par tête (5.25 personnes par exploitation)  
 Revenu net des fermiers par tête

<sup>/1</sup> Planté en association avec le mil.  
<sup>/2</sup> C'est le budget de ferme (sans le projet) d'un fermier Wogo qui loue 25% des terres cultivées en riz et 18% des terres en culture sèche des propriétaires Kados.

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IRRIGATION PROJECT/PROJET D'IRRIGATION

Agricultural Development/Développement Agricole

Farm Budget/Budget de ferme

	CFAF/FCFA		E. Riziculture (1 ha - 1 récolte)
<b>B. Rice Cultivation (one ha - one crop)</b>			
<u>Farmers' Gross Income</u>			<u>Revenu brut des fermiers</u>
Paddy 4,800 kg at CFAP 45	216,000		Paddy
<u>Farmers' Cultivation Expenses</u>			<u>Frais de culture des fermiers</u>
Soil Preparation /1	2,007		Préparation du sol /1
Nursery /2	6,522		Pépière /2
Fertilizer (200 kg of urea)	8,000		Engrais (200 kg d'urée)
Insecticides /3	812		Insecticides /3
Rent of Paddle Thrashers /4	3,500		Location de batteuses à pédales /4
Crop Transport /5	1,522		Transport de la récolte /5
Sub-total	22,413		Total partiel
Hired Labor /6	7,900		Frais de main-d'oeuvre salariée /6
Irrigation Water /7	12,150		Frais d'irrigation /7
Total Farmers' Cultivation Expenses	47,463		Total des frais de culture des fermiers
<u>Capital Recovery Charges</u>	32,850		<u>Charges de recouvrement de l'investissement</u>
Total Farmers' Expenses	80,313		Total des frais des fermiers
<u>Farmers' Net Income (one ha - one crop) for half a year</u>	135,687		<u>Revenu net des fermiers (1 ha - 1 récolte) pour six mois</u>
or (0.5 ha - two crops) for a year			ou (0,5 ha - 2 récoltes) pour un an
<u>Labor Requirements (0,5 ha - two crops: 97 man-days per year)</u>			<u>Besoins de main-d'oeuvre (0,5 ha - 2 récoltes: 97 hommes-jours par an)</u>
Farmers' Gross Income per Man-day	2,227		Revenu brut des fermiers pour un homme-jour
Farmers' Net Income per Man-day	1,399		Revenu net des fermiers pour un homme-jour
Farmers' Gross Income per Capita (5.25 people in farming unit)	41,143		Revenu brut des fermiers par tête (5,25 personnes par exploitation)
Farmers' Net Income per Capita	25,845		Revenu net des fermiers par tête
<u>Subsidies</u>			<u>Subventions</u>
Soil Preparation - Flowing equipment sold to farmers at CFAP 8,000 (73% subsidy from cost of CFAP 29,400)	410		Préparation des sols - matériel agricole de labour vendu aux fermiers à FCFA 8.000 (subvention de 73 % pour un coût de FCFA 29.400)
Fertilizer - Urea sold to farmers CFAP 40/kg (43% subsidy from cost of CFAP 70/kg)	6,000		Engrais - urée vendue aux fermiers à FCFA 40/kg (subvention de 43 % pour un coût de FCFA 70/kg)
Insecticides - Insecticides sold to farmers CFAP 600/liter (25% subsidy from cost of CFAP 800/liter)	271		Insecticides - insecticides vendus aux fermiers à FCFA 600/litre (subvention de 25 % pour un coût de FCFA 800/litre)
Crop Transport - Cart sold to farmers CFAP 48,000 (32% subsidy from cost of CFAP 71,000)	161		Transport de la récolte - charrettes vendues aux fermiers à FCFA 48.000 (subvention de 32 % pour un coût de FCFA 71.000)
Total Subsidies (one ha - one crop)	6,842		Total des subventions
/1 3 days of plowing. A pair of oxen cost CFAP 618 per day. Under the assumption that the pair costs CFAP 59,300 per year and works 96 days per year. The plow and the Arara tool bar (CFAP 8,000 to farmers) are used on 12 ha yearly and last 6 years.		/1 3 jours de labour. La paire de boeufs coûte FCFA 618 par jour. En supposant que la paire revient à FCFA 59.300 par an et travaille 96 hommes-jours par an. La charrue et le bâti Arara (vendus FCFA 8000 aux fermiers) sont utilisés sur 12 ha par année et durent 6 ans.	
/2 At cost. The project proposes to eliminate the subsidy on seedlings from the nursery. In 1976 seedlings were sold at a cost of CFAP 3,444/ha to farmers (43% subsidy from cost of CFAP 6,522). Main assumptions for nursery: 1 ha of nursery for 14 ha of rice cultivation; 3,000 m <sup>3</sup> of water/ha; 37 man-days of labor; and 600 kg/ha of fertilizer.		/2 Au prix de revient. Le projet propose d'éliminer la subvention au niveau de la pépière. En 1976 les plants avaient été vendus au coût moyen de FCFA 3.444 l'hectare aux fermiers (43 % de subvention pour un coût de FCFA 6.522). Les hypothèses principales pour les frais de pépières: 1 ha de pépière pour 14 ha de riziculture; 3.000 m <sup>3</sup> d'eau à l'hectare; 37 hommes-jours de travail; et 600 kg d'engrais.	
/3 Based on the average used for all schemes in 1976.		/3 Sur la base de la moyenne utilisée sur l'ensemble des aménagements en 1976.	
/4 10 days at CFAP 350/day.		/4 10 jours à FCFA 350/jour.	
/5 2 days of carting. The cart (CFAP 48,000) is used 60 days yearly and lasts 6 years.		/5 2 jours de charrois. La charrette sert 60 jours par an et dure 6 ans.	
/6 79 man-days of hired labor/ha at CFAP 200/man-day are required during the rainy season. (39.5 man-days as an average for the year).		/6 79 hommes-jours par hectare de main-d'oeuvre salariée à FCFA 200 par homme-jour sont requis pendant la saison des pluies. (39,5 hommes-jours en moyenne pour l'année).	
/7 17,500 m <sup>3</sup> per cropping season at CFAP 0.98/m <sup>3</sup> (Cost of Toula works).		/7 17.500 m <sup>3</sup> par saison de culture à FCFA 0,98/m <sup>3</sup> (coût sur l'aménagement de Toula).	

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Farm Budget/Budget de ferme

	Yield/ Rendement Kg/ha	Producer Price/ Prix au Producteur CFAF/kg - FCFA/kg	Sorghum/ Sorgho	Cowpeas/ Niébé	Onions/ Oignons	Tomatoes/ Tomates	Gombos/ Gombos	Other Vegetables/ Autres Légumes	Total (CFAF '000)	CFAF/FCFA		
											C. Mixed Cropping (Namarigoungou)	
<b>Farmers' Gross Income</b>												
Sorghum	2,500	35	87,500								Revenu brut des fermiers	
Cowpeas	1,200	45		54,000							Sorgho	
Onions	30,000	196			5,880,000						Niébé	
Tomatoes	25,000	38				950,000					Oignons	
Gombos	700	340					238,000				Tomates	
Other Vegetables	1,500	160						240,000			Gombos	
Farmers' Gross Income per ha (CFAF)			87,500	54,000	5,880,000	950,000	238,000	240,000			Autres légumes	
Area Under Cultivation (ha)			150	90	10	20	20	10			Revenu brut par ha (FCFA)	
Farmers' Gross Income for the Area (CFAF '000)			13,125	4,860	58,800	19,000	4,760	2,400	102,945		Superficie cultivée (ha)	
											Revenu brut des fermiers pour l'ensemble (FCFA '000)	
<b>Farmers' Cultivation Expenses</b>												
Soil Preparation /1			2,007	2,007	2,007	2,007	2,007	2,007			Frais de culture des fermiers	
Land Plowing			-	771	771	771	771	771			Préparation du sol /1	
Fertilizer /2			6,000	3,000	13,000	21,000	17,000	17,000			Affinage	
Seeds or Seedlings			640	1,350	10,000	1,200	12,800	12,800			Engrais /2	
Insecticides /3				3,600		14,400					Semences ou plants	
Sub-total			8,647	10,728	25,778	39,378	32,578	32,578			Total partiel	
Hire Labor /4				5,400	5,400	5,400	5,400	5,400			Main-d'oeuvre salariée /4	
Irrigation Water /5			4,410	9,310	11,760	11,760	11,760	11,760			Eau d'irrigation /5	
Farmers' Cultivation Expenses per ha			13,057	25,438	42,938	56,538	49,738	49,738			Frais de culture par ha	
Farmers' Cultivation Expenses for the area (CFAF '000)			1,959	2,289	429	1,131	925	497	7,300		Frais de culture pour l'ensemble (FCFA '000)	
Capital Recovery Charges /6 for the area (CFAF '000)			4,928	2,957	329	657	657	329	9,857		Charges de recouvrement de l'investissement /6 (FCFA '000)	
Farmers' Net Income for the area (CFAF '000)			5,113	(386)	58,042	17,212	3,108	1,274	85,788		Revenu net des fermiers pour l'ensemble (FCFA '000)	
Labor Requirements (man-days per ha)			60	45	85	92	105	105			Besoins en main-d'oeuvre (hommes-jours par ha)	
Total Labor Requirements for the area (man-days)			9,000	4,050	850	1,840	2,100	1,050	18,900		Besoins totaux en main-d'oeuvre pour l'ensemble (hommes-jours)	
Farmers' Gross Income per Man-day									5,450		Revenu brut des fermiers par homme-jour	
Farmers' Net Income per Man-day									4,540		Revenu net des fermiers par homme-jour	
Farmers' Gross Income per Farming Unit /7									68,600		Revenu brut par exploitation /7	
Farmers' Net Income per Farming Unit /7									57,200		Revenu net par exploitation /7	
Farmers' Gross Income per Capita /8									13,100		Revenu brut par tête /8	
Farmers' Net Income per Capita /8									10,900		Revenu net par tête /8	
<b>Subsidies</b>												
Soil Preparation /1	410/ha								164		Subventions	
Fertilizer - Subsidized 48%									3,193		Préparation du sol /1 410/ha	
Insecticides - Sold to farmers CFAF 600/liter (25% subsidy from cost)									264		Engrais - subventionné à 48%	
Total Subsidies									3,621		Insecticides - vendus aux fermiers (subvention 25% du coût d'achat)	
											Total des subventions	

/1 See Table  
/2 Sorghum 50 kg/ha of super and 100 kg of urea, Cowpeas 75 kg/ha of super, Onions: 150 kg super, 100 kg urea, 100 kg KCL, Tomatoes 250 kg super, 200 kg urea, 100 kg KCL.  
/3 6 liters for cowpeas and 24 liters for tomatoes.  
/4 27 man-days per ha at CFAF 200/man-day during the rainy season.  
/5 4,500 m<sup>3</sup>/ha for sorghum, 9,500 m<sup>3</sup>/ha for cowpeas and 12,000 m<sup>3</sup>/ha for other vegetables at CFAF 0.98/m<sup>3</sup>.  
/6 At CFAF 2,250/ha.  
/7 At 0.10 ha per farming unit.  
/8 At 5.25 people per farming unit.

/1 Voir table  
/2 Sorgho: 50 kg/ha de super et 100 kg d'urée, Niébé: 75 kg/ha de super, Oignons: 150 kg de super, 100 kg d'urée, 100 kg KCL, Tomates: 250 kg de super, 200 kg d'urée, 100 kg KCL.  
/3 6 litres pour niébé et 24 litres pour tomates.  
/4 27 hommes-jours à l'ha à FCFA 200/homme-jour durant la saison des pluies.  
/5 4,500 m<sup>3</sup>/ha pour sorgho; 9,500 m<sup>3</sup>/ha pour niébé, et 12,000 m<sup>3</sup>/ha pour autres légumes à FCFA 0,98/m<sup>3</sup>.  
/6 A FCFA 2,250/ha.  
/7 A 0,10 ha par exploitation.  
/8 A FCFA 5,25 personnes par exploitation.

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IRRIGATION PROJECT/PROJET D'IRRIGATION

Agricultural Development/Développement agricole

Farm Budget/Budget de ferme

	Per ha (CFAF) L'hectare (FCFA)	CFAF '000/FCFA '000					Total 1980-84 CFAF/FCFA
		1980	1981	1982	1983	1984	
D. <u>Wood Plantations (Namarigoungou)</u>							
Area planted per year (ha)		7	8	10			
Area planted cumulative (ha)		7	15	17	10		
		<u>CFAF '000/FCFA '000</u>					
<u>Income from Wood Sales</u>							
1,000 trees at CFAF 1,600/tree	1,600,000	-	-	12,000	12,000	16,000	40,000
<u>Wood Plantations Expenses</u>							
Seedlings and plantation expenses	188,500	1,414	1,414	1,885			4,713
Maintenance and sprinkling	95,000	712	1,425	2,375	1,663	950	7,126
Felling	71,500			537	537	715	1,789
<u>Total Plantation Expenses</u>		2,127	2,839	4,797	2,200	1,665	13,628
Capital Recovery Charges /1		247	493	822	575	329	2,466
<u>Wood Plantations Net Income</u>		(2,374)	(3,332)	6,381	9,225	14,006	23,906

D. Plantations (Namarigoungou)  
Surface plantée par année (ha)  
Surface plantée cumulée (ha)

Revenu des ventes de bois  
1000 arbres à FCFA 1600 par arbre

Frais de plantation  
Plants et frais d'établissement  
Entretien et arrosage  
Abattage

Total des frais de plantation

Charges pour recouvrement de l'investissement

Revenu net des plantations

/1 CFAF 32,850/ha.

/1 32,850 FCFA l'hectare.

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IRRIGATION PROJECT/PROJET D'IRRIGATION

Agricultural Development/Développement agricole

Farm Budget/Budget de ferme

1977 (Without Project/ Sans le Projet)	1980	1981	1982	Total 1980-82
	(CFAF '000)/(FCFA '000)			
<b>E. Rainfed Development (Namarigoungou)</b>				
<u>Farmers' Gross Income</u>				
Incremental Crop Production (tons)				
- Millet	260	860	1,460	
- Sorghum	50	160	280	
- Cowpeas	(60)	(130)	(160)	
Value of Incremental Crop Production (CFAF '000)				
- Millet (CFAF 32/kg)	8,300	27,500	46,700	82,500
- Sorghum (CFAF 32/kg)	1,600	5,100	9,000	15,700
- Cowpeas (CFAF 45/kg)	(2,700)	(5,900)	(7,200)	(15,800)
Total Value of Incremental Production	7,200	26,700	48,500	82,400
<u>Farmers' Cultivation Expenses (CFAF '000)</u>				
Additional Agricultural Equipment Amortization /1	70	140	140	350
Fertilizer		1,810	3,530	5,340
Insecticides /2		390	640	1,030
Total Farmers' Incremental Cultivation Expenses	70	2,340	4,310	6,720
Farmers' Incremental Net Income	7,130	24,360	44,190	75,680
Farmers' Incremental Gross Income per Farming Unit at Full Development (1982) /3			CFAF 16,200	
Farmers' Incremental Net Income per Farming Unit at Full Development (1982) /3			CFAF 14,700	
Farmers' Incremental Gross Income per Capita at Full Development (1982) /4			CFAF 3,086	
Farmers' Incremental Net Income per Capita at Full Development (1982) /4			CFAF 2,805	
<u>Subsidies</u>				
Additional Agricultural Equipment -Sold to farmers at CFAF 3,000/unit (70% subsidy from cost of CFAF 9,916/unit)				804
Fertilizer - Sold to farmers with 48% subsidy				5,411
Insecticides - Sold to farmers with 25% subsidy				343

/1 Basic equipment amortized over rice cultivation, additional equipment required amortized over 6 years.

/2 4.5 l/ha on cowpeas.

/3 Assuming 3,000 farming units.

/4 Assuming 5.25 people in the farming unit.

**E. Développement en cultures sèches (Namarigoungou)**

<u>Revenu brut des fermiers</u>	
Production agricole (tonnes)	
- Mil	
- Sorgho	
- Niébé	
Valeur de la production agricole supplémentaire (FCFA '000)	
- Mil (FCFA 32/kg)	
- Sorgho (FCFA 32/kg)	
- Niébé (FCFA 45/kg)	
Valeur totale de la production agricole supplémentaire	
<u>Frais de culture des fermiers (FCFA '000)</u>	
Amortissement de l'équipement agricole supplémentaire /1	
Engrais	
Insecticides /2	
Total des frais de culture supplémentaires	
Revenu net supplémentaire des fermiers	
Revenu brut supplémentaire par exploitation au stade de plein développement (1982) /3	
Revenu net supplémentaire par exploitation au stade de plein développement (1982) /3	
Revenu brut supplémentaire par tête au stade de plein développement (1982) /4	
Revenu net supplémentaire par tête au stade de plein développement (1982) /4	
<u>Subventions</u>	
Matériel agricole supplémentaire - Vendu aux fermiers à FCFA 3000/l'unité (subvention de 70 % pour un coût de FCFA 9916/l'unité)	
Engrais - Vendu aux fermiers avec une subvention de 48 %	
Insecticides - Vendus aux fermiers avec une subvention de 25 %	

/1 Matériel agricole de base amorti sur le budget de riziculture, l'équipement supplémentaire est amorti sur 6 ans.

/2 4,5 l/ha pour le niébé.

/3 Supposant 3,000 exploitations.

/4 Supposant 5,25 personnes par exploitation.

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IRRIGATION PROJECT/PROJET D'IRRIGATION

Agricultural Development/Développement agricole

Farm Budget/Budget de ferme

		No.	1981	No.	1982	
<b>F. Livestock Sub-Project (Namarigoungou)</b>						<b>F. Sous-projet élevage (Namarigoungou)</b>
Increase in Liveweight Meat /1 (tons)	Animals	250	16	500	32	Gain de viande poids vif /1 (tonnes)
Value of Liveweight Meat (CFAF '000)	at CFAF 180/kg		2,900		5,800	Valeur du gain de viande poids vif (FCFA '000) à FCFA 200/kg
<b>Expenses: (CFAF '000)</b>						<b>Dépenses (FCFA '000)</b>
Green Fodder	Hectares	13		25		Fourrage vert
Flowing /2	at CFAF 3,000/ha		38		75	labour /2
Fertilizer /3	at CFAF 18,000/ha		225		450	Engrais /3
Irrigation Water /4	at CFAF 24,500/ha		307		613	Irrigation /4
Cost of Green Fodder Prior to Capital Recovery Charges			570		1,138	Coût du fourrage vert avant charges de recouvrement du capital
Capital Recovery Charges /5			821		1,643	Charges de recouvrement du capital /5
Total Cost of Green Fodder			1,391		2,781	Coût du fourrage vert
Rice By-Products /6	Tons	90		180		Son de riz /6
Value (CFAF '000)	at CFAF 1.2/kg		108		216	Valeur (FCFA '000)
Salt /7	Tons	7		14		Sel /7
Value (CFAF '000)	at CFAF 12/kg		84		162	Valeur (FCFA '000)
Total Expenses			1,583		3,159	Total des dépenses
Total Net Income from Livestock Sub-project (CFAF '000)			1,317		2,641	Revenu net total du sous-projet élevage (FCFA '000)
Farmers' Net Income per Farming Unit at Full Development (1982) /8			31,819		61,819	Revenu net par exploitation au stade de développement final (1982) /8
Farmers' Net Income per Capita /9 (CFAF)			6,061		12,364	Revenu net par tête /9 (FCFA)
Subsidies						Subventions
Fertilizer (CFAF '000)				413		Engrais (FCFA '000)

- /1 700 g per day per animal for 90 days.  
 /2 Every 2 years.  
 /3 300 kg of urea and 150 kg of superphosphate.  
 /4 2,500 m<sup>3</sup> at CFAF 0.98/m<sup>3</sup>.  
 /5 CFAF 32,850/ha/season.  
 /6 4 kg per animal per day during 90 days.  
 /7 0.3 kg per animal per day during 90 days.  
 /8 Assuming that 83 farming units participate.  
 /9 Assuming 5.25 people in the farming unit.

- /1 700 g par jour par animal pour 90 jours.  
 /2 Tous les 2 ans.  
 /3 300 kg d'urée et 150 kg de superphosphate.  
 /4 2.500 m<sup>3</sup> à FCFA 0,98/m<sup>3</sup>.  
 /5 FCFA 32.850 par hectare par saison de culture.  
 /6 4 kg par jour par animal pour 90 jours.  
 /7 0,3 kg par jour par animal pour 90 jours.  
 /8 Supposant que 83 exploitations participent.  
 /9 Supposant 5,25 personnes par exploitation.



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IRRIGATION PROJECT

Namarigoungou Irrigation Works

A. Constraints to Development Under Traditional Irrigation

1. Farmers traditionally sow rice in July and harvest it in March-April. The Niger river floods are supposed to provide the water supply to replace rainfall after it stops in September. The main physical constraints to the development of traditional irrigation are the following:

- (i) The river floods do not completely meet the demand for water requirements. In September the average monthly rainfall is 70 mm, 1/ while rice requirements for the month can be estimated at 270 mm (Annex 8, Table 1). Although the river level starts rising in August, it reaches only the lower polders in September, those located at an altitude of less than 3 m over the riverbed. In Niamey in September the floods of the Niger River reach, on the average, an altitude of 2.72 m, and 2.36 m with an eight to ten year frequency. In October the floods, on the average, reach 3.0 m, but it is too late.
- (ii) Very often the water level in the lower polders rises too fast. Between August and September when the lower polders get submerged, the rise of the water level is 3.6 cm/day in an average year, and 4.9 cm/day in the one/ten year flood. Both measures are in excess of the speed usually tolerated, 3 cm/day, for floating rice.
- (iii) The maximum height reached by the river level on the lower terraces usually exceeds the limit for high yielding varieties. For instance, the limit of flooding for the D 52-37 variety, which yields 2.5-3.5 tons of paddy per ha, is 0.5-0.6 m, while flooding in Niamey on the lower terraces varies between 1.64 m on the average in August and 3.76 m on the average in February, and can even reach 4.16 m in February in a one to ten year frequency.
- (iv) Rice-eating fish are a natural pest.

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1/ The rainfall exceeds 30 mm 8 years out of 10.

B. Improved Irrigation System

2. The first irrigation works, starting in 1954, comprised essentially the construction of a dike around the polder equipped with gates and fish screens. These works could slow down the speed of the rising flood, limit flooding somewhat, and protect rice against fish.

3. However, under local conditions these works have the following deficiencies:

- (i) They do not help bridge the gap between rainfalls and the river high water levels;
- (ii) The height of flooding still exceeds the limits for high yielding varieties, and the lack of natural drainage still makes harvesting from boats necessary; and
- (iii) These works do not allow double cropping.

4. Because of the above deficiencies, and also as a political choice, since Niger has limited irrigation potential and intends to use it to its fullest, schemes built according to the above model are being reconditioned.

5. Variations on the above system have been introduced, with the equipment of the schemes with: pumps, simplified irrigation networks and construction of bunds to limit the quantities of water pumped. However, the oversized irrigated lots (due to the insufficient irrigation network and limited number of bunds) and the lack of land levelling, required enormous volumes of pumped water per ha, and did not reduce the height of flooding in the schemes, which still exceeded (0.5-0.8 m) the limit for high yielding varieties. These schemes are also being reconditioned.

6. The only schemes now being considered in Niger are those with full control of the water level and land levelling. Such schemes comprise, in addition to the dike, pumping stations for irrigation and drainage, complete irrigation and drainage systems, and land levelling and bunds along contour lines.

C. Proposed Works for the Namarigoungou "Polder"

7. Main Technical Characteristics. A first feasibility study was prepared in 1972 by Consultants Carlo Lotti for the construction of a scheme of the simpler design. Following Government's policy decision on the subject, a new feasibility study for a scheme with full water control was prepared by SOGREAH in 1974 with FAC financing. The following are the characteristics of the system proposed in this project.

- (i) Area: The Namarigoungou polder (1,550 of total net area) would be divided into two perimeters of equal size. Of

the 1,550 ha, 1,350 ha would be under rice and 150 ha under mixed cropping; 25 ha under fodder crops and 25 ha under eucalyptus.

- (ii) Dike: Because the southern perimeter of the Namarigoungou polder is protected by the island of Darbani, which acts as a natural dike, the length of the dike compared to the area protected is the smallest of all existing polders. The dike would average 7.7 ml/ha compared to 20 ml/ha in Toula, and the volume of earth moved for the dike would be 120 m<sup>3</sup> compared to 363 m<sup>3</sup>/ha in Toula. The dike would be 11.6 km long and 3.0 m high. It would be built for the 1:100 year frequency flood as derived from statistical observations over the period 1962-1974. At the location of the pumping station furthest upstream (SPI) the levels for various frequencies of floods would be as follows:

Flood frequency	1:20	1:50	1:100
Water level before diking	205.38	205.46	205.52
Water level after diking	205.83	205.93	206.05
Freeboard	0.60	0.60	0.60
Crest level of dike	206.43	206.53	206.65

Because of the small cost supplement (about 1%) over the 1:20 year frequency, the 1:100 frequency was selected. The width of the dike has been fixed at 3 m and the dike will be covered with a layer of compacted laterite of 10 cm. Geotechnical tests have shown that the slopes of the dike should be 2.5 horizontal to 1 vertical. The southern part of the dike would be equipped with a flap gate for gravity drainage when the river waters are low.

- (iii) Pumping Stations. There will be two pumping stations; each serving a separate district and equipped with 4 vertical axial electric pumps each. All pumps are identical with a discharge of 600 l/sec and a maximum manometric head of 6 m. The intakes of the pumping stations will also permit withdrawing water by gravity during the Niger floods. During the floods the lowest pumping station SP2 would also be used through gated devices to drain water from the scheme back to the river. A 31 km long, 20 KV high tension line connecting the 2 pumping stations to Tillabery is also included in the project. At peak irrigation periods the pump would operate 16 hours per day.

(iv) A complete irrigation network: including 27 km of primary and 36 km of secondary canals: 1/

- The network for rice irrigation would be designed for 2.8 l/sec/ha, on the assumption that the maximum continuous requirements would be 1.86 l/sec/ha on a continuous basis, and that farmers would irrigate a maximum of 16 hours per day.
- The network for mixed cropping irrigation would be designed for 2 l/sec/ha on the assumption that the maximum continuous requirement would be 1 l/sec/ha and that farmers would irrigate the plots under mixed cropping only during the daytime (12 hours), since mixed cropping cultivation is more delicate than rice cultivation. The plants would be grown on the beds between two furrows.
- Permeability tests carried out by SOGREAH determined that a significant length of primary and secondary canals should be concrete lined because of permeability and construction considerations. Since the exact amount of concrete lining cannot be determined prior to negotiations, project costs include the lining of 100% of primary and secondary canals, but assurances would be sought at negotiations that concrete lining would be done only where technically justified. The criteria to be used to decide whether concrete lining would be justified would be agreed at negotiations.
- Concrete lining would be 9-15 cm thick at the bottom of the canals and 7-12 cm on the sides. Primary and secondary canals would be built for most of their length on land fills (270 m<sup>3</sup> of fills per ha for the south perimeter and 202 m<sup>3</sup> for the north perimeter).

(v) A network of tertiary canals. The tertiary canals would be spaced every 200 m and their length could reach up to 700 m. Their discharge would vary between 20 and 40 l/sec and they would control irrigation blocks of up to 14 ha.

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1/ The corresponding ratios are 18 ml/ha and 24 ml/ha, respectively. These are relatively high.

- (vi) A drainage network designed for 1.2 l/sec/ha: Using as much as possible the natural network of the existing streams, and connected to a channel of the Niger River, which would have been cut off by the construction of the dike. Because there is more natural drainage in the southern perimeter, more drains would be dug in the northern perimeter (85 m<sup>3</sup>/ha versus 43 m<sup>3</sup>/ha). The density of the drains would be identical in the two perimeters (71 ml/ha).
- (vii) A network of tracks along the dike and along all primary and secondary canals, and transversal tracks every 3-4 km: These would be laterite-covered.
- (viii) Land levelling including:
- clearing and de-stumping;
  - plowing at 30 cm (a subsoiling had been recommended by the feasibility study but should not be carried out since it would risk increasing the subsoil permeability);
  - land levelling without filling (motorgrader), and land levelling with filling (bringing in earth with motorscraper or bulldozer) in the areas of the perimeter along the edges; and
  - building contour bunds so that there is not more than 15 cm of difference in the ground level in the same plot.

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Namarigoungou Irrigation Works/Ouvrages d'Irrigation de Namarigoungou

Quantities of Main Works/Quantités des ouvrages principaux

1. <u>On-farm Works</u>		1. <u>Aménagements à la parcelle</u>
Clearing	1,750 ha	Débroussaillage
Deep plowing and surfacing	1,350	Sous-solage (0,35 m) et surfaçage
Levelling between 750 and 2,000 m <sup>3</sup> /ha	700 ha	Nivellement compris entre 750 et 2000 m <sup>3</sup> /ha
Bunding	568,000 m	Diguettes
Tertiary irrigation canals	75,000 m	Canaux d'irrigation tertiaires (arroseurs)
Tertiary drain canals	84,000 m	Drains tertiaires
2. <u>Earthworks on Irrigation and Drainage Systems</u>		2. <u>Terrassements</u>
Excavations		Déblais
- Irrigation canals	58,000 m <sup>3</sup>	- Canaux d'irrigation
- Drainage canals	225,000 m <sup>3</sup>	- Canaux de drainage
Earthfills (of which for dike)	504,000 m <sup>3</sup> (340,000) / <u>1</u>	Remblais (dont pour la digue)
Roads along canals	79,000 m	Pistes de circulation le long des canaux
3. <u>Concrete Works</u>		3. <u>Ouvrages en bétons</u>
Concrete	1,750 m <sup>3</sup>	Bétons
Reinforced concrete	350 m <sup>3</sup>	Béton armé
Steel for reinforcement	65 T	Acier pour armatures
Concrete lining (between 9 and 15 cm)	165,000 m <sup>2</sup>	Revêtement en béton (entre 9 et 15 cm)

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/1 Earthfills for the main canals adjoining the dike are included in that figure.

/1 Les remblais des canaux principaux adjacents à la digue sont inclus dans ce chiffre.

NIGER

IRRIGATION PROJECT

Water Demand

1. Total irrigation requirements for double cropping of rice in the Tillabery region are estimated at about 31,000 m<sup>3</sup>/year (Table 1), requiring a network capacity of:

1.86 l/s/ha on a continuous basis (24 h/24 h);

2.8 l/s/ha when pumping 16 h/24 h.

2. Total irrigation requirements for double cropping of maize and cowpeas in the mixed cropping areas of the Tillabery region are estimated at 14,000 m<sup>3</sup>/year, requiring a network capacity of:

1 l/s/ha on a continuous basis;

2 l/s/ha when pumping 12 h/24 h.

In this case irrigation is difficult at night and would entail much higher losses.

3. These water requirement estimates are comparable to actual experience on the existing schemes.

NIGER  
IRRIGATION PROJECT/PROJET D'IRRIGATION

Water Demand/Demande d'eau

(Measured by Blaney-Bridle Modified Method/Mesurée par la méthode du Blaney-Bridle)

	June 10-30	July 1-5	July 6-31	August	September	October	November	Total
	Jun 10-30	Juil.1-5	Juil.6-31	Août	Septembre	Octobre	Novembre	
-----mm/day/ha-mm/jour/ha-----								
1. Submersion (150 mm)		6	6					
2. Seepage		2.2	2.2	2.2	2.2	2.2	2.2	
3. ETO <sup>/1</sup>	7.1	5.2	5.2	3.5	6.1	5.8	7.3	
4. Ke (Rice)	1.1	1.1	1.1	1.1	1.1	1.0	0.95	
5. ET (Rice)		7.8	5.7	5.7	3.9	6.7	5.8	6.9
Total		16.0	15.9	7.9	6.1	8.9	8.0	9.1
6. Less useful rainfall <sup>/2</sup>		(1.1)	(2.1)	(2.1)	(3.1)	(1.0)		
Water requirements in the field		14.9	11.8	5.8	3.0	7.9	8.0	9.1
Water requirements at the pumping station <sup>/3</sup>		15.0 <sup>/4</sup>	11.8 <sup>/4</sup>	7.7	4.0	10.5	10.7	12.1
Water requirements l/s/ha (24h/24h)		1.74	1.37	0.89	0.46	1.22	1.24	1.40
Water requirements l/s/ha (16h/24h)		2.61	2.06	1.34	0.69	1.83	1.86	2.10

	Dec 11-31	Jan 1-15	Jan 6-31	February	March	April	May
	Déc 11-31	Jan 1-15	Jan 6-31	Février	Mars	Avril	Mai
1. Submersion (150 mm)		6	6				
2. Seepage		2.2	2.2	2.2	2.2	2.2	2.2
3. ETO <sup>/1</sup>	6.3	6.6	6.6	7.3	7.0	6.5	6.6
4. Ke (Rice)	1.1	1.1	1.25	1.25	1.25	1.1	1.0
5. ET (Rice)		6.9	7.3	8.3	9.1	8.8	7.2
Total		15.1	15.5	10.5	11.3	11.0	9.4
6. Less useful rainfall <sup>/2</sup>		-	-	-	-	-	-
Water requirements in the field		15.1	15.5	10.5	11.3	11.0	9.4
Water requirements at the pumping station <sup>/3</sup>		15.7 <sup>/4</sup>	16.1 <sup>/4</sup>	14.0	15.1	14.6	12.5
Water requirements l/s/ha (24h/24h)		1.82	1.86	1.62	1.75	1.70	1.45
Water requirements l/s/ha (16h/24h)		2.73	2.79	2.43	2.63	2.54	2.18

<u>A. Besoins en eau pour le riz</u> <u>durant la saison des pluies</u>	
1. Submersion (150 mm)	
2. Pertes par infiltration	
3. ETO <sup>/1</sup>	
4. Ke (Riz)	
5. ET (Riz)	
Total	
6. Pluie efficace <sup>/2</sup>	
Besoins en eau à la parcelle	
Besoins en eau à la station de pompage <sup>/3</sup>	
Besoins en eau l/s/ha (24h/24h)	
Besoins en eau l/s/ha (16h/24h)	

<u>B. Besoins en eau pour le riz</u> <u>durant la saison sèche</u>	
1. Submersion (150 mm)	
2. Pertes par infiltration	
3. ETO <sup>/1</sup>	
4. Ke (Riz)	
5. ET (Riz)	
Total	
6. Pluie efficace <sup>/2</sup>	
Besoins en eau à la parcelle	
Besoins en eau à la station de pompage <sup>/3</sup>	
Besoins en eau l/s/ha (24h/24h)	
Besoins en eau l/s/ha (16h/24h)	

<sup>/1</sup> ETO. Evaporation of a green grass area, 8-15 cm high.

<sup>/2</sup> 100% of rainfall of 0.2 frequency.

<sup>/3</sup> With a 75% efficiency.

<sup>/4</sup> Using the Van de Goor-Zyljstra formula to compensate the losses through evaporation in the parts of the perimeter already underwater.

<sup>/1</sup> Evaporation d'une surface de matière verte haute de 8-15 cm.

<sup>/2</sup> 100 % de la pluie dans une fréquence de 0,2.

<sup>/3</sup> Avec efficacité de 75 %.

<sup>/4</sup> En utilisant la formule de Van de Goor-Zyljstra pour compenser les pertes d'évaporation dans le périmètre déjà submergé.



NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Project Costs and Financing/Coût du projet et financement

	1978	1979	1980	1981	1982	Total 1978-1982		IDA Financing	KFW Financing
	-----CPAF '000-----					CPAF '000	US\$ '000	US\$ '000	US\$ '000
<b>Irrigation Works Construction</b>	196,300	294,400	163,000	70,000		490,700	2,000	1,400	600
Equipment and vehicles		232,400				465,400	1,900	1,330	570
Operating expenses		223,500	163,000	145,500		611,000	2,490	1,750	740
Labor and staff	2,000					240,700	980	680	300
Supplies	57,800	145,600	37,300			164,000	670	470	200
Pumping stations		104,800	39,200			124,000	510	360	150
20 kv line from Tillabery		100,000	24,000						
Sub-total Irrigation Works	256,100	1,100,700	523,500	215,500		2,095,800	8,550	5,990	2,560
<b>Direction "Office des Aménagements Hydroagricoles"</b>									
Local staff salaries	6,000	6,000	6,000	6,000	6,000	30,000	120	90	30
Expatriate staff salaries	14,000	34,000	34,000	34,000	34,000	150,000	610	430	180
Constructions	8,000	9,100				17,100	70	50	20
Vehicles	2,000	2,000				4,000	20	10	10
Sub-total Direction	30,000	51,100	40,000	40,000	40,000	201,100	820	580	240
<b>Administrative and Financial Services</b>									
Local staff salaries	3,200	14,800	15,400	16,000	14,800	64,200	260	180	80
Expatriate staff salaries	17,500	41,800	41,800	41,800	41,800	184,700	750	530	220
Construction of buildings	39,000	7,300				46,300	190	130	60
Equipment	11,400	2,800				14,200	60	40	20
Vehicles	5,400	7,600				13,000	50	40	10
Administrative and indirect expenses	9,200	26,700	28,200	28,500	28,500	121,100	500	350	150
Sub-total Administrative and Financial Services	85,700	101,000	85,400	86,300	85,100	443,500	1,810	1,270	540
<b>Agricultural Development Services</b>									
Local staff salaries	19,700	32,100	37,700	43,300	43,300	176,100	720	510	210
Construction of buildings		29,200	21,200			50,400	200	140	60
Equipment	60,400	17,000	31,800			109,200	440	310	130
Vehicles		3,400	800	17,200		21,400	90	60	30
Sub-total Agricultural Dev. Serv.	80,100	81,700	91,500	60,500	43,300	337,100	1,450	1,020	430
<b>Support Unit</b>									
Expatriate staff salaries	20,000	50,400	50,400	50,400	50,400	221,600	900	630	270
Construction of buildings		32,900				32,900	140	100	40
Vehicles		3,800				3,800	20	10	10
Sub-total Support Unit	20,000	87,100	50,400	50,400	50,400	258,300	1,060	740	320
<b>Health Component and Training</b>									
Wells at 2 villages			3,200			3,200	20	10	10
Village health kits			2,700			2,700	10	10	10
Training of First Aid volunteers			7,600	10,900	6,800	25,300	100	70	30
Sub-total Health Component and Training			13,500	10,900	6,800	31,200	130	90	40
<b>Agricultural Equipment and Incremental Inputs</b>									
Rice development		65,800	41,300	22,000		129,100	530	370	160
Rainfed development		9,200	8,600			17,800	70	50	20
Livestock subproject		15,300	8,900			24,200	100	70	30
Sub-total Ag. Equipment and Incremental Inputs		90,300	58,800	22,000		171,100	700	490	210
<b>Other</b>									
Agricultural Projects Coordinator		24,500	24,500	24,500		73,500	300	300	-
Audit of project accounts		1,600	1,600	1,600		4,800	20	10	10
Specialized consulting services	6,400	3,700	1,800			11,900	50	40	10
Gabou-Bonfeba feasibility study			129,000			129,000	530	370	160
Sub-total Other	6,400	29,800	156,900	26,100	1,600	220,800	900	720	180
Base Cost Estimate	478,300	1,541,700	1,080,000	811,700	227,200	3,778,900	15,420	10,900	4,520
Physical Contingencies 1/	63,900	210,300	128,800	55,800	22,700	482,400	1,970	1,390	580
Price Increases 2/	44,900	283,000	279,200	155,500	121,100	885,700	3,610	2,710	900
Total Expected Cost of Project	587,000	2,035,000	1,488,000	724,000	371,000	5,145,000	21,000	15,000 3/	6,000 3/

<b>Ouvrages d'irrigation</b>	Equipment et véhicules	Coûts d'opération	Salaires	Fournitures	Stations de pompage	Ligne de 20 KV de Tillabery
Sub-total ouvrages d'irrigation	2,560					
<b>Direction "Office des Aménagements Hydroagricoles"</b>	Salaires du personnel local	Salaires du personnel expatrié	Constructions	Véhicules	Sub-total Direction	
Sub-total Direction	240					
<b>Services administratifs et financiers</b>	Salaires du personnel local	Salaires du personnel expatrié	Constructions	Équipement	Véhicules	Dépenses administratives et indirectes
Sub-total services adm. et financiers	540					
<b>Services du développement agricole</b>	Salaires du personnel local	Constructions	Équipement	Véhicules	Sub-total services du développement agricole	
Sub-total services du développement agricole	430					
<b>Unité d'appui</b>	Salaires du personnel expatrié	Constructions	Véhicules	Sub-total unité d'appui		
Sub-total unité d'appui	320					
<b>Composante santé et formation</b>	Puits dans deux villages	Pharmacie de village	Formation des secouristes de village	Sub-total		
Sub-total	40					
<b>Équipement agricole et intrants supplémentaires</b>	Développement rizicole	Développement en cultures sèches	Sub-projet élevage			
Sub-total équipement agricole et intrants supplémentaires	210					
<b>Divers</b>	Coordinateur des projets agricoles	Audit des comptes du projet	Services de consultants	Étude de faisabilité de Gabou-Bonfeba	Sub-total divers	
Sub-total divers	180					
Coûts de base estimatifs	Imprévus physiques 1/	Augmentation de prix 2/	Coûts totaux prévus			
6,000 3/						

1/ 15% on irrigation works and 10% on the rest./ 15% sur les ouvrages d'irrigation et 10% sur le reste.  
 2/ 1978 = 8%; 1979 = 7.5%, and 1980-82 = 7%./ 1978 = 8%; 1979 = 7.5%; et 1980-82 = 7%.  
 3/ 70% IDA - 30% KFW.  
 US\$1 = CFAF 245.  
 DM1 = US\$0.50.

NIGER

Namarigoungou Irrigation Project/Projet d'irrigation de Namarigoungou  
Construction of Irrigation Works/Construction des ouvrages d'irrigation

	CFAF '000/FCFA '000				
	1978	1979	1980	1981	Total
<b>A. Procurement of Equipment and Vehicles /1</b>					
1. For earthmoving	140,700	211,000	-	-	351,700
2. For concrete works	21,600	32,500	-	-	54,100
3. For supervision and maintenance	34,000	50,900	-	-	84,900
Total Equipment and Vehicles	196,300	294,400	-	-	490,700
<b>B. Operating Expenses</b>					
1. Fuel and Oil /2					
- For earthmoving		71,000	49,600	21,000	141,600
- For concrete works		13,000	9,500	4,500	27,000
- For supervision and maintenance		38,000	26,700	11,600	76,300
Subtotal		122,000	85,800	37,100	244,900
2. Spares and Consumables					
- For earthmoving		78,000	54,500	23,100	155,600
- For concrete works		4,400	3,100	1,300	8,800
- For supervision and maintenance		28,000	19,600	8,500	56,100
Subtotal		110,400	77,200	32,900	220,500
Total B - Operating Expenses		232,400	163,000	70,000	465,400
<b>C. Labor and Staff</b>					
1. Expatriate staff /3		125,500	135,000	95,500	356,000
2. Local civil servants	2,000	8,000	10,000	5,000	25,000
3. Local technical staff	-	30,000	35,000	15,000	80,000
4. Temporary Casual Labor	-	60,000	60,000	30,000	150,000
Total Labor and Staff	2,000	223,500	240,000	145,500	611,000
<b>D. Supplies</b>					
1. Cement /4	21,900	51,200	-	-	73,100
2. Steel /5	3,500	8,300	-	-	11,800
3. Wood for forms and miscellaneous /6	20,100	33,600	13,400	-	67,100
4. Hydro-mechanical equipment /7	12,300	28,700	-	-	41,000
5. Supplies from small local contractors /6	-	23,800	23,900	-	47,700
Total Supplies	57,800	145,600	37,300	-	240,700
<b>E. Pumping Stations /8</b>					
Civil works (including taxes)	-	79,800	34,200	-	114,000
Equipment /9 (free of taxes)	-	25,000	25,000	-	50,000
Total Pumping Stations	-	104,800	59,200	-	164,000
<b>F. 20 KV H.T. Line from Tillabery to Namarigoungou /8, /10 (including taxes)</b>	-	100,000	24,000	-	124,000
<b>Total Cost of Works</b>	<b>256,100</b>	<b>1,100,700</b>	<b>523,500</b>	<b>215,500</b>	<b>2,095,800</b>
(Salvage value of equipment)				(135,000)	
To Add:					
Physical Contingencies at 10%					
Price contingencies					

/1 See details in Appendix 1 to Table 2.  
 /2 Gas-oil free of tax price per liter CFPAF 57.8  
 Oil free of tax price per liter CFPAF 322  
 Benzine including taxes CFPAF 97  
 /3 See details in Annex 11, Table 3.  
 /4 Cement: 3,050 tons at CFPAF 23,950/ton (free of taxes).  
 /5 Steel: 94,000 kg at between CFPAF 123 per kg (free of taxes) and 156.6  
 /6 Including taxes.  
 /7 Hydro-mechanical equipment: gates for irrigation works and for pumping stations (free of taxes).  
 /8 To be constructed by contractors after International Competitive Bidding.  
 /9 Plus around CFPAF 13.2 million for gates already accounted for in item D4 above.  
 /10 31 km (including connection of the 2 pumping stations) at CFPAF 4 millions per km.  
 at February 1978.

/1 Voir détails dans l'Appendice 1 de la Table 2.  
 /2 Gas oil hors taxe (HT) Huiles (HT) Essence taxes comprises (TTC)  
 /3 Voir détails dans Annexe 11, Table 3.  
 /4 Ciment: 23,950 FCFA la tonne (HT) (35,000 FCFA TTC)  
 /5 Acier: 94,000 kg à un prix au kg variant entre 123 FCFA et 156.6 (HT) TTC.  
 /6 Matériel hydro-mécanique: vannes et vannettes pour ouvrages d'irrigation et stations de pompage (HT)  
 /8 A construire par des Entrepreneurs après Appel d'offres international.  
 /9 Plus environ 13,2 millions FCFA pour vannes, déjà décomptés au D4 ci-dessus.  
 /10 31 km (y compris raccordement des 2 stations de pompage) à 4 millions de FCFA par km.  
 Au février 1978.

<b>A. Achat de matériels et véhicules /1</b>
1. Pour terrassements
2. Pour ouvrages en béton
3. Pour la surveillance et l'entretien
Total matériels et véhicules
<b>B. Coûts d'exploitation</b>
1. Carburants et lubrifiants /2
- Terrassements
- Ouvrages en béton
- Surveillance et entretien
Total partiel
2. Pièces détachées et consommables
- Terrassements
- Ouvrages en béton
- Surveillance et entretien
Total partiel
Total coûts d'exploitation
<b>C. Cadres et main-d'oeuvre</b>
1. Expatriés /3
2. Fonctionnaires locaux
3. Personnel technique local
4. Main-d'oeuvre temporaire
Coût total main-d'oeuvre
<b>D. Fournitures</b>
1. Ciment /4
2. Acier /5
3. Bois de coffrage et divers /6
4. Matériel hydro-mécanique /7
5. Fournitures par tâcherons /6
Total fournitures
<b>E. Stations de pompage /8</b>
Génie civil (TTC)
Matériel (HT) /9
Total stations de pompage
<b>F. Ligne 20 KV, Tillabery-Namarigoungou /8, /10 (TTC)</b>
Coût total des travaux
(Valeur résiduelle du matériel)
<b>À ajouter:</b>
Imprévus et divers 10%
Révisions des prix

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Project Costs/Coût du projet

1/

List and Cost of Construction Equipment/Liste et coût du matériel de construction

<u>ITEM</u>	<u>Number</u> <u>Nombre</u>	<u>Unit Price</u> <u>Prix unit</u> ------(CFAF '000/FCFA '000)----- (H.T.)	<u>Cost</u> <u>Coût</u>	<u>Nature du matériel</u>
1. <u>For Earthmoving</u>				1. <u>Pour terrassement</u>
Crawler tractor of 200 hp	1	25.2	25.2	Tracteur à chenilles de 200 cv
Crawler tractor of 165 hp	1	16.5	16.5	Tracteur à chenilles de 165 cv
Agricultural tractor of 80 hp	1	2.7	2.7	Tracteur agricole de 80 cv
Scrapers 150 hp (self-propelled)	4	22.3	89.2	Décapeuse de 150 cv (automotrice)
Motorgraders 180 hp	3	24.5	73.5	Niveleuse de 180 cv
Hydraulic excavator 120 hp	1	22.5	22.5	Pelle hydraulique de 120 cv
Combined hydraulic excavator and loader	1	8.0	8.0	Combine pelle hydr. et chargeuse
Compactor type 815	1	23.0	23.0	Compacteur type 815
Roller with Grid	1	7.0	7.0	Rouleau tracté à grille
Clearer disks 32" offset	1	2.9	2.9	Défricheur disques 32" "offset"
Disk plough, 28" disks offset	1	3.0	3.0	Pulvérisateur lourd disques 28" "offset"
Dump truck, 5m3	4	5.1	20.4	Camion-benne 5m3
Watertank truck, 7,000 l	2	4.8	9.6	Camion citerne eau, 7,000 l
Fuel tank truck, 7,000 l	1	5.2	5.2	Camion citerne carburant, 7,000 l
Trailer (for transporting equipment)	1	18.4	18.4	Camion porte engin
Watertank, 3,000 l	1	0.6	0.6	Citerne à eau (tractée), 3,000 l
Compressors	1	3.0	3.0	Compresseur
Pumps	2	1.5	3.0	Pompes d'épuisement
Vibrating Roller	1	3.0	3.0	Rouleau vibrant
Small Equipment		<u>15</u>	<u>15</u>	Petit matériel
Sub-total No. 1			351.7	Sous-total No. 1
2. <u>For Concrete Works</u>				2. <u>Pour ouvrages en béton</u>
Loader (on tires), 300 l	1	12	12	Chargeur sur pneus, 300 l
Dump truck, 5m3	2	5.1	10.2	Camion benne 5m3
Flat truck 5 to 6 tons	1	4.3	4.3	Camion plateau 5 à 6 tonnes
Moto-concrete dumpers	3	1.8	5.4	Moto-basculeurs pour béton
Concrete batchers, 320 l	3	1.5	4.5	Bétonnières, 320 l
Vibrating beam	8	0.21	1.7	Règle vibrante
Trailers	1	2.5	2.5	Remorques plateaux
Small equipment			8.0	Petit matériel
Laboratory equipment			<u>5.5</u>	Équipement pour laboratoire
Sub-total No. 2			54.1	Sous-total No. 2
3. <u>Transport Equipment and Workshop</u>				3. <u>Véhicules, garage et atelier</u>
Truck for transport (15 tons)	1	11.6	11.6	Camion de service (15t)
Workshop truck	1	17.9	17.9	Camion atelier
4-wheel drive	4	2.2	8.8	Véhicule tout terrain 4x4
Pick-up	6	1.3	7.8	Pick-up et fourgonnettes
Breaks	2	2.2	4.4	Break
Watertank (trailer)	1	0.6	0.6	Citerne à eau tractée
Fuel tank (trailer)	1	0.6	0.6	Citerne à carburant tractée
Generator 150 kva	2	6	12	Groupe électrogène 150 kva
Hydraulic press	1	1.2	1.2	Presse hydraulique
Workshop equipment			<u>20</u>	Équipement atelier
Sub-total No. 3			84.9	Sous-total No. 3
TOTAL			<u>490.7</u> 2/	Total général

1/ All costs are without taxes and are based on economic conditions at end 1977. They were derived from those obtained for the tender for similar equipment for the Cameroon-Semry II project./Tous les coûts sont hors taxes et sont basés sur les conditions économiques en vigueur fin 1977. Ils ont été déduits de ceux obtenus dans l'Appel d'offres pour du matériel similaire pour le projet Cameroun-Semry II.

2/ At the end of the construction of project works, the residual value of the equipment will be about CFAF 135 million./Quand la construction des ouvrages du projet sera terminée, la valeur résiduelle du matériel sera d'environ 135 millions de FCFA.

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Project Costs/Coût du projet

Staff Costs/Salaires

(CFAF '000/FCFA '000)

Unit Cost February - 1978/Coûts unitaires février 1978	1979		1980		1981		1982		Total 1978-1982
	No.		No.		No.		No.		
<u>Direction "Office des Aménagements Hydroagricoles"</u>									
Director	1	6,000	1	6,000	1	6,000	1	6,000	24,000
Technical Assistant (expatriate)	1	34,000	1	34,000	1	34,000	1	34,000	136,000
Sub total		40,000		40,000		40,000		40,000	160,000
<u>Namarigoungou Works Construction</u>									
Engineer TP/Hydro (expatriate)	1	32,000	1	32,000	1	32,000			96,000
Topo Engineer (expatriate)	1	24,000	1	24,000	1	24,000			72,000
Topo Technicians (expatriate)	1	22,000	1	22,000	1/2	11,000			55,000
Works (expatriate)									
- General Foreman (earthmoving)	1	19,000	1	19,000	1/2	9,500			47,500
- General Foreman (concrete)	1	19,000	1	19,000	1/2	9,500			47,500
- General Foreman (on-farm)	1/2	9,500	1	19,000	1/2	9,500			38,000
Sub-total		125,500		135,000		95,500			356,000
Local Civil Servants		8,000		10,000		5,000			23,000
Local Technical Staff		30,000		35,000		15,000			80,000
Temporary Casual Labor		60,000		60,000		30,000			150,000
Sub-total Namarigoungou Works		223,500		240,000		145,500			609,000
<u>Administrative and Financial Services</u>									
Chief Accountant (expatriate)	1	22,800	1	22,800	1	22,800	1	22,800	91,200
Accountants	3	9,000	3	9,000	3	9,000	3	9,000	36,000
Chief Mechanic (expatriate)	1	19,000	1	19,000	1	19,000	1	19,000	76,000
Mechanics	2	4,000	2	4,000	2	4,000	2	4,000	16,000
Supporting Staff	3	1,800	4	2,400	5	3,000	3	1,800	9,000
Sub-total Administrative and Financial		56,600		57,200		57,800		56,600	229,200
<u>Agricultural Development Services</u>									
Chief Agricultural Development Services	1	3,500	1	3,500	1	3,500	1	3,500	14,000
Training Specialist	1	3,000	1	3,000	1	3,000	1	3,000	12,000
Heads of Irrigation Units	4	12,000	4	12,000	4	12,000	4	12,000	48,000
Extension Works - Irrigation	13	10,400	19	15,200	25	20,000	25	20,000	65,600
- Rainfed	4	3,200	5	4,000	6	4,800	6	4,800	16,800
Sub-total Agricultural Development		32,100		37,700		43,300		43,300	156,400
<u>Support Unit</u>									
Agriculturist - Irrigation (expatriate)	1	26,400	1	26,400	1	26,400	1	26,400	105,600
Agro-economist (expatriate)	1	24,000	1	24,000	1	24,000	1	24,000	96,000
Sub-total Technical Assistance Unit		50,400		50,400		50,400		50,400	201,600
<b>Total Staff Salaries</b>		<b>402,600</b>		<b>425,300</b>		<b>337,000</b>		<b>190,300</b>	<b>1,355,200</b>

Direction "Office des Aménagements Hydroagricoles"

Directeur  
Assistant technique (expatrié)  
Total partiel

Construction des ouvrages de Namarigoungou

Ingénieur TP/Hydro (expatrié)  
Ingénieur topo (expatrié)  
Ingénieur géomètre (expatrié)  
Travaux (expatrié)  
Conducteur terrassements (expatrié)  
Conducteur ouvrages et bétons (expatrié)  
Conducteur aménagements à la parcelle (expatrié)

Total partiel  
Fonctionnaires locaux  
Personnel technique local  
Main-d'oeuvre temporaire  
Total partiel

Services administratifs et financiers

Chef comptable (expatrié)  
Comptables  
Chef mécanicien (expatrié)  
Mécaniciens  
Personnel subalterne  
Total partiel services administratifs et financiers

Services du développement agricole

Chef des services du développement agricole  
Spécialiste de formation  
Chefs de périmètre  
Agents de vulgarisation - irrigation  
- cultures sèches  
Total partiel développement agricole

Unité d'appui

Agronome d'irrigation (expatrié)  
Agro-économiste (expatrié)  
Total partiel unité d'appui

Salaires Totaux

Salaires totaux à l'exception des travaux de Namarigoungou

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Project Costs/Coût du Projet

Construction /Constructions

	Unit Cost/Cout unitaire Mid 1977/ mi-1977 <sup>1/</sup> (CFAF'000)/(FCFA'000)	No. 1978	No. 1979	No. 1980	1981	1982	Total 1978-1982	
----- CFAP'000/FCFA'000-----								
<u>Direction</u>								<u>Direction</u>
Director "Office" p.m. (Niamey)								Bureau de Directeur (Niamey)
Project Unit Manager House	7,500		1	7,500			7,500	Maison du Dir. du Bureau du Projet
Utilities at 15%				1,100			1,100	Utilités publiques à 15%
<b>Total Direction</b>				<b>8,600</b>			<b>8,600</b>	<b>Total direction</b>
<u>Namarigoungou Works Construction</u>								<u>Construction des ouvrages de Namarigoungou</u>
Engineer TP/Hydro - House	7,500	1	7,500				7,500	Maison d'ingénieur TP/Hydro
<u>Administrative and Financial Services</u>								<u>Services adm. et financiers</u>
Chief Accountant House	7,500	1	7,500				7,500	Maison de chef - comptable
Chief Mechanic House	7,500	1	7,500				7,500	Maison de chef mécanicien
Offices - Accounting Staff	100 m <sup>2</sup> @ CFAP 60,000/m <sup>2</sup>	1	6,000				6,000	Bureaux - personnel comptable
- Other Staff	100 m <sup>2</sup> @ CFAP 60,000/m <sup>2</sup>		1	6,000			6,000	- autre personnel
Garage	250 m <sup>2</sup> @ CFAP 40,000/m <sup>2</sup>	1	10,000				10,000	Garage
Utilities at 15%				900			6,700	Utilités publiques à 15%
<b>Total Administrative and Financial Serv.</b>		<b>36,800</b>	<b>6,900</b>				<b>43,700</b>	<b>Total services adm. et financiers</b>
<u>Agricultural Development Services</u>								<u>Service de développement agricole</u>
Chief Agricultural Development Services House	7,500		1	7,500			7,500	Maison du chef
Service Centre Stores	2 of 500m <sup>2</sup> @CFAP 40,000/m <sup>2</sup>		1	20,000	1	20,000	40,000	Magasins
<u>Technical Assistance Unit</u>								<u>Unité d'assistance technique</u>
Agronomist (Irrigation) House	7,500		1	7,500			7,500	Maison d'agronome (irrigation)
Socioeconomist House	7,500		1	7,500			7,500	Maison de socio-économiste
Agronomist (Rain-Fed) House	7,500		1	7,500			7,500	Maison d'agronome (cult. sèche)
Utilities at 15%				4,500			4,500	Utilités publiques à 15%
Training Center Rehabilitation	100 m <sup>2</sup> @CFAP 40,000/m <sup>2</sup>		1	4,000			4,000	Réaménagement du centre de formation
<b>Total Technical Assistance Unit</b>				<b>31,000</b>			<b>31,000</b>	<b>Total unité d'assistance technique</b>
<b>Total Constructions</b>		<b>44,300</b>	<b>74,000</b>	<b>20,000</b>			<b>138,300</b>	<b>Total constructions</b>

<sup>1/</sup> For base cost February 1978, 6% was added./ Pour le cout de base de février 1978 on a ajouté 6%.

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Project Costs/Coût du Projet  
Equipment / Matériel

		<u>Unit Cost</u>										
		<u>Mid 1977</u>										<u>Total</u>
		<u>(CFAF'000)</u>	<u>No.</u>	<u>1978</u>	<u>No.</u>	<u>1979</u>	<u>No.</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>		<u>1978-1982</u>
<u>Namarigoungou Works Construction</u>												
Included in Construction Costs												<u>Construction des ouvrages de Namarigoungou</u> Compris dans les coûts de construction
<u>Administrative and Financial Services</u>												<u>Services administratifs et financiers</u>
Office Furniture		1,300	1	1,300	1	1,300						2,600
Office Machines		1,300	1	1,300	1	1,300						2,600
Safe		200	1	200								200
Garage		8,000	1	8,000								8,000
Subtotal Administrative and Financial Serv.				10,800		2,600						13,400
<u>Agricultural Development Services</u>												
Livestock Sub-project included in Table												
<u>Rice Research</u>		57,000	1	57,000								57,000
<u>Rice Seed Multiplication</u>		16,000			1	16,000						16,000
Tillabery Rice Mill (Rehabilitation)		30,000					1	30,000				30,000
Subtotal Agricultural Development Serv.				57,000		16,000		30,000				103,000
<u>Health Sub-Project</u>												
Wells for the two new Villages @CFAF 50,000/meter x 30 m.							2	3,000				3,000
Total Equipment				67,800		18,600		33,000				119,400

1/ For base cost February 1978, 6% was added./ Pour le coût de base de février 1978 on a ajouté 6%.

NIGER  
IRRIGATION PROJECT/PROJET D'IRRIGATION

Project Costs/Coût du Projet

Vehicles / Véhicules

	Unit Cost Mid 1977 <sup>1/</sup> (CFAF'000)	No.	1978	No.	1979	No.	1980	No.	1981	No.	1982	Total 1978-1982	
<u>Direction</u>													
Director "Office" - Light Vehicle	1,900	1	1,900									1,900	Directeur de l'Office - véhicule lég.
Project Unit Manager - Light Vehicle	1,900			1	1,900							1,900	Direct. du projet - véhicule léger
<u>Namarigoungou Works Construction</u> (Included in Cost of Works)													
<u>Administrative and Financial Services</u>													
Chief Accountant - Light Vehicle	1,900	1	1,900									1,900	Chef Comptable - véhicule léger
Chief Mechanic - Four Wheel Drive	3,200	1	3,200									3,200	Chef mécanicien - véhicule à 4 roues
Garage - Four Wheel Drive	3,200			1	3,200							3,200	Garage - véhicule à 4 roues
- 5 ton Truck	4,000			1	4,000							4,000	- camion de 5 tonnes
Total Administrative and Financial Services			5,100		7,200							12,300	Total des Services adm. et financiers
<u>Agricultural Development Services</u>													
Chief - Four Wheel Drive	3,200			1	3,200							3,200	Chef - véhicule à 4 roues
Extension Agents motorcycles	200					4	800	1	200			1,000	Agents de vulgarisation- motocyclettes
Marketing 12 ton Truck	8,000							2	16,000			16,000	Commercialisation - Camion de 12 tonnes
Total Agricultural Development Services					3,200		800		16,200			20,200	Total du service de dev. agricole
<u>Technical Assistance Unit</u>													
Agronomist (irrigation) - Pick-up	1,200			1	1,200							1,200	Agronome(irrigation) - Pick-up
Socioeconomist - Pick-up	1,200			1	1,200							1,200	Socioeconomiste - Pick-up
Agronomist (dry land) - Pick-up	1,200			1	1,200							1,200	Agronome (cult. sèche) -Pick-up
Total Technical Assistance Unit					3,600							3,600	Total de l'Assistance technique
Total Vehicles			7,000		15,900		800		16,200			39,900	Véhicules Totaux

<sup>1/</sup> For base cost February 1978, 6% was added./ Pour le coût de base de février 1978 on a ajouté 6%.

NIGER  
IRRIGATION PROJECT  
Project Cost

Administrative and Indirect Expenses/Depenses administratives et indirectes

	Unit Cost Mid 1977 <sup>1/</sup> (CFAF'000)	<u>1978</u>		<u>1979</u>		<u>1980</u>		<u>1981</u>		<u>1982</u>		<u>Total</u> <u>1978-1982</u>	
		No.	No.	No.	No.	No.	No.	No.	No.				
<u>Vehicles Running Cost</u>													<u>Coûts de fonctionnement des Véhicules</u>
Light Vehicles	1,100	2	2,200	4	4,400	4	4,400	4	4,400	4	4,400	19,800	Véhicules légers
Four Wheel Drive	1,900	1	1,900	2	3,800	2	3,800	2	3,800	2	3,800	17,100	Véhicules a 4 roues
Motorcycles	60		-		-	4	200	5	300	5	300	800	Motocyclettes
Subtotal Vehicles Running Cost			4,100		8,200		8,400		8,500		8,500	37,700	Total Partiel des Véhicules
<u>Vehicles Spares</u>													<u>Pièces détachées</u>
30% of Preceeding			1,200		2,500		2,500		2,600		2,600	11,400	30% du précédent
<u>Utilities</u>													<u>Utilités publics</u>
CFAF 300,000 per House	300	5	1,500	13	3,900	14	4,200	14	4,200	14	4,200	18,000	à FCFA 300.000 par maison
<u>Building Maintenance</u>													<u>Entretien des Bâtiments</u>
3.5% of Cost			1,600		4,100		4,800		4,800		4,800	20,100	3,5% du coût
<u>Office Supplies</u>													<u>Fournitures de bureau</u>
CFAF 15,000 per Employee	15	18	300	30	500	45	700	50	800	55	800	3,100	à FCFA 15.000 par employé
<u>Rice Multiplication Operating Expenses</u>													<u>Depenses de Fonctionnement pour le</u>
					<u>6,000</u>		<u>6,000</u>		<u>6,000</u>		<u>6,000</u>	<u>24,000</u>	<u>multiplication des semences riz</u>
<u>Total Administrative and Indirect Expenses</u>													<u>Depenses Administratives et indirectes</u>
			<u>8,700</u>		<u>25,200</u>		<u>26,600</u>		<u>26,900</u>		<u>26,900</u>	<u>114,300</u>	<u>Totales</u>

<sup>1/</sup> For base cost February 1978, 6% was added./ Pour le coût de base de février 1978 on a ajouté 6%.



NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Project Cost/Coût du Projet

Agricultural Equipment and Incremental Inputs/Équipement agricole et intrants supplémentaires

Unit Cost/Coût unitaire										Total		
Mid-1977/mi-1977 2/		No.	1978	No.	1979	No.	1980	No.	1981	No.	1982	1978-1982
(CFAF)	/(FCFA)	-----CFAF'000/FCFA'000-----										
<b>Rice Cultivation</b>												
Basic Units 1/	- Number		80		125		125		125		125	
	- Value	CFAF 34,878/Unit		2,800		4,400		4,400		4,400		16,000
Oxen	- Number		80		125		125		125		125	
	- Value	CFAF 120,000/Pair		9,600		15,000		15,000		15,000		54,600
Carts	- Number		20		20		20		20		20	
	- Value	CFAF 71,000/Unit		1,400		1,400		1,400		1,400		5,600
Urea Incremental Tonnage	- Value	CFAF 70/Kg	635	44,500	1,800	16,800	120	8,400		-		69,700
Insecticides Incremental Liters	- Value	CFAF 800/Liter	4,760	3,800	1,400	940	800					6,000
Subtotal Rice Cultivation				62,100		39,000		30,000		20,800		151,900
<b>Rain-Fed Development</b>												
Attachment for toolbar	- Number				170		170					
	- Value	CFAF 9,916/Unit				1,700		1,700				3,400
Super phosphate incremental Tonnage	- Value	CFAF 90/Kg			40		38		3,400			7,000
Urea Incremental tonnage	- Value	CFAF 70/Kg			36		34		2,400			4,900
Insecticides Incremental Liters	- Value	CFAF 800/Liter			1,080		720		600			1,500
Subtotal Rain-Fed Development						8,700		8,100				16,800
<b>Livestock Sub-Project</b>												
Tractor		CFAF 6,000,000			1		6,000					6,000
Fertilizer							900		900			1,800
Oxen	- Number				250		250					
	- Value	CFAF 30,000				7,500		7,500				15,000
Subtotal Livestock Sub-Project						14,400		8,400				22,800
<b>Health Sub-Project</b>												
Village Health Kits		@ CFAF 30,000 per Farmer Group			82		2,500					2,500

<b>Riziculture</b>	
Unité de base 1/	- Nombre
	- Valeur
Boeufs	- Nombre
	- Valeur
Charrettes	- Nombre
	- Valeur
Tonnage suppl. d'uree	- Valeur
Litres suppl. d'insecticides	- Valeur
Total partiel Riziculture	
<b>Développement de la culture en sèche</b>	
Attachement au multiculteur	- Valeur
Tonnage supplémentaire de super-phosphate	- Valeur
Tonnage suppl. d'urée	- Valeur
Litres suppl. d'insecticides	- Valeur
Total partiel	
<b>Sous-projet élevage</b>	
Tracteur	
Engrais	
Boeufs	- Nombre
	- Valeur
Total Partiel de l'élevage	
<b>Sous-projet santé</b>	
Pharmacie de village	

1/ Arara toolbar, plow and hoe.

2/ For February 1978 base cost of 6% was added./ Pour un coût de base de février 1978 on a ajouté 6%.

1/ Multiculteur, charrue, houe.

NIGER

IRRIGATION PROJECT, PROJET D'IRRIGATION

Project Cost/Coût du projet

Training Programs - Audit - Visiting Consultants Programmes de formation - Audit des comptes - Honoraires des consultants

	Unit Cost mid-1977/ 1/ coût uni- taire mi- 1977 (CFAF)	-----CFAF '000, FCFA '000-----								Total 1978-1982
		No. 1978	No. 1979	No. 1980	No. 1981	No. 1982				
<b>A. Training Programs</b>										
<u>Blacksmith Training Program</u>										
Instructor's Salary - D Level	420,000		1	400	1	400	1	400		1,200
Blacksmiths' Subsistence, Transport	CFAF 500/day (40 days)		5	100	10	200	10	200		500
Blacksmiths' Equipment	180,000			900		1,800		1,800		4,500
Sub-total Blacksmith Training Program				1,400		2,400		2,400		6,200
<u>Other Technical Training (mechanics, watermen)</u>										
Total Technical Training Programs				2,000		4,000		4,000		10,000
<u>Training of Farmers' Delegates, Farmer Accountants, and Shepherds</u>										
Subsistence	CFAF 350/day (50 days)		82	1,500	82	1,500				3,000
Transport				500		500				1,000
Pedagogical Equipment				700		700				1,400
Agricultural Training Equipment				700		800				1,500
Total Training of Farmers' Delegates, Farmer Accountants and Shepherds				3,400		3,500				6,900
<u>Training of First Aid Volunteers</u>										
Subsistence	CFAF 350/day (15 days)		41	200	41	200				400
Transport				100		100				200
Miscellaneous				100		100				200
Training of First Aid Volunteers				400		400				800
Total Training Programs				7,200		10,300		6,400		23,900
<b>B. Audit of Project Accounts</b>										
			1,500	1,500		1,500		1,500		6,000
<b>C. Visiting Consultants for Namarigoungou Construction</b>										
		6,000	3,500	1,700						11,200
<b>D. Feasibility Study (Gabou Bonfeba)</b>										
Topography at 1/5000 on 5,000 ha	CFAF 7000/ha			35,000						
Soils Classification on 6,000 ha	CFAF 3500/ha			21,000						
Factibility Study 1% of Project Cost (Project Cost 2,370 ha x CFAP 2 million = CFAP 4.7 billion)				47,000						
Other (gravity primary canal to Namarigoungou)				15,000						
Total Feasibility Study				122,000						

A. Programmes de formation

Programme de formation des forgerons  
Salaire du moniteur - niveau D  
Frais de nourriture, transport des forgerons  
Equipement forgeron  
Sous-total Programme de formation des forgerons

Autre formation technique (mécaniciens, alquadiers)  
Total formation technique

Formation des représentants des fermiers, des comptables paysans et des bouviers  
Frais de nourriture  
Transport  
Equipement pédagogique  
Equipement de formation agricole  
Total formation des représentants des fermiers, des comptables paysans et des bouviers

Formation des secouristes de village  
Frais de nourriture  
Transport  
Divers  
Formation des secouristes

Total programmes de formation

B. Audit des Comptes

C. Honoraires de consultants pour la construction de Namarigoungou

Etude de factibilité (Gabou Bonfeba)  
Topographie à 1/5000<sup>00</sup> sur 5000 ha  
Etude des sols sur 6,000 ha  
Etude de factibilité 1% du coût du projet (Coût du projet 2,370 ha x FCFA 2 millions = FCFA 4,7 milliards)  
Autre (canal primaire pour alimentation gravitaire de Namarigoungou)  
Total étude de factibilité

1/ For base cost February 1978 6% was added./Pour un coût de base en février 1978, on a ajouté 6%.

NIGER

IRRIGATION PROJECT

Project Cost

IDA Disbursement Schedule

IDA Fiscal Year and Quarter	Cumulative Disbursement at End of Quarter (US\$'000)
<u>FY 78/79</u>	
3rd Quarter	500
4th Quarter	1,000
<u>FY 79/80</u>	
1st Quarter	1,500
2nd Quarter	2,000
3rd Quarter	3,500
4th Quarter	5,000
<u>FY 80/81</u>	
1st Quarter	6,500
2nd Quarter	8,000
3rd Quarter	9,000
4th Quarter	10,000
<u>FY 81/82</u>	
1st Quarter	11,000
2nd Quarter	12,000
3rd Quarter	12,500
4th Quarter	13,000
<u>FY 82/83</u>	
1st Quarter	13,500
2nd Quarter	14,000
3rd Quarter	14,500
4th Quarter	15,000

NIGER

IRRIGATION PROJECT

Construction of Irrigation Works by Force Account

1. The high cost of irrigation works in West Africa is due to two factors:
  - (a) the increasing degree of sophistication of the irrigation design;
  - (b) the increase in the unit costs charged by the contractors.
  
2. Increasing Degree of Sophistication. Annex 7 showed that the type of design for the irrigation schemes in Niger has rightly evolved from a dike with a flood gate, to a minimum distribution network, to a system with movable pumping stations, to full water control with pumping and land levelling. 1977 costs of these different types of schemes would be:
  - from CFAF 400,000 to CFAF 700,000/ha for the dike with flood gate;
  - from CFAF 1 million to CFAF 1.5 million/ha for partial control of the water level and movable pumping stations;
  - from CFAF 2.3 million to CFAF 3 million/ha for the recent schemes with full water control and pumping.
  
3. In addition to the greater security of production and the higher benefits for farmers, the schemes with full water control, despite their high cost per ha, have similar economic returns to those of the least sophisticated schemes because they make possible double cropping at high yields.
  
4. The following table compares the cost of the most recent and most comparable scheme, Toula, with the three schemes to be built in the "polders" under this project.

	<u>Toula</u>	<u>Namarigoungou</u>	<u>Daibery</u>	<u>Yelewani</u>
Net area (ha)	260	1,500	357	120
	<u>Cost per ha (CFAF '000 - 1977 Terms)</u>			
	(Actual)			
Dike	580	193	750	640
Pumping stations (including electrical equipment)	197	232	490	803
Irrigation and drainage networks	1,400	1,625	990	1,105
Land planing, tertiary distribution and drainage system	435	360	290	262
Tracks, miscellaneous	/1	/1	120	81
Total	2,612	2,410	2,640	2,891

/1 Included in preceding items.

Except for Toula, for which the figures are actual costs updated to 1977, the figures for the other schemes are estimates, which in the case of Namarigoungou would be modified by the change in specifications studied as part of the detailed engineering study.

5. The unit cost of 5 projects (up-dated to mid-1977) have been compared:

- Niger - Namarigoungou, SOGREAH study, 1974, estimate of cost by contractors;
- Niger - Toula, actual costs of contractors SFEDTP and SATOM/SNGTN, April 1974;
- Niger - Konni, actual costs of contractors SATOM/SNGTN, October 1976;
- Mauritania - Gorgol, SCET estimate based on Dagana, Senegal; actual costs + 20% to take into account the distance;
- Senegal - Recent bids for an irrigation project in the Senegal delta.

6. The results for Namarigoungou, Toula and Konni are summarized below:

	<u>Namarigoungou</u>	<u>Toula</u>	<u>Konni</u>
1. Land moving, filling	Normal	Normal	50% to 100% greater than Toula
2. Concrete and steel	Overestimated by 20%	Normal	30% to 40% greater than Toula
3. Concrete lining of canals	Overestimated 10-30%	Normal	N.A.
4. On-farm Works	Slightly Underestimated	30% to 100% greater than Namarigoungou	N.A.

7. From the following comparisons it can be concluded that:

- (a) Contractors are not accustomed to do on-farm works and tertiary networks.
- (b) The available unit costs for Konni are much higher than those for Toula. Since Konni is the latest scheme built, it can be expected that contractors would base their offers on these prices. Since Konni is about 400 km from Niamey and Toula less than 100 km, the Konni costs could justify only a 10-20% price differential.
- (c) Prices obtained in Senegal are some 30% below those for Toula.

8. In light of the fact that there is limited competition among local contractors, and that there is a substantial backlog in Niger for civil works (especially roads), the tendency to higher construction costs will most likely accelerate.

9. This can only be prevented by: increasing the advertising for the works to be built over the next few years, building up the capabilities of the smaller contractors, and developing capabilities to do the works on force account within a number of government agencies. This would be one of the reasons for the establishment of the "Office National des Amenagements Hydroagricoles."

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IRRIGATION PROJECT

Organization and Training

1. The "Office National des Amenagements Hydroagricoles"

1.01 It was shown in Annex 2 that Government had decided to create an "Office National des Amenagements Hydroagricoles" to (i) overcome the deficiencies of "Genie Rural" and UNCC; and (ii) regroup under the same agency the construction and management of irrigation schemes. The "Office" would also introduce the principles of farmers' organization described in this annex.

1.02 Government requested FAC financing for a study of the statutes and organization of ONAHA. The study was completed in November 1977, but its recommendations have not been approved by Government or IDA. IDA has been requested to finance another study by consultants under a project preparation facility. The recommendations of the study should be available for the negotiations of the proposed project. The consultants will also determine the requirements for technical assistance, taking into account the number of local rural engineers available, and will propose a training program and a schedule to phase out the expatriate technical assistance.

1.03 ONAHA would be responsible for engineering and construction of irrigation works and agricultural development on the schemes and the rainfed holdings of scheme participants.

1.04 ONAHA could eventually cover some 200,000 ha of irrigated land. ONAHA would be set up with central headquarters in Niamey which would be responsible for general policy, planning and studies, and branches where major investments are planned. These local branches would be responsible for the implementation of the investment programs and agricultural development in their areas of jurisdiction.

1.05 The organization chart for ONAHA is attached to the present annex.

1.06 The articles of agreement creating ONAHA would incorporate the dispositions of Law No. 60-28 of May 25, 1960, referred to in Annex 2, and would, in particular, ensure that formal contracts be signed between Government and ONAHA for management of the schemes, and that farmers' right to occupancy be guaranteed by leases.

2. Farmers' Organization

2.01 The organization of farmers in the schemes should be given greater attention than in the past, so that eventually all schemes would be managed

Government meet its goal of increased food supply, and assuring a greater chance for recovery of Government's investment in the schemes.

2.02 The organization of farmers on the schemes should be evolutive, with ONAHA's directive involvement being progressively replaced by the cooperatives as they assume greater management activities. In the first few years ONAHA would be responsible for the procurement of services (extension, credit, water, collection of credit, marketing of crops), for which farmers would pay whole or part; and the farmers would be responsible for the allocation of these services amongst themselves.

2.03 At the same time a number of problems would need to be solved:

- land reallocation, its impact on the populations;
- indoctrination and motivation of farmers to join the scheme;
- teaching of irrigation methods;
- grouping of farmers.

To help solve these problems, which basically are common to all schemes, ONAHA would be given a support unit, staffed with appropriate specialists.

2.04 The progressive transfer of all management activities to farmers should be done under the guidance of a union of cooperatives or a recognized cooperative body, which would transfer onto new schemes the experience learned on older ones and would support the newly-formed cooperatives with the network of the already-formed cooperatives.

2.05 The organization of the farmers would therefore require that in the first years ONAHA be responsible for the procurement of services to farmers, and assist in solving the initial problems of farmers' settlement with a specialized support unit. All management activities would be progressively transferred to farmers, with farmers being regrouped into cooperative units, and the cooperative units being guided and supported by a broader union of cooperatives.

2.06 Farmers would be organized in the smallest groups compatible with the physical management of the schemes. Since water application for rice cultivation is shared between 10 farming units cultivating 5 ha altogether, groups would be made up of 10 farming units each. These farming units would co-opt themselves on the basis of inter-individual affinities in a process similar to the "bogu" (Annex 2). The number 10 is small enough for the group to escape the control of the traditional chieftains and corresponds to the smallest number for water application, and could serve to establish the basis (which does not exist at present) for financial solidarity for credit repayment.



2.07 Since the average village's population 1/ is 400, comprising some 80 farming units, the village would be made up of some 8 farmers' groups, represented at the village level by a delegate in each group. The village would have one paid farmer accountant keeping the books for the 8 farmers' groups. In the case of Namarigoungou (1,550 ha net area, 3,000 farming units) there would be 300 farmers' groups represented by 300 delegates. The books would be kept by 40 farmer accountants. The Namarigoungou villages would be regrouped into three zones.

### 3. Farmers' Training

3.01 Besides farmers' training conducted as part of the normal extension work, and in addition to the training of technicians and health volunteers, there are three types of farmers who would receive specialized training under the proposed project: the delegates of farmers' groups, the farmer accountants keeping the books for the farmers' groups, and the herdsmen. The work expected of these farmers and their training requirements are listed below:

	<u>Number</u>	<u>Work</u>	<u>Training</u>
Delegates	1/10 farmer units	Teaching of irrigation techniques, procurement and distribution of inputs and equipment of farmers' groups and control of irrigation	Training (cultivation, irrigation, maintenance), notions of organization
Farmer Accountants	1/80 farmer units	Keep farmers' groups accounts for credit, marketing, water charges	Notions of accounting
Herdsmen	1/80 farmer units	Training of draft oxen and teaching of use of ox-drawn equipment.	Technical

3.02 The delegates would be trained on their lots for a 5 month period with no subsistence allowance. Farmer accountants and shepherds would alternate training in Tillabery and training in their villages for a total period of 5 months. It is assumed that 50 days would be charged to the project for their training. Cost of subsistence and training is at Annex 9, Table 9. Altogether, about 400 delegates, 90 farmer accountants and 90 shepherds would be trained. Teaching would be done by ONAHA staff.

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1/ Or "quartier" for the big villages.

### 4. Training in Technical Skills

#### 4. Training in Technical Skills

4.01 The proposed project includes funds for the training of a number of artisans in basic skills, and for providing them with some equipment. Since the needs have not yet been quantified, the number of people to be trained and their specialities have yet to be determined. This project component could address itself to the training of small civil engineering contractors, mechanics, watermen, etc., and could follow the training of blacksmiths outlined below, which has been fairly successful in Niger and Mali.

4.02 The Blacksmith Training Program. The first step would be to make an inventory of the number of blacksmiths in the project area and their capabilities, and to enlist the participation of the various villages to determine which blacksmiths should be trained first. The staff member responsible for the program would himself have participated in blacksmith training courses, either in Niger (Maradi) or in other countries (Mali-Mali-Sud area) for a period of about six months.

4.03 The courses would comprise:

- (i) construction of proper sheds, training in the proper use of blacksmiths' equipment;
- (ii) fabrication of improved traditional blacksmith tools;
- (iii) teaching brazing, tempering, fabrication of plow parts and spares, and small equipment used on the irrigation schemes;
- (iv) teaching some elements of management.

The courses would last 40 days and would be broken up into a number of periods. At the end of the courses the blacksmiths would be given some equipment which they would repay over a 3-year period at the going interest rate and without subsidies. Twenty-five blacksmiths could be trained under this program.

#### 5. Monitoring and Evaluation

##### Objectives

5.01 In broad terms the objectives of monitoring the project's performance would be to design and operate an information collection system which would help to identify issues or problems of implementation and operation. This would serve the project as a management tool for both operational and policy decisions.

5.02 The information system would supply project management with key indicators to ensure that the project meets its development objectives. Efficiency of project implementation would be measured in respect to standards of performance in terms of targets set at appraisal.

5.03 Ongoing evaluation of problems of project implementation and operation would allow project management to adapt the project to changing objectives and circumstances.

#### Design of the Data Collection System

5.04 The support unit of the project Agricultural Development Services would be responsible for design and operation of the monitoring and evaluation system. The design would include selected summary indicators, showing project progress, both at farm and project levels, in the following fields:

- investments, both physical and costs of infrastructure and equipment;
- agricultural inputs and outputs;
- operation and maintenance of irrigation and drainage systems;
- irrigation water management;
- reimbursements of farmers' credits;
- project cost-recovery; and
- the socioeconomic impact of the project.

5.05 IDA would review both the design of the system before it becomes operational and the form of presentation.

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IRRIGATION PROJECT

Terms of Reference for the Engineering Consulting Firm

Special Clauses

I. Objective of the Bidding. General Features of the Project.  
Administration Organization.

Objective of the Bidding

1.1 The Government of the Republic of Niger decided to call for bids from various engineering consulting firms to provide technical assistance to implement the Namarigoungou Irrigation Project, for which a joint IDA/KFW credit has been negotiated.

General Features of the Project

1.2 The above mentioned project includes the following components:

- (a) Construction of a protection dike and irrigation and drainage networks (including on-farm works) in the Namarigoungou cuvette along the Niger river (about 1,500 net ha) located about 30 km upstream of Tillabery;
- (b) Farmers' training and management of the irrigation perimeters in the Tillaberry and Tera arrondissements and of the Namarigoungou perimeter during the course of its development;
- (c) Improvement of health conditions in the perimeters mentioned in paragraph (b) above;
- (d) Training of Nigerien staff, farmers and artisans;
- (e) Construction of infrastructure and purchase of equipment to implement the project; and
- (f) Preparation of a feasibility study for the Gabou-Bonfeba cuvette (about 3,300 net ha), located directly upstream of the Namarigoungou cuvette.

1.3 The technical assistance necessary to accomplish objectives (c) and (f) of paragraph 1.2 above, is not included in this call for bids.

Technical features of the Namarigoungou Cuvette Irrigation Works and Methods of Executing the Works

1.4 The works envisaged for the Namarigoungou cuvette are the following:

- (a) a protection dike against the Niger River floods, 12 km long and 3 m high on the average;
- (b) two pumping stations, equipped with electric vertical axial pumps. A 22 Kv power line will be built from Tillabery to Namarigoungou under the supervision of NIGELEC.
- (c) complete networks of irrigation and drainage canals and tracks.
- (d) on-farm works, including land clearing, land levelling, construction of bunds and irrigation and drainage ditches.

1.5 Maps and detailed engineering for the execution of these works, based on a scale of 1/2000 for the irrigation and drainage works, and 1/500 for the pumping stations, are available. They were drawn up in 1977 by consulting engineers SOGREAHA.

1.6 Works (a), (c), and (d) above would be implemented by force account, with all the necessary equipment (the purchase of which was provided for under the project). Works (b): pumping stations (civil engineering and electro-mechanical equipment) as well as the provision of the hydro-mechanical equipment for all the irrigation works under the project will be done by contractor, under the supervision of the staff responsible for project implementation. Technical assistance by the engineering consulting firm is required for all the works (a) through (d) of paragraph 1.4 (i.e., the execution of works by force account and the supervision of works done by contractors).

Administrative Organization

1.7 The Government of Niger is on the verge of establishing an Office National des Amenagements Hydro-Agricoles (ONAHA) to carry out studies and works on the schemes, and to handle training and management of the irrigated perimeters. ONAHA, whose central office will be located at Niamey, will theoretically be operational before end 1978.

1.8 An ONAHA Regional Office will be set up at Tillabery, and its installation and operating expenses for four years will be financed under the IDA/KFW credit. The Regional Director, who will be a Nigerien, will be in charge of all project activities, as described in paragraph 1.2 above. The Regional Office at Tillabery, which will require the technical assistance of the engineering consulting firm, will comprise:

- (a) Equipment Services, within which a Namarigoungou Studies and Works Division;
- (b) Agricultural Development Services, which will cover the entire Niger River Region;



(d) Garage and Repair Shop

- 1 Chief Mechanic, Garage and Repair Shop Chief

(e) Administrative and Accounting Services

- 1 Chief Accountant, Chief of Administrative and Accounting Services.

2.3 In total, 11 expatriates are required; the approximate duration of their employment is given in the attached Table 1 (approximate total: 35.5 man-years). The total duration of the project is four years (from 1979 to 1982).

Responsibilities and Qualifications of the Personnel to be Provided by the Engineering Consulting Firm

2.4 The Technical Adviser to the Regional Director at Tillabery

- (a) Responsibilities: As indicated previously, he will be the Deputy of the Regional Director of ONAHA, and will primarily be responsible (under the authority of the Regional Director of course) for the execution of the project financed under the IDA/KFW credit. He will, moreover, supervise the activities of all the expatriates provided by the engineering consulting firm selected.
- (b) Qualifications. He should have at least 10 years' experience in the design, execution and management of irrigation schemes, preferably in Sahelian Africa, where he will have proven his technical ability and his skills in organization, extension work, and management of irrigation projects. He should, preferably, have a degree in Agronomy or Rural Engineering.

2.5 TR/TP Hydraulic Engineer

- (a) Responsibilities: He will be Chief of the Namarigoungou Studies and Works Division, and as such, should:
- finalize designs for the construction of irrigation and drainage networks and hydraulic structures;
  - organize and superintend works done by force account;
  - supervise the construction of pumping stations (which will be done by contractor); and
  - supervise the preparation of surveys, detailed estimates of quantities for each type of work, basic production cost data, etc.

- (b) Qualifications: He should have at least 5 years' experience in the study and execution of irrigation schemes, preferably in Africa. He will have a degree in Rural Engineering/or Rural Works/or Public Works, or in Hydraulic Engineering.

2.6 Engineer-Topograher

- (a) Responsibilities: He will be in charge of all the topographical work necessary to implement the Namarigoungou works: supplementary maps, sitings, surveys, etc. If necessary, he will be assisted in his task by the Topographical Service of ONAHA's Equipment Services, which will monitor the quality of his work.
- (b) Qualifications: At least 5 years' experience in implementing irrigation schemes. He will have a degree from a school for Engineer-Geometers or for Topographers, or possibly, will be a senior topographical technician.

2.7 The Topographical Technician will assist the Engineer-Topographer and should have at least 5 years' experience in performing the topographical duties to implement irrigation schemes.

2.8 The Three Foremen

- (a) Responsibilities: They will be responsible for the works to be implemented by force account in the irrigated schemes in the Namarigoungou cuvette.
- The first (No. 1) will be responsible for the construction of earthworks (dike, irrigation and drainage canals, access tracks);
  - The second (No. 2) will be responsible for the construction of concrete (or masonry) works in the irrigation and drainage networks. In addition, he will supervise the execution of civil engineering works done by contractor for the two pumping stations;
  - The third (No. 3) will be responsible for the execution of on-farm works (land clearing, land levelling, construction of bunds, and digging irrigation and drainage ditches).
- (b) Qualifications: The three foremen should, in particular, be qualified in the execution of irrigation works by force account, and should be especially experienced in the use of heavy earth-moving equipment and other heavy equipment. The foremen should have at least 10 years' experience in the execution of this type of works, at least 5 years of which should be in the execution of works by force account.



2.9 The Agronomists

- (a) Responsibilities: They will assist the Chief of the Agricultural Development Services (a Nigerian Agronomist/Manager) in training farmers, management of the schemes and assisting cooperatives in all the perimeters in the administrative arrondissements of Tillabery and Tera.
- The Irrigation Agronomist will be primarily responsible for agricultural development: selection of crops, systems of production, organizing and setting up seed programs, agricultural extension, etc.
  - The Agro-Economist will assist in setting up and monitoring programs to create and develop cooperatives, in the execution of rural economic studies, socio-economic surveys, etc.
- (b) Qualifications: The two Agronomists should have at least 5 years' experience in their specialties, preferably in irrigation projects in Sahelian Africa. They should have degrees in agronomy.

2.10 The Chief Mechanic

- (a) Responsibilities: He will be Chief of the Public Works and Transportation equipment garage, and responsible for agricultural equipment, as well as for the Regional Repair Shop at Tillabery.
- (b) Qualifications: He should have at least 10 years' experience in the repair and maintenance of heavy public works and transportation equipment. He should have a degree from a professional school.

2.11 The Chief of the Administrative and Accounting Services

- (a) Responsibilities: He will be the Chief of the Administrative and Accounting Services of ONAHA's Regional Office. He will be, in particular, responsible for keeping accounts of commitments, cash flows, and payments approved by the Regional Director.
- (b) Qualifications: He should have a degree in accounting, with at least 10 years' experience in the financial administration of important development projects. He should likewise be well versed in administrative questions (personnel management and general administration) relative to such projects.

Detailed Curriculum Vitae

2.12 Detailed curriculum vitae will be provided for each of the 11 expatriates proposed by the engineering consulting firm, which will give, among others, complete information on:

- their degrees and professional qualifications;
- their experience in the areas required, with details about the projects (or parts of projects) for which they have been responsible;
- evaluations by the administrative authorities for whom these projects were executed;
- etc....

Special Responsibility of the Expatriates Recruited to Train their Nigerien Counterparts

2.13 Whether they fulfill executive responsibilities such as Chief of a Service or Division, or whether they serve as technical advisers, the expatriates provided by the engineering consulting firm should devote a considerable portion of their activities to training the Nigerien counterparts under their jurisdiction. This very important aspect of the expatriates' role should not be neglected. Experience in training will be an important selection criterion. The training programs will be submitted to the Association for approval.

III. Special Clauses

3.1 Housing: Only 5 houses, furnished and air conditioned, will be provided free of charge to the engineering consulting firm, at Tillabery. 1/ (4 with 2 bedrooms, living room, kitchen and bathroom, and 1 with 3 bedrooms, living room, kitchen and bathroom). In view of the close contact that he must maintain with ONAHA's Central Office, the Agro-GR Engineer (Principal Technical Adviser) will be authorized to live in Niamey, at the consulting firm's expense. Utilities for the 5 houses at Tillabery (water, gas, electricity) will likewise be paid by the engineering consulting firm.

3.2 Offices - Vehicles 1/: Offices and vehicles for the expatriates will be provided by ONAHA, which will likewise pay the operating costs.

3.3 Payments. The engineering consulting firm will be paid for each month spent in the field by the expatriates seconded to ONAHA at rates which will be negotiated in the contract and will be based on proposals made during bidding. The monthly rates, which will be renegotiated at the beginning of each calendar year, will include allowances, salaries and expenses during leave, overheads, and profits for the engineering consulting firm, etc., excluding travel expenses, which will be reimbursed on a case by case basis upon presentation of appropriate justification.

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1/ Construction, purchasing and operating costs are provided for in the IDA/KFW credit.

1.4 Possible Pooling of 2 Engineering Consulting Firms

In view of the wide range of qualifications required by the expatriates sought, 2 engineering consulting firms (at the most) might associate to make a joint offer. In this case, it is expressly stated that they would be mutually liable and that, in addition, the Agro-GR Engineer (referred to in para 2.4 above) will be solely responsible for all expatriates provided by the two firms under the project.

3.5 Arbitration: An international arbitration clause will be included in the contract to be concluded with the engineering consulting firm.

3.6 Start of Secondment: In principle, secondment of the required experts should begin in early January 1979.

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

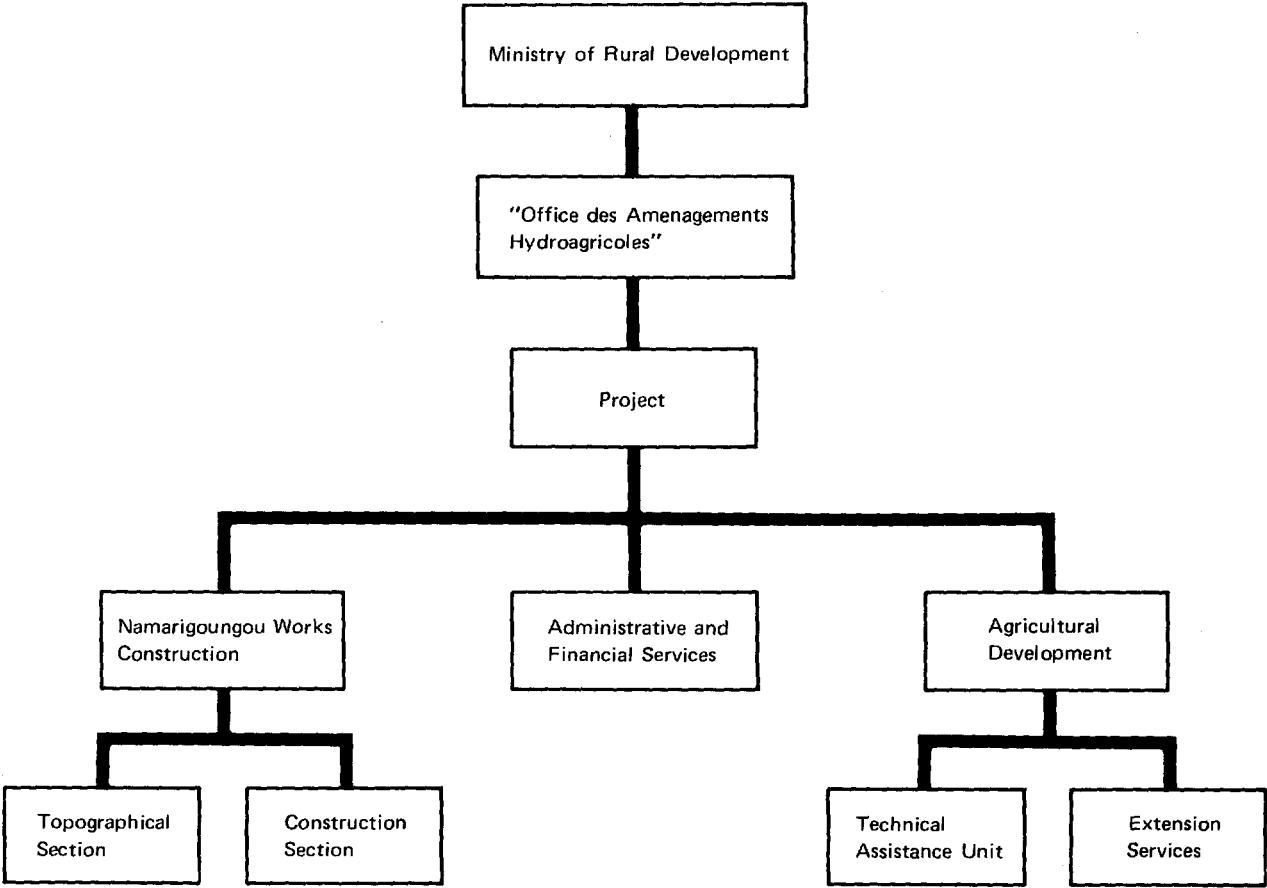
TERMS OF REFERENCE/TERMES DE REFERENCE

For the Engineering Consultant Firm/Pour Le Bureau d'Etudes d'Ingénieurs Conseils  
Technical Assistance Personnel/Personnel d'Assistance Technique

(Man-Years)/(Hommes-Années)

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	
<u>Management</u>						<u>Direction</u>
Project Unit Manager	5/12	1	1	1	1	Directeur du Bureau du Projet
<u>Works Construction Section</u>						<u>Execution des ouvrages</u>
<u>Topographical Section</u>						<u>Section TI/Hydro</u>
TF/Hydro Engineer	5/12	1	1	1/2		Ingénieur TF/Hydro
Engineer/Topographer		1	1	1/2		Ingénieur topo
Topographical Technician		1	1	1/2		Ingénieurs topographe
<u>Construction Section</u>						<u>Section Travaux</u>
Head Foreman		1	1			Conducteur de travaux
Site Foreman (Canals)	5/12	1	1	1/2		Chef de chantier (canaux)
Site Foreman (on-farm works)		7/12	1	1/2		Chef de chantier (aménagement terminaux)
<u>Administrative and Financial Services</u>						<u>Administration/Services Généraux</u>
Chief Accountant and Administrative Director	5/12	1	1	1	1	Chef comptable et directeur administratif
Chief Mechanic	5/12	1	1	1	1	Chef mécanicien
<u>Agricultural Development Services</u>						<u>Mise en valeur</u>
Agronomist (irrigation)	5/12	1	1	1	1	Agronome (irrigation)
Agro-economist	5/12	1	1	1	1	Agro-économiste

**NIGER  
IRRIGATION PROJECT  
ORGANIZATION CHART**





NIGER  
IRRIGATION PROJECT/PROJET D'IRRIGATION

Prices and Impact on Government Finances/Prix et impact sur les finances gouvernementales

Rice and Paddy Economic Prices/Prix économiques du riz et du paddy

1978 Constant Terms/En termes constants 1978

1980-1985

A. Import Substitution

<u>Rice FOB Bangkok</u>	
- IBRD Projections - Thai 5% Broken / <u>1</u>	422
- Discount from IBRD Projections / <u>2</u>	(127)
	US\$ 295
at CFAF 245 = US\$1	CFAF 72,300
<u>FOB Bangkok - CIF Cotonou - Transport at Cotonou</u>	<u>8,500</u>
- Loading	1,500
- Unloading	1,200
- Transit	1,200
- Supervision	200
Total at Cotonou	<u>4,100</u>
Cotonou - Niamey Transport	21,900
Niamey - Unloading	<u>1,400</u>
Total Import Costs at Niamey	<u>35,900</u>
<u>Rice Import Substitution Price /<u>2</u></u>	<u>108,200</u>
Paddy Equivalent / <u>3</u>	69,600
<u>Tillabery - Niamey - Transport - Handling</u>	(5,000)
<u>Tillabery - Factory Processing /<u>4</u></u>	(10,000)
<u>Farmers to Tillabery - Transport /<u>5</u></u>	(2,000)
Paddy Import Substitution Value	<u>52,600</u>

A. Substitution d'importation

<u>Riz FOB Bangkok</u>	
- Projections BIRD - Thai 5% brisures / <u>1</u>	(127)
- Décote par rapport aux projections BIRD / <u>2</u>	(127)
	à FCFA 245 = EU\$1
<u>FOB Bangkok - CAF Cotonou - Transport Cotonou</u>	<u>8,500</u>
- Chargement	1,500
- Déchargement	1,200
- Transit	1,200
- Supervision	200
Total à Cotonou	<u>4,100</u>
Cotonou - Niamey Transport	21,900
Niamey - Déchargement	<u>1,400</u>
Coûts d'importation totaux	<u>35,900</u>
<u>Prix de substitution d'importation pour le riz équivalent en paddy</u>	<u>108,200</u>
<u>Tillabery - Niamey - transport - manutention</u>	(5,000)
<u>Tillabery - Usinage</u>	(10,000)
<u>Fermiers - Tillabery - Transport</u>	(2,000)
Valeur de substitution d'importation du paddy	<u>52,600</u>

1 October 1977.

2 70% based on Niger production of 30%-100% broken (55% discount) and of 70%-20% broken (20% discount).

3 at 64.71%, which is the average ratio in Niger.

4 CFAF 10/kg of paddy (1977 average).

5 CFAF 2/kg of paddy.

1 Octobre 1977.

2 70 % basé sur la production du Niger de 30% (décote 55 %) de brisures et de 70% (avec 20% de brisures (décote 20%).

3 A 64,71 %, qui est la moyenne au Niger.

4 FCFA 10/kg de paddy (moyenne de 1977).

5 FCFA 2/kg de paddy.

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Rent and Recovery Indices/Rente foncière et Indice de recouvrement

	<u>CFAF/FCFA</u>		<u>CFAF '000</u>	
	Rice/ Riz (0.50 ha)	Mixed Cropping/ Polyculture (0.1 ha)	Total Project / Project total / <sup>5</sup>	
1. Gross Value of Farm Production at Farm Gate	216,000	68,600	686,100	1. Valeur brute de la production des fermiers sortie ferme
2. Less Production (Cash Costs)	(30,300)	(7,400)	(86,900)	2. Moins coûts réels de production
3. Net Cash Income	185,700	65,200	599,200	3. Revenus monétaires nets
4. Less Imputed Value of Family Labor / <sup>1</sup>	(15,000)	(2,000)	(43,500)	4. Moins valeur du travail familial / <sup>1</sup>
5. Less Imputed Value of Management / <sup>2</sup>	(21,600)	(6,900)	(68,700)	5. Moins valeur de la gestion familiale / <sup>2</sup>
6. Allowance for Risk/Uncertainty / <sup>3</sup>	(21,600)	(6,900)	(68,700)	6. Provision pour risques/incertitudes / <sup>3</sup>
7. Rent	127,500	49,400	418,300	7. Rente foncière
8. Rent as a Percentage of Net Cash Income	69%	76%	70%	8. Rente foncière en pourcentage du revenu monétaire
9. O.M. Water Charges	(17,200)	(3,400)	(47,000)	9. Coûts d'opération et d'entretien
10. Capital Recovery Charge	(32,800)	(6,600)	(89,600)	10. Charge de recouvrement du capital
11. Total Direct Charges (9 & 10)	(50,000)	(10,000)	(136,600)/ <sup>4</sup>	11. Total des charges directes
12. Rent Recovery Index (11+7)	39%	20%	33%	12. Indice du recouvrement par rapport à la rente
13. Public Sector Outlays (Capital + O.M.) / <sup>4</sup>			3,660,000 / <sup>4</sup>	13. Dépenses du secteur public / <sup>4</sup>
14. Cost Recovery Index (11+13)			37%	14. Indice de recouvrement des coûts
15. Farmers' Income per Capita in 1982, at Full Development			US\$ 197	15. Revenu des paysans par tête en 1982, à plein développement
16. Estimated Critical Consumption Level			US\$ 63	16. Estimation du niveau critique de consommation (1982)
17. Estimated National per Capita Income			US\$ 130	17. Estimation du revenu national per capita

- <sup>1</sup> For family labor requirements, see Annex 6.  
Valued at CFAF 200/man-day during 55% of the year;  
Valued at CFAF 100/man-day during 45% of the year; or  
CFAF 155/man-day on the average.
- <sup>2</sup> 10% of gross production.
- <sup>3</sup> 10% of gross production.
- <sup>4</sup> Discounted at 10% over 25 years.
- <sup>5</sup> 1,350 ha under rice and 150 ha under mixed cropping.

- <sup>1</sup> Pour les besoins en main-d'oeuvre voir Annexe 6.  
Évalué à 200 FCFA/homme-jour, 55% de l'année;  
Évalué à 100 FCFA/homme-jour, 45% de l'année; ou  
155 FCFA en moyenne.
- <sup>2</sup> 10% de la production brute.
- <sup>3</sup> 10% de la production brute.
- <sup>4</sup> Actualisé à 10% sur 25 ans.
- <sup>5</sup> 1,350 ha de riz et 150 ha de polyculture.



NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

Prices and Impact on Government Finances/Prix et impact sur les finances du Gouvernement  
(CFAF'000)

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	Average 1983- 1987	Average 1988- 1997	Average 1998- 2027	
<b>I. Cash Inflows</b>									<b>I. Flux positifs</b>
Farmers Direct Charges			38,800	77,500	155,000	155,000	155,000	155,000	Charges directes des fermiers
Indirect taxes on farmers /1			10,500	20,900	41,800	41,800	41,800	41,800	Taxes indirectes sur fermiers /1
OPVN profits /2			9,000	19,200	40,200	40,200	40,200	40,200	Profits de l'OPVN /2
<b>Total Cash Inflows</b>			<b>58,300</b>	<b>117,600</b>	<b>237,000</b>	<b>237,000</b>	<b>237,000</b>	<b>237,000</b>	<b>Total des flux positifs</b>
<b>II. Cash Outflows</b>									<b>II. Flux négatifs</b>
Operating and maintenance expenses			(13,400)	(26,900)	(53,700)	(53,700)	(53,700)	(53,700)	Coûts d'opérations et d'entretien
Extension and administration						(50,000)	(40,000)	(40,000)	Vulgarisation et administration
IDA credit									Crédit IDA
- Service charge	(3,000)	(14,200)	(21,800)	(25,500)	(27,600)	(27,600)	(26,200)	(12,400)	- Commission de service
- Amortization							(36,800)	(110,300)	- Amortissement
<b>Total Cash Outflows</b>	<b>(3,000)</b>	<b>(14,200)</b>	<b>(35,200)</b>	<b>(52,400)</b>	<b>(81,300)</b>	<b>(131,300)</b>	<b>(156,700)</b>	<b>(216,400)</b>	<b>Total des flux négatifs</b>
<b>Net Cashflow</b>	<b>(3,000)</b>	<b>(14,200)</b>	<b>23,100</b>	<b>65,200</b>	<b>155,700</b>	<b>105,700</b>	<b>80,300</b>	<b>20,600</b>	<b>Flux nets</b>

/1 10% of farmers' rent (Annex 12, Table 2).

10% de la rente foncière des paysans (Annexe 12, tableau 2).

/2 Estimated at CFAF 5/kg of rice.

Estimée à 5 FCFA/kg de riz.

NIGER

IRRIGATION PROJECT

Rate of Return Calculations

Assumptions

1. The economic rate of return is based on the following assumptions:
  - (a) Rice Price. The farm gate price used for paddy in the economic calculations is derived from the commodity price forecasts at October 1977, expressed in 1978 constant terms. Appropriate adjustments have been made for freight, handling and processing (Annex 12, Table 1).
  - (b) Benefits. The project would benefit all farmers cultivating on the irrigation schemes in the "Arrondissements" of Tillabery and Tera. However, since the main beneficiaries would be the farmers taking up cultivation on the Namarigoungou polder, and since in the other schemes the project would benefit from important "sunk" costs, for the purpose of the rate of return calculations only the benefits accruing to the Namarigoungou farmers have been quantified.
  - (c) Costs.
    - Project costs have been estimated in 1978 constant terms and include physical contingencies. They are net of the cost of the health and training components, audit and studies, for which no meaningful rate of return could be estimated.
    - Operating and maintenance costs have been estimated at CFAF 34,300/ha per year or about CFAF 1/m<sup>3</sup> based on the experience on the Toula scheme.
    - Extension and administration after the project period (beyond 1983) have been kept at 80% of the 1982 level.
    - Agricultural seasonal inputs have been kept at the level reached in 1982.
    - Hired labor has been estimated at 112,000 man-days for the Namarigoungou scheme, based on the farm budgets at Annex 6 estimating the total yearly requirements for hired labor at 79 man-days/ha for double cropping of rice and at 27 man-days/ha for mixed cropping. The

cost of CFAF 200/man-day is the prevailing wage rate in the project area.

- Family labor is estimated at 287,100 man-days for the Namarigoungou scheme, based on the farm budgets at Annex 6 estimating the total yearly requirements for family labor at 194 man-days/ha for double cropping of rice and at 126 man-days/ha for mixed cropping. The family labor availability is determined from Annex 6, Table 3, which shows the time required for cultivating the traditional farm and the balance of labor available. The assumption is that farmers would continue cultivating their traditional farms. At the time of labor deficit (May and from July until December) farmers would call on hired laborers. In these months of tight labor supply (55% of the time) family labor has been costed at the prevailing wage rate of CFAF 200/man-day; at other times the opportunity cost of family labor has been assumed to be worth 50% of the prevailing wage rate.

- (d) Adjustment for Shadow Pricing of Foreign Exchange. The shadow price of Niger CFAF was determined following the standard conversion factor approach per "World Bank Staff Working Paper No. 239," August 1976, and assuming minimal trade distortions on the export side where the equation for the standard conversion factor becomes  $L = \frac{M}{M + T_m}$ , where

M equals the value of imports and  $T_m$  equals the value of import taxes, has been 0.86 over the period 1970-1977, based on an average value of imports of 32.9 billion CFAF and an average value of import taxes of 5.44 billion CFAF. The shadow exchange rate therefore can be estimated at CFAF 285 = US\$1, instead of the official exchange rate of CFAF 245 = US\$1. In the economic calculations the foreign exchange components (100% of the incremental value of paddy production was shadow priced; 71% of project costs and operating and maintenance costs; and 80% of agricultural equipment and seasonal inputs) were shadow priced..

2. Economic Rate of Return and Sensitivity. With the preceding assumptions the rate of return for the base case calculations would be 12.5%, assuming a 25 year project life. The sensitivity results are:

		<u>Rate of Return</u>
Base Case		12.55
Benefits	+ 25%	17.35
	+ 10%	14.55
	- 10%	10.55
	- 25%	7.05
	Costs Unchanged	
Costs	- 25%	18.75
	- 10%	14.75
	+ 10%	10.75
	+ 25%	8.25
	Benefits Unchanged	

Other tests have been run:

(a)	Paddy production 25% lower; rest remains unchanged	8.15
(b)	Cropping intensity (175%); rest remains unchanged	10.45
(c)	No increase in rainfed production	11.55
(d)	Keeping technical assistance 5 years after project completion	12.15

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IRRIGATION PROJECT/PROJET D'IRRIGATION

Rate of Return Calculations/Calculs du taux de rentabilité

	1978	1979	1980	1981	1982	1983	1984
Project Life = 25 years Namarigoungou Scheme							
<b>I. Benefits (CFAP '000)</b>							
<u>Rice</u>							
Incremental Paddy Production (tons)							
- With Project			3,300	6,500	13,000	13,000	13,000
- Without Project			(500)	(500)	(500)	(500)	(500)
Net Incremental Paddy Production (tons)			2,800	6,000	12,500	12,500	12,500
Value of Incremental Production - Paddy /1			147,300	315,600	657,500	657,500	657,500
- Mixed Cropping /2			25,500	50,900	101,800	101,800	101,800
- Wood Plantations /3					12,000	12,000	16,000
- Livestock /4				2,900	5,800	5,800	5,800
- Rainfed /5			7,200	26,700	48,500	48,500	48,500
Total Economic Benefits			180,000	396,100	825,600	825,600	825,600
<b>II. Costs</b>							
Project Costs /6	(555,900)	(1,617,100)	(890,700)	(465,000)	(240,700)		
Operating and Maintenance			(13,400)	(26,900)	(53,700)	(53,700)	(53,700)
Extension and Administration						(50,000)	(40,000)
Agricultural Equipment		(13,800)	(36,000)	(30,000)			
Seasonal Inputs		(48,300)	(74,400)	(90,900)	(90,900)	(90,900)	(90,900)
Hired Labor /7			(5,600)	(11,200)	(22,400)	(22,400)	(22,400)
Family Labor /8					(44,500)	(44,500)	(44,500)
Total Economic Costs	(555,900)	(1,679,200)	(1,020,100)	(624,000)	(452,200)	(261,500)	(261,500)
<b>III. Adjustment for Foreign Exchange Shadow Pricing</b>							
- Value of Paddy /9			24,000	51,500	107,300	107,300	107,300
- Costs /10	(64,400)	(195,600)	(119,200)	(72,800)	(46,000)	(18,100)	(18,100)
	(64,400)	(195,600)	(95,200)	(21,300)	61,300	89,200	89,200

Durée du projet = 25 ans  
Aménagement de Namarigoungou

I. Avantages

Riz

Production supplémentaire (tonnes)

- Avec projet

- Sans projet

Production supplémentaire nette (tonnes)

Valeur de la production supplémentaire - paddy /1

- polyculture /2

- plantations /3

- élevage /4

- cultures sèches /5

Total des avantages économiques

II. Coûts

Coûts du projet /6

Opérations et entretien /6

Vulgarisation et administration

Équipement agricole

Intrants saisonniers

Main-d'oeuvre /7

Travail familial /8

Total des coûts économiques

III. Ajustement pour valeur virtuelle de la composante en devises - paddy /9  
- coûts /10

/1 At CFAP 52,600/ton of paddy.

/2 Annex 6, Table 9.

/3 Annex 6, Table 10.

/4 Annex 6, Table 12.

/5 Annex 6, Table 11.

/6 Net of health, agricultural equipment, training, audit, feasibility study (Annex 9, table 1); year-end 1977 prices.

/7 At CFAP 200/day. (123,900 man-days).

/8 At CFAP 155/day (316,300 man-days).

/9 Value of paddy at CFAP 285 vs 245.

/10 71% of project costs and operating and maintenance; 80% of agricultural equipment, seasonal inputs.

/1 A FCFA 52.600/tonne de paddy.

/2 Annexe 6, tableau 9.

/3 Annexe 6, tableau 10.

/4 Annexe 6, tableau 12.

/5 Annexe 6, tableau 11.

/6 Non compris santé, équipement agricole, formation, étude de factibilité, (Annexe 9, tableau 1); prix fin-1977.

/7 A FCFA 200 par jour (123.900 homme-jours).

/8 A FCFA 155 par jour (316.300 homme-jours).

/9 Valeur du paddy estimée à FCFA 285 au lieu de 245.

/10 71% des coûts du projet et des opérations et entretien; 80% de l'équipement agricole et intrants saisonniers.

NIGER

IRRIGATION PROJECT/PROJET D'IRRIGATION

PROJECT COSTS/COUTS DU PROJET

Implementation Schedule - Schéma de réalisation

Negotiations  
Organization

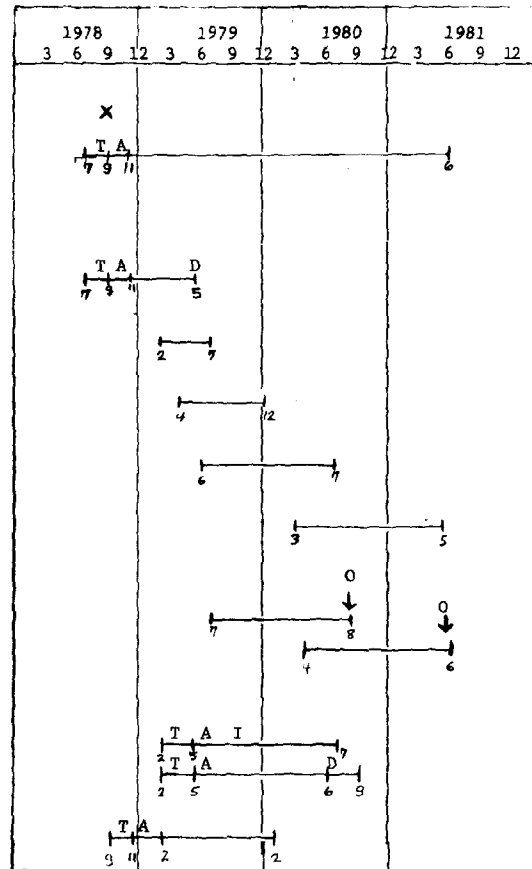
1. Creation of the "Office"
2. Selection of consultants

Construction by Force Account

3. Procurement of Equipment
4. Access Roads, buildings, stores, installations
5. Construction of dike
6. Irrigation and Drainage Systems
  - Upstream District (800 ha)
  - Downstream District (750 ha)
7. On-farm works
  - Upstream district
  - Downstream district

Contracted Works

8. Pumping Stations
  - Civil Engineering
  - Equipment
9. H.T. Line Tillabery Namarigoungou



Négociations  
Organisation

1. Création de l'Office des Aménagements
2. Sélection des ingénieurs conseils

Construction "en Régie"












3. Achat du matériel
4. Accès, bâtiments, installations de chantier
5. Construction de la digue
6. Réseaux d'irrigation et de drainage
  - Secteur amont (800 ha)
  - Secteur aval (750 ha)
7. Aménagements "à la parcelle"
  - Secteur Amont
  - Secteur Aval

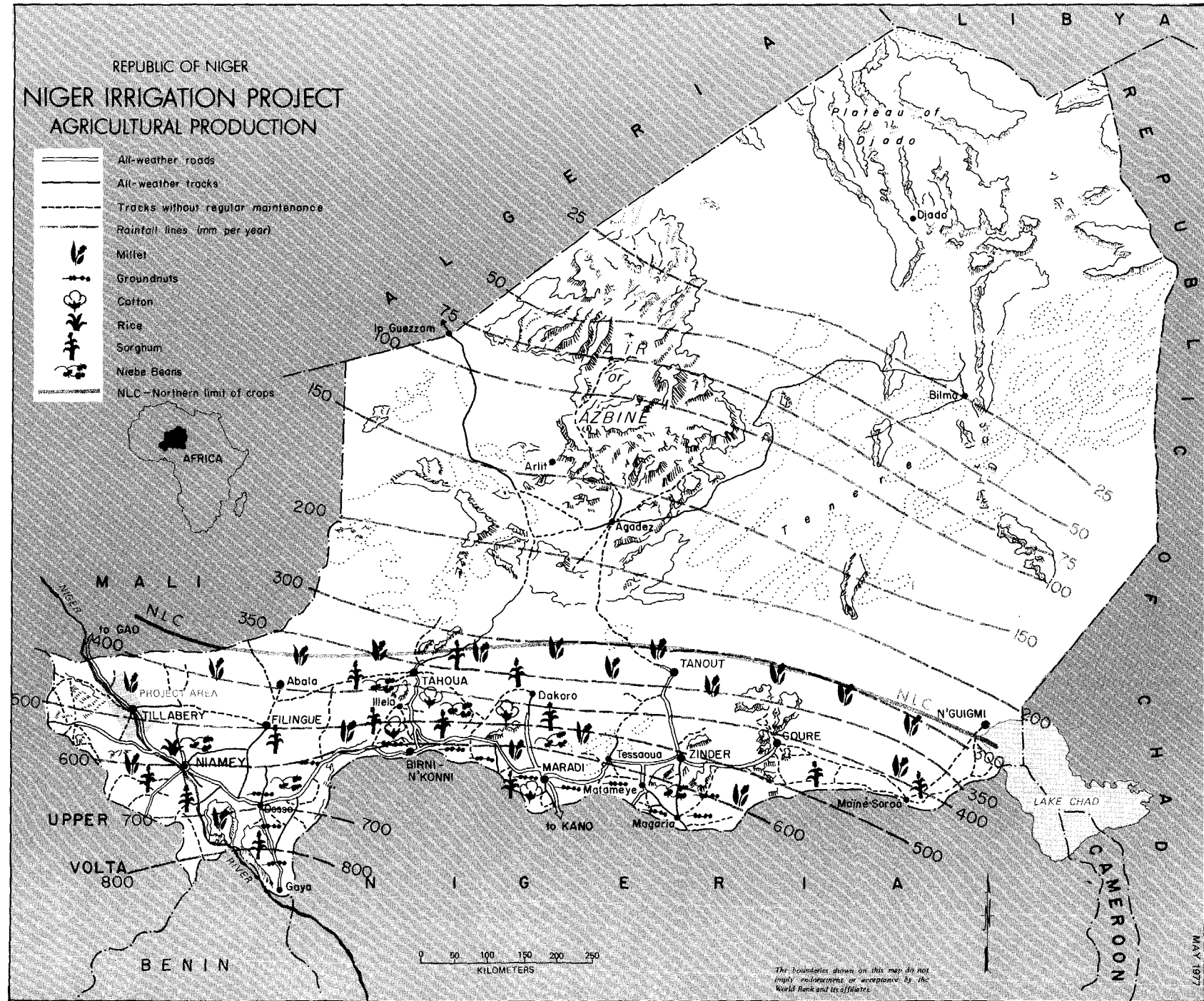
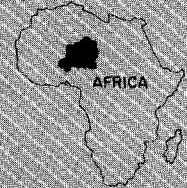
Travaux "à l'Entreprise"

8. Stations de pompage
  - Génie civil
  - Matériel
9. Ligne H.T. Tillabery Namarigoungou

- 1/ T= Tender/Appel d'offres  
A= Award/Sélection  
I= Implementation/Exécution  
D= Delivery/Livraison  
O= Operation/Mise en exploitation  
↓

REPUBLIC OF NIGER  
**NIGER IRRIGATION PROJECT**  
**AGRICULTURAL PRODUCTION**

-  All-weather roads
-  All-weather tracks
-  Tracks without regular maintenance
-  Rainfall lines (mm per year)
-  Millet
-  Groundnuts
-  Cotton
-  Rice
-  Sorghum
-  Nibe Beans
-  NLC - Northern limit of crops

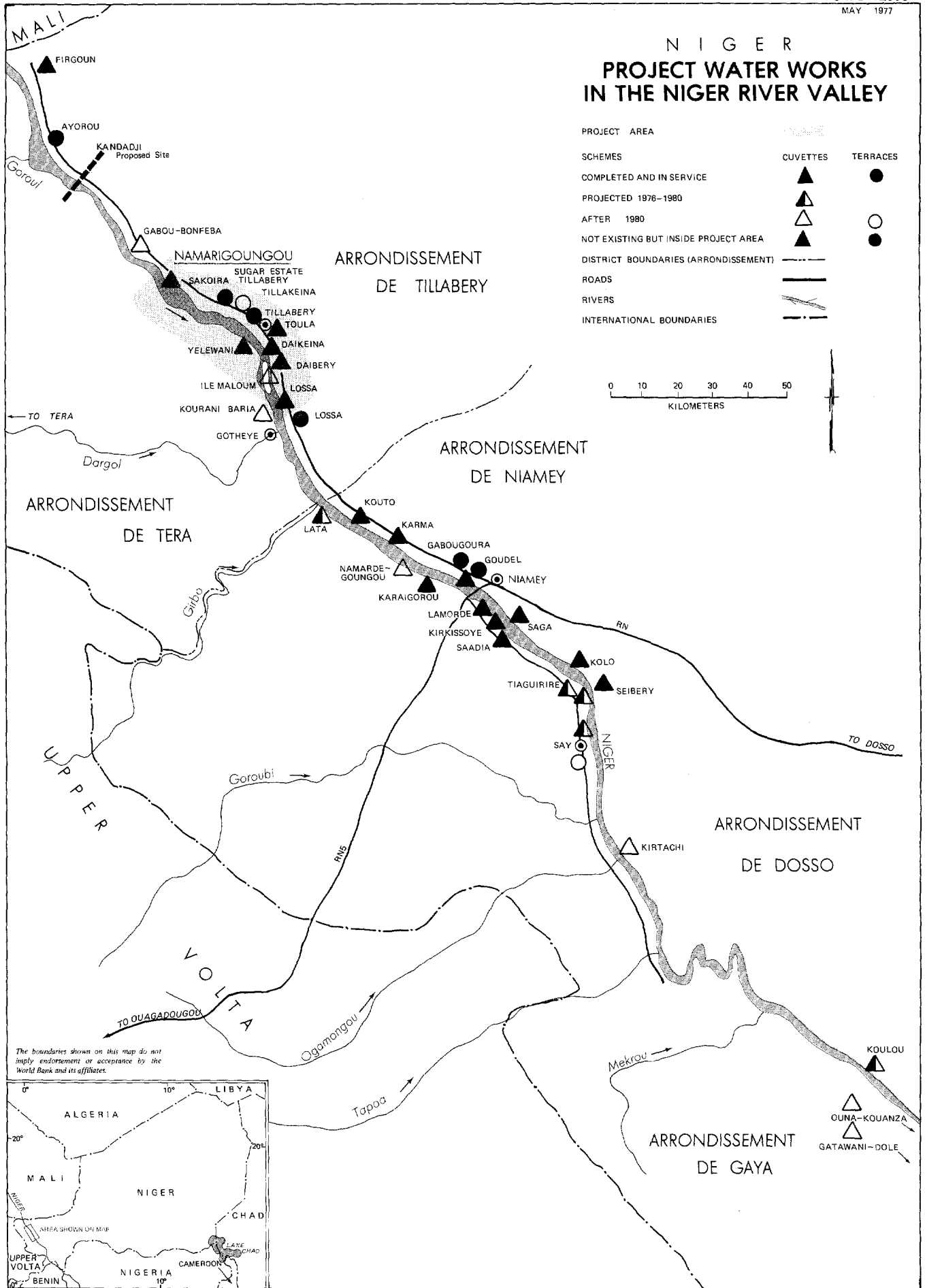


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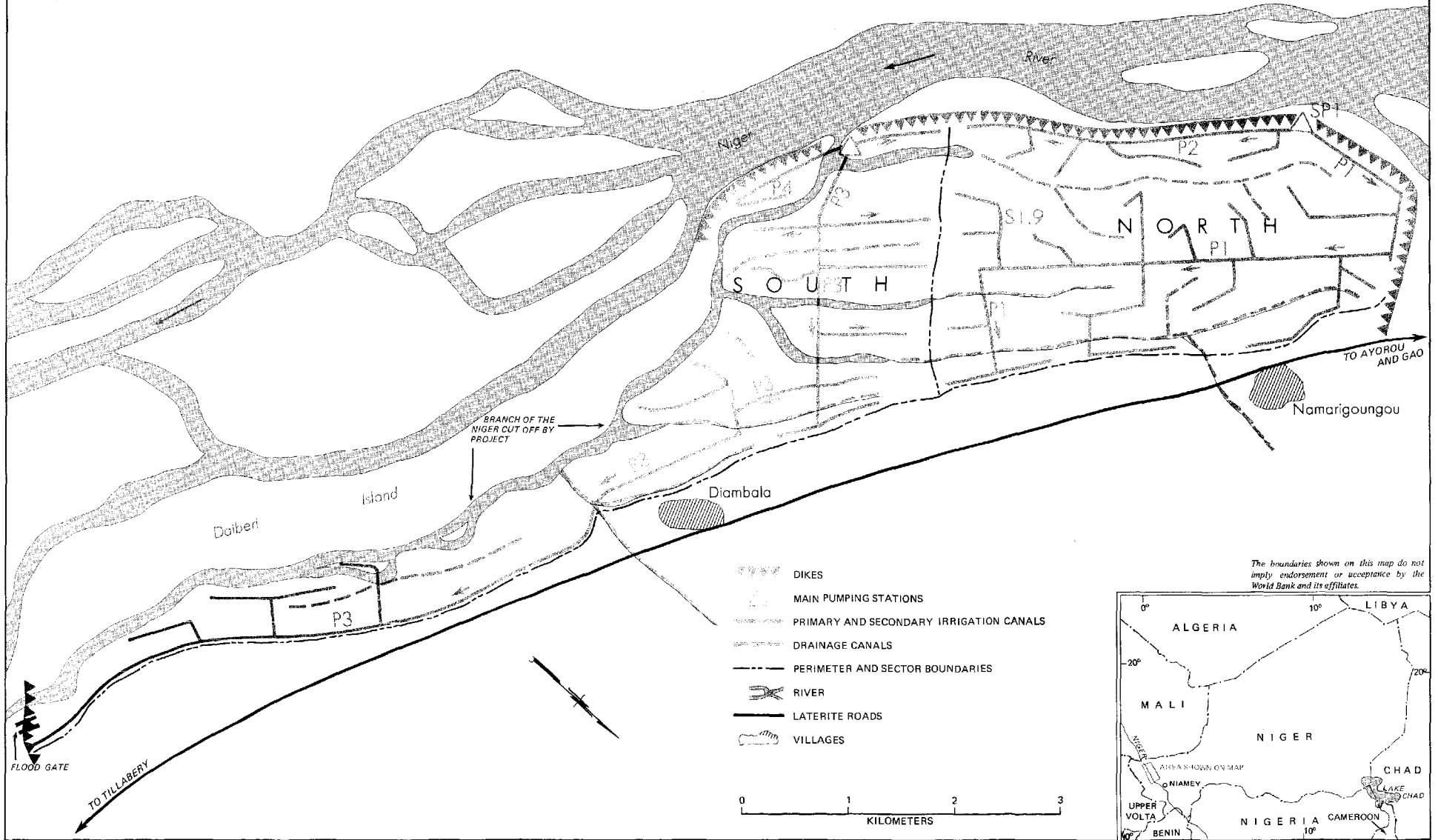


# NIGER PROJECT WATER WORKS IN THE NIGER RIVER VALLEY





N I G E R  
**NAMARIGOUNGOU IRRIGATION SCHEME**  
General Plan of the Proposed Project in the Feasibility Report, Sogreah 1974



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