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DEVELOPMENT OF IRRIGATED AGRICULTURE IN MALI

GENERAL OVERVIEW AND PROSPECTS,

- PROPOSALS FOR A SECOND PROGRAMME 1980-1985 -

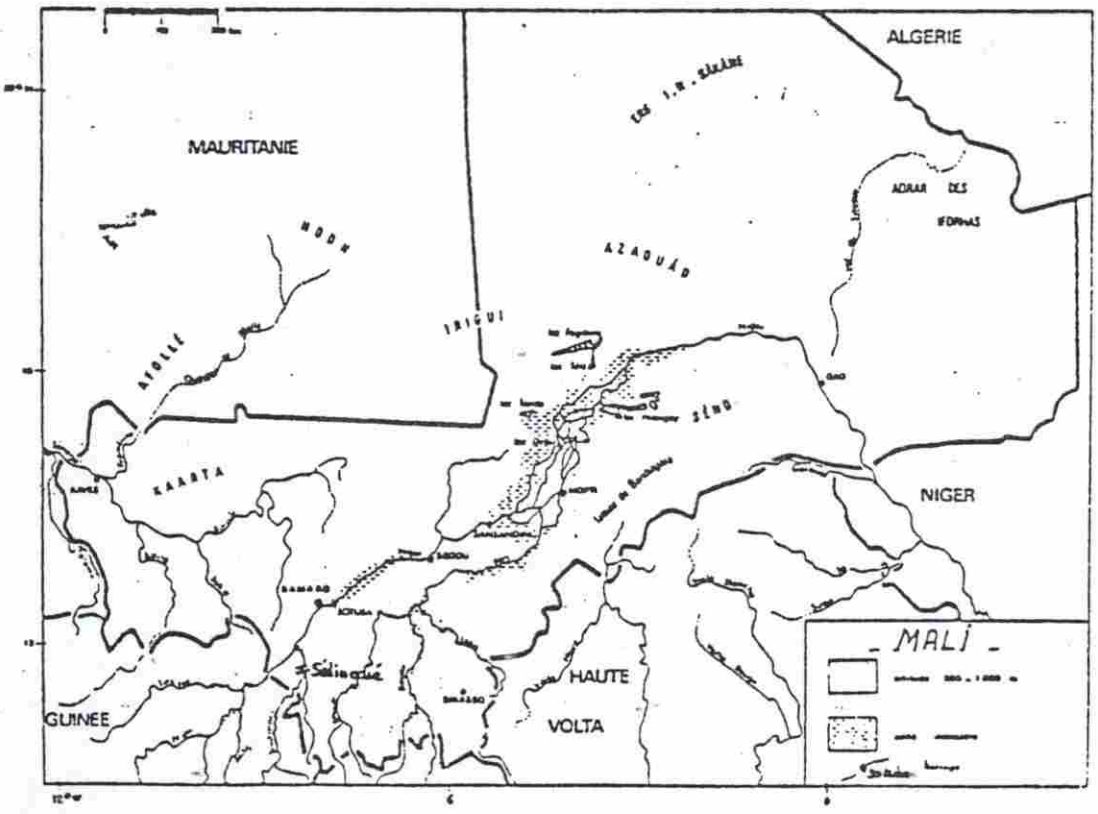

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TABLE OF CONTENTS

		Page
	PREFACE	
	SUMMARY AND CONCLUSIONS	
I -	STATUS OF IRRIGATED FARMING IN MALI	1 to 29
	1.1 Possibilities and characteristics of irrigation	1
	1.11 Possibilities; encouraging circumstances	1
	1.12 The major hydraulic networks	3
	1.13 Structures	5
	1.14 The main systems of irrigation	8
	1.2 Existing projects and prospects	14
	1.21 Kayes region	14
	1.22 Koulikoro region	15
	1.23 Sikasso region	15
	1.24 Segou region	15
	1.25 Mopti region	16
	1.26 Timbuktu region	16
	1.27 Gao region	17
	1.28 The Office du Niger	18
	1.3 Irrigated crops and national needs	22
	1.31 A variable annual rice crop	22
	1.32 Growing demand for sugar and cereals	23
	1.33 Cereal programme objectives	23
	1.34 Productions: results of the cereals programme (1974-78)	25
II -	CONSTRAINTS TO THE DEVELOPMENT OF IRRIGATED FARMING	30 to 40
	2.1 Regions and General irrigation policy	30
	2.11 Constraints associated with partial water control	30
	2.12 Constraints associated with price policy	32
	2.13 Inadequate complementary activities	34
	2.14 Crop protection	35
	2.15 The communications problem	
	2.2 Problems of the Office du Niger	37
	2.21 The price of paddy	37
	2.22 Deterioration of production equipment	37
	2.23 Lack of a transport network	37
	2.24 Farmers' equipment is inadequate	38
	2.25 Administrative structures	38
	2.26 Crop protection	38
	2.27 Sponsorship of complementary activities	38

		Page
	2.3 Some considerations and recommendations	38
III -	STATUS OF THE CILSS FIRST GENERATION PROGRAMME	41 to 50
	3.1 Preliminary remarks	41
	3.2 Execution of hydro-agricultural developments included in the plan	41
	3.3 Status of hydro-agricultural development studies in 1979	43
	3.4 Office du Niger: Status of the rehabilitation project	45
	3.41 Foreign aid already secured by the Office du Niger	45
	3.42 Expected aid	46
	3.5 Status of first generation projects	48
IV -	PROPOSALS FOR A SECOND GENERATION PROGRAMME (1980-85)	51 to 67
	4.1 Overall directions	51
	4.11 Regional distribution	51
	4.12 Consolidation of irrigation	51
	4.13 Improvement of farmers' equipment	52
	4.14 Integration of complementary activities	52
	4.15 Further basic investigations, surveys	52
	4.16 Reducing dependence on foreigners	53
	4.2 Project proposals for the 1980-1985 period	54
	4.21 Kayes region	54
	4.22 Koulikoro region	54
	4.23 Sikasso region	55
	4.24 Segou region	56
	4.25 Mopti region	57
	4.26 Timbuktu region	58
	4.27 Gao region	59
	4.28 Office du Niger projects	59
	4.3 Recapitulative table of Office du Niger projects	64
	4.4 Recapitulative table of projects in the Second Irrigated Farming Programme in Mali (1980-1985)	65
	4.5 Observations on project proposals	66

ANNEXES

		Page
ANNEX A :		
	Information on Mali	70
	- Geographic location	70
	- Climate	70
	- Population	70
	- Industry, Mining, Infrastructure	71
	- Agriculture	72
	- Public finance	73
ANNEX B :	MAPS OF MALI	
	B1 - Administrative map	74
	B2 - Relief and hydrography	75
	B3 - Main existing or projected irrigated perimeters	76
	B4 - Office du Niger	77
	B5 - Zone covered by the Segou rice project	78
	B6 - Bani basin	79
	B7 - General layout of the plains secured by the Djenne threshold dam	80
	B8 - Map of developments in the lake zone	81
	B9 - Location of Tossaye and Labezanga dams	82
ANNEX C :		
	- Trend of prices from 1974 to 1978	83
	- Trend of daily earnings for agricultural work by main crops	84
	- Rice in West Africa	85
	- Short bibliography	86
ANNEX D :		
	Niger and Senegal River Developments	88
ANNEX E :		
	Project sheets (N°s. 1 - 7)	93 to 128

FOREWORD

At the third meeting of the Club du Sahel (Amsterdam, November 1978), it was recalled that the main objective of the development policy in Sahel countries is to increase crop production. The 1979 work programme thus gives priority to first generation projects for rainfed and irrigated farming. The meeting laid special emphasis on the need to prepare a second generation programme of irrigated farming projects in 1979.

Experts of the Club du Sahel (FAC, AID) and of the CILSS visited Mali from the 13th to the 27th of June 1979 to study the status of irrigation and irrigated farming projects with Malian authorities, to perform a general overview of the CILSS first generation programme, to analyze prospects and, finally, to compile the data necessary for drafing a second generation programme covering the period 1980 - 1985.

More concretely, the mission attempted to:

- analyze the main constraints, in the light of experience acquired on existing perimeters and to bring to light the constraints hampering the development of irrigation at the level of management of perimeters and at national level.

- to make concrete proposals to overcome these constraints and fill the gaps which hamper the implementation of a true irrigation policy.

- to identify the studies and projects available or under way.

- to gather all the data necessary for a set of new projects to be identified, in the light of the general planning work already performed by the CILSS (see in particular the reports of the Working Group on Irrigated Farming) In addition to projects already available or under study, these projects will, assuming they are approved by the Malian authorities, constitute the second generation programme:

- to specify the needs for executive staff at all levels (managers, accountants, agronomists, various technicians, advisory personnel, etc.) entailed by this programme, and to determine the training actions required.

- to sketch out the timing of the studies to be undertaken to implement each of the projects selected up to the feasibility stage.

This report is completed by an annex giving a short overview of the main data on the physical, human and economic resources of Mali, as well as its rural development policy, and showing the role played by irrigated crops in the economy and in national planning. According to WARDA(1), Mali remains the largest rice producer of the CILSS countries, and can be compared with other West African countries.

The potential for irrigated farming has been assessed for each region of Mali; irrigable land is available in abundance. The main constraints to the development of irrigation at present have been analyzed with particular emphasis on the Office du Niger (trend of production since its creation).

The proposals made for a programme of projects and studies have been developed in collaboration with Malian authorities of the Rural Engineering Directorate, Service of the Office du Niger and relate to actions which would be implemented in the short term (1980-85). They would constitute the CILSS second irrigated farming programme in Mali. These proposals are made for each administrative region, and separately for the Office du Niger; they are given in detail in specific technical sheets for each region.

Proposals for General Studies have also been made, especially for the development of the Niger river. A regional research and experimental project on wheat, in which Mali would participate (2), has been proposed.

The present report attempts to faithfully reflect the information and views conveyed by Malian authorities, as well as the contents of official documents submitted to or consulted by the mission.

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(1) West African Rice Development Association

(2) Wheat projects: see the report on "The Development of Irrigated Farming in Senegal", CILSS/Club du Sahel, October 1979, Annex F.

SUMMARY AND CONCLUSIONS

1. One of the main objectives of the 1974-78 five-year plan was to "meet the basic needs of the population, especially for cereals ..." At the end of the Plan, this objective had not been reached in Mali, since the real cereal deficit for the crop year 1978-79 was estimated at 80,500 tons - of which 40,000 tons of rice. The deficit in the prior crop year was 216,500 tons of cereal. Notwithstanding, the country's agricultural potential is considerable; it is evaluated at over one million hectares for irrigated farming.

2. In practice, Malian cereal production is heavily dependent on rainfall - this is also true of irrigated crops, over half of which are farmed using natural or controlled submersion, relying on the floods of the Niger, Bani and Senegal rivers. In 1979, the areas cultivated with full water control did not exceed 47,000 hectares (of which 39,000 hectares developed by the Office du Niger), providing a relatively low yield of 2 tons of paddy per hectare, of which approximately one half is marketed through official channels.

3. After the good 1976-77 crop year, the 1977-78 crop year fell below expectations because of too light rainfall. In 1978-79, it rained enough, but although early, the flooding of the Niger and Bani did not reach the level of normal years. The Senegal river also rose less than the previous year.

4. Accordingly, one of Mali's major objectives is to consolidate the production obtained through irrigated farming, i.e., to ensure that every year and whatever the level of the floodwaters, the plots under controlled submersion are supplied with enough water. A major programme for securing the supply to perimeters under controlled submersion has been under way since 1972, especially in the Mopti and Segou regions (Segou rice project, Mopti rice project) with the assistance of the FED, IBRD and the FAC. With a low investment per hectare secured, (200 to 500,000 MF/hectare), these projects have obtained worthwhile yields of 1 to 1.2 tons of paddy per hectare.

5. Land developed by Office du Niger remains the largest gravity-irrigated perimeter with full water control in the Sahel region, with 53,260 hectares developed between 1933 and 1965. Yields

have remained quite low - at 2 to 2.2 tons of paddy per hectare, of which 1 to 1.6 tons is marketed. Several problems account for this: defective drainage through lack of maintenance of networks, invasion of rhizome-carrying wild rice, lack of hydraulic infrastructure maintenance, under-equipment of settlers, and producer prices for paddy. These problems led to large areas of developed lands being abandoned: 13,690 hectares were not farmed in 1977/78 and 17,760 hectares in 1978/79!

The Malian Government wishes to remedy this position and to do so, a rehabilitation programme was put in hand at the end of 1978 with the assistance of the World Bank; technical assistance was provided, and a test 1,500 hectare rehabilitation project will soon be implemented; the technical records of this redevelopment will be available at the end of 1980.

6. Official producer prices offer inadequate incentives for intensification of rice farming and an increase in production and the area under cultivation. In these circumstances, farmers sell their products unofficially; the official marketing apparatus has handled only 5 to 6% of the total production of the regions, and 73% ofthe production obtained by the Office du Niger, in the last few years.

7. Actions to accompany irrigation programmes are curtailed through shortage of resources. This is the case for research, and experiments to follow up general development studies on the Niger and Bani, and the development scheme for the lake region. There are too few advisers, yet the needs for the next programme are enormous. If training is to be sustained and developed, it will have to be adapted to the realities in the field, and especially avoid the "bureaucratization" of cadres. Finally, permanent access roads are indispensable for the development of irrigated crops, especially in the central delta of the Niger and the lake region, whose isolation must be remedied.

8. On the whole, the first generation programme has not as yet advanced very far. The 1974-78 Plan had scheduled development of a total of 158,000 hectares (from full water control to development of lowlands)with work on a further 45,000 hectares to consolidate their production. Unfortunately, the ratios of achievement of these objectives were only 30% and 2% respectively. In addition, the studies put in hand are lagging behind seriously. As regards the Office du Niger, the meeting between donors and Malian authorities organized in September 1978 by the CILSS and the Club was useful: France and the Netherlands are supplying aid in addition to that already provided by the World Bank and the People's Republic of China, and other actions are under study by Germany, USAID, IFAD, etc. The technical

records of the first rehabilitation programme are being prepared by the World Bank, and will be ready at the end of 1980.

9. Project proposals for a second programme (1980-85) are made by the CILSS/Club du Sahel, in collaboration with Malian authorities. The main thrusts of this new programme are the regional distribution of activities, the consolidation of supplies to irrigated land under controlled submersion, the improvement of farm machinery, the integration of accompanying activities such as research, training, and health and, lastly, a major effort to free the country from dependence on foreigners for studies and the execution of work.

10. As regards the Segou rice project, covering 34,000 hectares at present and 40,000 hectares in 1980, priority will be given to the development of 11,500 hectares, as well as to building the Macina-Tenenkou road, and a rice mill with 15,000 tons capacity. The Mopti rice project already covers nearly 41,000 hectares, and the project identification documents are available. The construction of the Djenne threshold-dam on the Bani is scheduled together with the associated developments, i.e., approximately 16,000 hectares, plus the consolidation of 6,000 hectares already developed. Similarly, the programme includes the perimeters along the Macina-Tenenkou track covering 16,000 hectares, plus 5,500 hectares already developed, now to be consolidated. Various actions and studies are projected in the Tombouctou and Gao regions: their emergence from isolation is a necessity which goes beyond the framework of an irrigation programme, especially that of the lake region and the heart of the Niger delta. The programme of small dams in the Dogon district will be followed up.

11. The construction of the Selingue dam is continuing, and completion of work, anticipated for 1980-81, makes it necessary to secure financing of the downstream perimeter without delay. A sugar perimeter of 5,000 hectares is envisaged in the second Region, but the site has not yet been officially designated.

12. The cost of the Second Generation Programme (1980-85) for irrigated farming in Mali is estimated in 1979 at 175 billion Malian Francs for the work (US$ 405 million), and 3 billion MF for studies (US$ 6.9 million). This estimate includes approximately 50 billion Malian francs for the Office du Niger and 50 billion for the 5,000 hectare sugar perimeter.

    It is probable that some of the large projects envisaged in this programme will be completed after 1985.

CHAPTER I

STATUS OF IRRIGATED FARMING IN MALI

1.1 - POSSIBILITIES AND CHARACTERISTICS OF IRRIGATION

1.11 POSSIBILITIES; ENCOURAGING CIRCUMSTANCES

The prospects for irrigation are immense. Since the turn of the century, long-term objectives exceeding 1 million hectares of irrigated land have been envisaged. Nevertheless, after fifty years of effort, the results are only a low percentage of the target with developed areas under controlled submersion of 69,000 hectares and 50,000 hectares with full control over water.

1.111 Plentiful water resources

Each of the regions is at least partially fed by surface water, which, as a first approach, can be taken as exceeding the amount required in the long term for irrigation; these resources are well known for the Niger and Senegal, and are dealt with accurately in available monographs.

Nevertheless, the distribution of water resources within regions is far from uniform, and their mobilization for irrigation sometimes necessitates considerable infrastructural work (dykes, canals, pumping).

1.112 A long tradition of irrigation

Rice farming is rooted in the customs of the people living along the Niger river. Farmers approve of the efforts undertaken for its improvement. The burden of tradition nevertheless makes intensification difficult, and up to now, apart from declarations of principle, no major commitment has been made to farm lands so as to obtain two crops a year.

1.113 Land in sufficient quantity

Land resources do not appear to be a general constraint on the development of irrigation. Nevertheless, locally (e.g., in the Senegal Valley) it was impossible to find sufficient land for projects covering a few hundred hectares. In addition, in other projects (e.g., Mopti I) soils unsuitable for irrigation have been included in projects. An inventory must be carried out in this field.

1.114 Satisfactory conditions for civil engineering work

Although it is a land-locked country and has its problems of supply of basic materials such as cement, the cost of civil engineering work is rather lower than in the neighboring countries (Senegal or Niger); it is in order to stress the important role in standardizing prices played by the fact that much of the work was done by para-statal organizations (regie), a process that was facilitated by the creation of the OTER in 1974 (1).

1.115 Studies on location

The Rural Engineering Department has a large consulting office staffed with more than 15 executives (but only two draftsmen) which can study programmes and technical execution dossiers. Notwithstanding, some points still need strengthening (2): topographical work, podological studies and studies of the cost price of technical dossiers.

(1) OTER: Rural Equipment Organization

(2) The services of the consulting office which could be strengthened concern the following in particular:

. Topographical documents are not always fully reliable; the existence of specialized agencies and organizations in Mali could overcome this problem.

. Agronomic feasibility: it appears that some basic investigations relating to pedology, the suitability of soils for irrigation, experiments and relationships with research organizations are not always carried sufficiently far.

. Management of the file of studies: there is no analytical accountancy, even of a summary nature, showing the cost of conducting studies; moreover, the filing system makes the technical archives difficult to consult.

1.116 Competent staff

At technical level, a policy of training at home and abroad has been pursued for many years (National Engineering School, Katibougou agricultural school) and has resulted in the availability of executives with satisfactory technical competence. But the administrative structure of departments and projects does not lend itself to their optimum rise and it is hard to convince the best technicians to stay in projects.

1.12 THE MAJOR HYDRAULIC NETWORKS

Traditional irrigation is carried out on 130,000 hectares along the Niger and Bani rivers. The work of the Office du Niger in the 30's and 40's should have resulted in the irrigation with full water control of several hundred thousand hectares (1). In fact, over 53,000 hectares were developed, and at present, only 39,000 hectares are farmed (2). Since 1960, 60,000 hectares of perimeters under controlled submersion have been developed, especially in the Segou and Mopti areas.

The various forms of irrigation, their present status and the projects envisaged in every natural region are examined in detail below. Before turning to them, it is worth discussing the main characteristics of the major hydraulic networks and the structuring facilities which govern the type of developments involved.

Three broad types of system can be distinguished: the Niger-Bani axis, the Senegal river and its main tributaries, and finally, the independent networks (lowlands, ponds, small dams.)

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(1) In the central delta area of the Niger river alone, there is a project dating back to 1929, prior to the creation of the Office du Niger, covering the development of 960,000 hectares.

(2) Approximately 2,750 hectares of new sugar cane perimeters should be added to these 39,000 hectares of rice plantations.

1.121 The Niger-Bani axis

Almost 1500 km of the course of the Niger river lies in Mali and supplies water to the largest towns, which except for Kayes and Sikasso, are all located on its banks: Bamako, Segou, Tomboctou, Mopti and Gao.

Shortly after entering Guinea, it runs parallel to the Sankarani - on which the Selingue dam is under construction - then flows through rapids downstream from Bamako, where the Sotuba hydroelectrical power plant has been built, and becomes suitable for navigation from Koulikiro for several months of the year. The average annual flow at this point is 48 billion cu. meters (an equivalent continuous average flow of 1,550 cu. meters per second), the slackwater flow is 50 cu. meters per second from February until June, occasionally but rarely falling to zero, and the flood season is from July until October. The river then crosses the vast floodliable plains in the Segou region, before narrowing at Markala, where the threshold-dam supplying the Office du Niger developments is installed.

A vast delta into which the floodwaters discharge covers more than 85,000 sq. km; the town of Mopti is located in the center of the delta, where the Niger is joined by its main tributary, the Bani, which has a similar regime, with an average annual flow of 15 billion cu. meters. Beyond the delta lies a region of large lakes (lake Horo, Debo, Fati...) which fill and empty seasonally as governed by the fluctuations of the flood, which reaches its maximum height in November-December.

The Niger then makes a loop; at Timbuktu it has lost nearly half its flow; it then crosses the Tossaye Canyons, where there is a dam site, and passes through the parched Gao region where the width of the major bed is between 1 and 3 km. It reaches the border of the Niger after rapids at Ansongo and Labezanga, where there is another dam site.

The Niger is suitable for navigation from:
. July to October, from the Guinean border to Bamako and Koulikoro to Mopti; a lock enables boats to by-pass the Markala dam.
. September to January, from Mopti to Gao.

1.122 The Senegal river

The Senegal river is formed by the confluence of the Bafing - on which the Manantali dam site is located - and the Bakoye, both flowing from Guinea, and flows 200 km through a valley with occasional lateral spreading. At Kayes, the average annual flow is 20 billion cu. meters and the difference between the low water and flood elevations is over 10 meters. Very irregular tributaries flow into it from the Sahel countries on the right bank (Terekole and Kolombine.)

1.123 Independent systems comprising essentially:

- the lowland areas in southern Mali (Sikasso region).
- irregular flows in areas with relief which can be partially regulated with small dams (Dogon district).
- ponds which are used mainly for watering livestock.

1.13 STRUCTURES (existing, under construction or scheduled)

These dams on the Niger, Bani and Senegal rivers are generally multipurpose: improvement of navigation, regulation of low water flows, raised water level to permit gravity irrigation, and electricity output.

Other structures include the communications network, whose quality determines the boundaries of "useful" Mali, as opposed to the enclave part of the country.

1.131 Dams on the Niger River

a) The Markala dam: Downstream from Segou, this dam was completed in 1945. It is a mobile submersible dam, raising the water level of the Niger river for the gravity supply of the perimeters developed by the Niger Bureau. The entry into service of the Selingue dam will guarantee a substantial year-round flow, adequate for irrigation of more than 100,000 hectares.

b) The Sotuba dam: This small hydro-electrical run-of-river plant, near Bamako, is in competition with the Baguineda perimeter in the low-water period. This constraint should be removed when the Selingue dam enters into service.

c) The Selingue dam: This dam is under construction on the Sankarani, approximately 150 km upstream from Bamako. When completed in 1981, it will enable the low-water rate of flow to be regulated at approximately 160 cu. meters per second and yield an output of 180 GWH of electricity (see annex sheet).

d) The Tossaye dam: The Tossaye site is undergoing a feasibility study for a dam which would yield an output of 70 GWH. Regulating the downstream flow will facilitate the extension of the perimeters in the Gao region, and the eddy current upstream could strengthen the supply of water to structures in the Timbuktu-Dire region.

e) Labezanga: A dam site has been identified there. Its sole function would be to produce electricity. This project would compete with the dam projected at Kandadji on the Niger.

1.132 Dams on the Bani

The study and construction of these threshold-dams should be executed rapidly in order to consolidate irrigation in the MOPTI and SAN zones.

- The Talo and Djenne threshold dams: These dams are under study by the Rural Engineering Department, for completion in the medium term to guarantee an adequate supply of water - whatever the level of the flood - to perimeters irrigated under controlled submersion in the SAN and Mopti areas.

- Dam on the Upper Bani: Several sites (Bagoe, Baoule I and II) have been identified on the upper Bani for dams to regulate the discharge of the river and produce approximately 400 GWH of electricity. (reconnaissance study, II - NUOVO-CASTORO).

1.133 Dams on the Senegal River

- Manantali dam: With a useful reservoir capacity of 10 billion cu. meters, this dam designed by the OMVS is expected to produce 800 GWH with a guaranteed capacity of 100 MW; it will also regulate the flow of the Senegal river to 300 cu. meters/s, which will allow several hundred thousand hectares to be irrigated and improve navigation from Saint-Louis to Kayes.

  In the near term, however, this dam has little impact on irrigation in Mali.

- Other dams: Other dam sites have also been identified, but their construction is projected in the very long term: the Gabugo dam, with a capacity of 30 billion cu. meters which will regulate the Senegal river at 440 cu. meters/s and produce 1520 GWH; while run-of-river plants supplied by the Folou and Gouina dams would produce 400 and 560 GWH respectively.

1.134 Communications: (See annex A, 1.4 - and general map)

Setting aside air links, there are:

- roads, which if not tarred, can hardly be used in the rainy season. There are tarred roads in Southern Mali and on the Bamako-Segou-Mopti axis, with a few feeder roads.

- the Koulikoro-Bamako-Kayes-Dakar railway, whose capacity is saturated and whose operating reliability is known to be less than 100%.

- navigation from Koulikoro to Mopti, and from Mopti to Gao a few months a year. It is of interest mainly for transporting traditional economic goods (salt, fish...) and some pulverized products. However, its seasonal nature and the discontinuities arising from transshipment make navigation an unsuitable medium for regular supply of the modern activity sector.

Accordingly, it has been accepted that unless reliance is placed on good roads which can be used all year round, it will be very difficult to promote the general development of irrigated farming: this applies to enclave zones, such as the first region (Kayes, Yelimane, Nioro), the sixth region (Tombuctou, Dire-Goundam) and the seventh region (Gao, Bourem, Ansongo).

Similarly, the development of areas such as Office du Niger perimeters and the Delta north of Mopti, is greatly hampered by communication problems in the rainy season.

1.14 THE MAIN SYSTEMS OF IRRIGATION

Various types of irrigation are in use in Mali:

- traditional irrigation under natural submersion, on 120,000 hectares
- traditional irrigation during the subsidence of the river, on 25 to 40,000 hectares
- improved irrigation under controlled submersion, on approximately 60,000 hectares
- irrigation with full water control on 50,000 hectares, of which 42,200 hectares developed by the Office du Niger.

1.141 Irrigation using natural submersion is to be found chiefly in the plains of the Niger and the Bani Rivers. The rice germinates under rain and grows when the floodwater rises. "Floating" rice is generally subject to uncertain climatic and

hydrological conditions. Yields are low, at 480 to 700 kg per hectare and could be improved only with difficulty. Possible actions are very limited (distribution of selected seeds, participation in the construction of small dams...) and it does not appear that any substantial improvement is to be envisaged.

1.142 Crops farmed in the subsidence period include sorghum, corn, which is sown after subsidence begins, and in the lake region, rice ("Kobe" rice) which is replanted in shallow ponds: these crops grow drawing on the residual humidity, and in the case of "Kobe" rice, at the end of the cycle, from the beginning of the rainy season. These crops are subject to the uncertainties of the river and are very vulnerable to birds, and as they grow out of season, their yield is low, varying between 0 and 800/900 kg per hectare.

Systems providing control over the subsidence of the river through the installation of dams on off-take channels are envisaged in the lake region; they would yield marked improvements at a very low cost (200,000 to 300,000 Malian francs per hectare).

1.143 Improved irrigation under controlled submersion was mainly introduced after 1960. It consists of controlling the rising of the water level after germination of rice, as required by the stage of plant growth, through a system of dykes, canals and cofferdam structures, valves and screens against rice-eating fish.

This system allows large improvements in yield to be obtained at a relatively low cost, 200,000 to 500,000 Malian francs per hectare, as it does not require "plot by plot" development. In good years, the yield can reach 1.5 tons or even 2 tons per hectare. This system has been implemented in the following regions in particular:

- Sikasso, through improvement of low land covering several thousand hectares
- Segou , in the "Mopti I rice" projects, which is being followed up by the Mopti II rice project covering 41,000 hectares.

Experience in the last few years has shown that in spite of its advantages of low cost, speed of implementation and simplicity of management, this type of development must be kept under close scrutiny, and in many cases renewed.

Some of the problems met in the Mopti II project will serve as an illustration:

- The preliminary studies were inadequate: over 5,000 hectares of the 31,000 scheduled could not be developed because of unfavorable or unsuitable topographical and podological characteristics.

- The original structures, fitted with cofferdams or screw gates had to be re-fitted with rack gates.

- Farming activities must be carried out simultaneously by all farmers on the same tract, which involves a substantial quantity of machinery used for only a short period.

- The flood waters do not rise everywhere, and some plots have been adequately submerged only once every seven years; in 1977/78, over 5,000 hectares were cultivated but not irrigated.

- The uniform rising of the water level on plots which are sometimes larger than 5,000 hectares necessitates the use of relatively unproductive varieties of floating rice in the lowest zones.

- Average yields are still low at 1,149 kg/hectare in 1975/76, 1,875 in 1976/77, 884 in 1977/78 and 1,000 in 1978/79. Farmers' incomes are too low to allow them to pay for the fertilizers whose use could generate a substantial increase in production.

- Seed quality is not guaranteed.

In both the "Segou rice" and "Mopti rice" projects emphasis is now laid on consolidating irrigation rather than extending it. The following developments in particular are envisaged for this purpose:

- recalibration of structures for better water supply and efficient control of variations in water level

- deep ploughing to extract self-sown roots

- agricultural machinery for the improvement of crop dressing

- In the long term, threshold-dams will be installed on the Bani river to guarantee the water supply of plots.

1.144 Irrigation with full water control

This system guarantees water supply and drainage as to both elevation and rate of flow. These developments therefore involve individual smoothing of plots and a fairly fine system of distributing channels and drains.

Up to now, the large-scale practice of irrigation with full control over water has been limited to the Office du Niger, whose main infrastructure was designed to irrigate 150,000 hectares. Development was carried out by tract over approximately 53,000 hectares, of which only 39,000 hectares are farmed today; 14,000 hectares were abandoned for various reasons (problems of drainage, intrusion of red rice, etc.) The great advantage of the Office du Niger is that both water supply and drainage can be performed everywhere by gravity (the pumping stations presently supplying sugar cane perimeters are provisional).

Another perimeter of approximately 1,100 hectares is also to be supplied by gravity, just downstream from Selingue.

Limited experiments on irrigation with full control with pumping are also in progress in the following perimeters:

- San perimeter, 1,000 hectares equipped but with only 150 hectares farmed for rice and fodder crops and a little cultivation.

- Dire perimeter, with 100 hectares equipped in 1979, to be increased to 300 to experiment on wheat farming.

- small perimeters in the Kayes region for market gardening crops and some polyculti-vation.

Without going into details on these various perimeters (see annexes) it can be said that pumping is a heavy cost, and the charge per cubic meter of water (5 to 10 Malian francs) prohibits the growing of cereals.

Apart from the problems raised by pumping, the main characteristics of irrigated farming with full water control are:

- the possibility of growing more than one crop per year. The prospects for intensification, although advocated in many projects, have not yet taken root, and no major experiments have yet been undertaken.

- Yields, which should reach 6 to 8 tons per hectare on experimental plots, and 5 to 6 tons in practical farming, are still low. In the best years, the Office du Niger obtained below 2.5 tons per hectare, for several reasons (poor smoothing, difficult drainage, invasion of weeds, non-respect of the agricultural calendar, insufficient experiments with varieties, etc.).

- Infrastructural costs are much greater than for controlled submersion, amounting to some 2 to 3 million Malian francs per hectare.

Other aspects more specifically related to the Office du Niger will be reviewed in the section devoted to this development.

NS: Natural submersion
CS: Controlled submersion
FC: Full water control

MAIN CHARACTERISTICS OF IRRIGATION IN MALI :

Possibilities, existing projects and productions, prospects

October 1979

Name of the area	Projects under way	Irrigable potential in thousands of hectares	Irrigated land in 1976/77 (in thousands of hectares)			Long. term irrigation prospects (year 2000)			Paddy production (in thousands of tons)	
			NS	CS	FC	NS	CS	FC	1976	Long term prospects
Niger River Loop (Gao, Tombuctou)	Rice-sorghum operation	60	16	1	-	8	10	5	9	22
Lacustre zone (Dire-Goundam)	Wheat project	100	19	1	-	5	10	12	11	56
Dead delta (Niger Bureau)	Niger Bureau	250	-	3	42	-	0	106	99	275
Centre delta		100	55	-	-	45	0	-	25	20
Mopti	Mopti rice projects I and II	100	5	16	-	2	20	10	24	113
Segou	Segou rice project	150	10	34	-	2	54	5	54	140
Southern Mali (Sikasso)	Sikasso rice project	70	11	3	2	4	4	5	12	48
Upper Niger Valley (Bamako)	Middle and upper valley project	100	2	2	1	0	7	8	6	31
Upper Senegal Valley (Kayes-Bafoulabe)	Irrigated farming project (IFP)	25	8	0	-	0	4	4	4	15
Kolombine-Terekolle (Yelimane-Nioro)		25	5	0	1	0	13	0	4	16
Other zones		20	5	9	2	5	9	2	12	12
TOTALS		1,000	132	69	47	71	131	157	262	748

1.2 - EXISTING PROJECTS AND PROSPECTS

The documents established by the Club du Sahel/CILSS Working group on Irrigated Farming in May 1977, divided Mali into several homogeneous natural regions and classified actual and potential irrigated land within each zone (see map B3 in annex).

The table on the previous page gives the main characteristics of irrigation by zone in Mali: possibilities, existing projects and production, and long-term development prospects for the year 2000.

In the light of the new administrative divisions, an analysis by region of irrigation is given below, showing the main features of developments under way, projects envisaged, as well as the funds needed for the corresponding work and studies.

The characteristics of the projects scheduled in the second generation programme of the CILSS/Club du Sahel are given in Chapter IV and in the technical notes.

1.21 KAYES REGION (1st region)

The efforts of the OPVSTM (Terekolle-Magui perimeter project in the Senegal Valley) have been in three main directions:

a) pursuance of irrigation of small perimeters by pumping in the Kayes region, where production consists mainly of market gardening crops. Operating costs are high and in 1978, of 131 hectares developed, only 45 were farmed, with a forecast of 91 hectares for 1979. In addition to proposals for pumping from the Senegal river, there are problems of finding outlets for market-gardening crops. The small Sapou perimeter seems to be the only one that is farmed on the total area developed.

b) Projects funded in particular by Kuwait are under way: a rice growing basin of 400 hectares can be developed in the near term.

c) North of Kayes, a major integrated development survey has been under way since 1976 in the Kolombine-Terekolle region, financed by Germany. Development of subsidence-period cultivation is envisaged in large depressions such as lake Magui.

1.22 KOULIKORO REGION (2nd region)

The market gardening perimeter in Baguineda (1) is the main existing earliest perimeter. It is under renovation and up to now has been farmed over several hundred hectares. Fruit and vegetables for the export market are grown on this tract, which should be extended progressively to 3,000 hectares.

The perimeter downstream from the Selingue dam is scheduled to be installed in the near term, covering 1,200 hectares to be harvested twice yearly (cost, 4 million Malian francs, financed by the FED). The implementation was to have been completed by the end of 1979.

Finally, a feasibility study is under way for a sugar perimeter of 5,000 hectares in the Bankoumana area (cost, about 50 billion Malian francs).

1.23 SIKASSO REGION (3rd region)

In general, small developments on plains of several hundred hectares are involved. They entail no major technical problems: funds would be provided by the FED.

1.24 SEGOU REGION

Apart from the Office du Niger, this region is covered essentially by the Segou rice project, which has been developed under controlled submersion over 35,000 hectares.

Projects in the near future mainly concern the completion and consolidation of developments with the construction of rice mills and tracks. The whole programme is estimated to cost 15 billion Malian francs. It is already partly financed by the FED.

A survey program complementing this working programme consists in particular of a threshold-dam on the Bani at Talo and the irrigation of the corresponding plains.

A special effort must be made in this region, whose irrigable potential is close to 200,000 hectares and where the farmers have reached an adequate level of technical capability.

(1) The Baguineda tract was developed in the 1930's, before the construction of the Markala dam.

1.25 MOPTI REGION (5th region)

Mopti is in the middle of the Niger Delta, and this region has major resources of land, water and qualified farmers. It can only be fully developed if access to the many zones concerned is opened up by all-weather tracks.

At present, the area developed stands at 40,000 hectares; the estimate of irrigable potential is approximately 130,000 hectares. The unit cost of development (apart from structural work) is of the order of 400,000 Malian francs per hectare.

In the Rural Engineering Department's programme, priority developments consist of the Djenne threshold-dam on the Bani river, the construction of a track from Macina to Tenenkou and the development of some 40,000 hectares between 1981 and 1987, at an estimated aggregate cost of 40 billion Malian francs (1979 prices).

The cost of studies necessary for the completion of the Djenne threshold dam and the preparation of feasibility studies for perimeters of the first phase is estimated at 900 million Malian francs by the Rural Engineering directorate.

Several small dams with irrigated perimeters can be found in the Dogon district, close to Mopti, whose topographical aspect is entirely different from that of the wide plains of the Niger river (the sandstone cliffs of Bandiagara...). The Rural Engineering Department is proposing an additional small dam construction programme at an annual cost of 180 million Malian francs (corresponding approximately to 3 dams) between 1980 and 1990. The need for financing for surveys over the next three years would be of the order of 60 million Malian francs.

1.26 TIMBUKTU REGION (sixth region)

In this extremely enclosed region, to which road access is extremely difficult, many trials have been attempted since 1920, of which one is an irrigated perimeter growing wheat on more than 5,000 hectares. The results have generally been disappointing and wheat farming experiments are presently under way at Dire and Kessou, with several projects for development of ponds.

According to the Rural Engineering Department and in the light of the reconnaissance already performed, an annual pace of development of 3,000 hectares of ponds at 150,000 Malian francs per hectare and 1,000 hectares of irrigated perimeters at 2,000,000 Malian francs per hectare could be envisaged for the next Plan, i.e., a budget of 2.5 billion Malian francs per year.

Additional reconnaissance surveys using the earlier maps prepared by the Office du Niger would cost 500 million Malian francs.

Approximately 4 billion Malian francs should be added to these figures for the construction of a track from Korientze to Niafunke, which is an indispensable precondition for any large-scale development.

In the longer term, there are important prospects for the development of several tens of thousands of hectares around Lake Horo and Lake Fati.

1.27 GAO REGION (7th region)

In this essentially desert region, only the main bed of the Niger river can be developed, and even then with difficulty, as embankments would have to be built and pumping would often be necessary if irrigation is to be guaranteed.

Irrigation experiments using small motorpumps have been carried out and some embankment construction has been executed using AID credits.

Feasibility studies covering approximately 4,000 hectares will soon be available and the corresponding programme of work (the preliminary estimate is 4 to 9 billion Malian francs) should be launched during the next Plan.

Additional prior studies for the 2nd generation programme will call for credits amounting to 200 million Malian francs.

1.28 THE OFFICE DU NIGER

In 1979, the largest irrigation project with full water control to have been developed in the Sahel countries and West Africa is still the Office du Niger development.

1.281 Main characteristics (1)

The Office du Niger was created in 1932 to execute an irrigation project covering 960,000 hectares; in practice, it installed a major hydraulic infrastructure for the gravity irrigation of 150,000 hectares. The maximum area developed, was reached in 1964 with 53,260 hectares.

However, since the beginning of the 70's, area cultivated has fallen continuously: it was 39,567 hectares in 1976/77, and declined to 35,500 hectares of paddy in the 1978/79 crop year, and 2,775 hectares of sugar cane grown on recently developed perimeters, provisionally irrigated by pumping. It may also be recalled that cotton growing was abandoned by the Niger Bureau in 1970. The only two crops now harvested are rice - by farmers - and sugar cane - using an industrial system.

1.282 Production

1.282 Rice is now the main crop produced by the Office du Niger, although its original aim had been cotton growing. The area planted to rice increased from 165 hectares in 1934-35 to 39,838 hectares in 1970-71. It remained at that level until 1977-78. During the last crop year 35,500 hectares were farmed. Yields were relatively low for many years, at 18 quintals of paddy per hectare in 1959-60, for a total crop of 60,000 tons. At the end of the 60's, the Office du Niger was confronted with serious problems: total production was barely 40,000 tons of paddy. Since that time, there has been a spectacular recovery; the number of settlers has increased from 30,000 to 51,000 and paddy production has risen to 90,000 tons, i.e. 40% of national production. Of its total production

(1) See report of CILSS/Club du Sahel, "Office du Niger: Rehabilitation project". (J. Le Bloas and D. Diamoutene, Sept. 1977) and "Office du Niger: identification report," June 30, 1978, IBRD.

the Office du Niger marketed 65,000 tons in 1976/77, or 2/3 of the volume marketed through Malian official channels. The revival since 1971 is due especially to the transfer to settlers of large areas earlier cultivated by a parastatal administration ("regie"), the conversion of cotton into rice fields, the inflow of new settlers after the period of drought, better producer prices, the introduction of fertilizers, the extension of new techniques, and finally, better management.(1)

The crop collected in the last 1978-79 crop year amounted to 52,000 tons of paddy, which was a slight fall by comparison with the two preceding harvests (65,500 tons in 1976-77).

1.2822 Sugar cane plantations have been one of the objectives of the Niger Bureau since the beginning of the 60's, to be located around two centers: DOUGABOUGOU which since 1964 has an experimental refinery capable of processing 4,000 tons of sugar, and SERIBALA which has a 15,000 ton refinery since 1976. At present, the two sugar perimeters cover 2,775 hectares out of a developed area exceeding 3,700 hectares.

The low yields obtained at the beginning in Dougabougou (45 to 60 tons of sugar cane per hectare) have been greatly improved at Seribala, where present yields range between 75 and 110 tons per hectare.

Sugar cane production in the 1978/79 crop year amounted to 210,000 tons, yielding 20,000 tons of sugar.

1.2823 Other activities

The Office du Niger also grow market gardening crops for local consumption. It is envisaging the cultivation of "long silk" cotton on the Mema perimeter, Northeast of Kouroumari, and has

(1) See chart in Annex showing trends in the area sown to rice and the amount of paddy harvested by the Office du Niger since 1933.

proposed a project covering 4,000 hectares. Japan could be interested in financing this.

Finally, various forms of animal breeding are undertaken by the Office du Niger (1).

1.283 Need for the rehabilitation of the Office du Niger perimeters

For many years, the Office du Niger has been confronted with serious problems whose most visible features are: the deterioration of the hydraulic infrastructure, a growing area of rice fields abandoned (2), a yield of approximately 1 ton of paddy harvested per hectare (3), and problems of management. These difficulties are reviewed in Chapter II.

In order to restore the position and draw maximum benefit from this tool of production, exceptional in several aspects, the Malian authorities requested World Bank assistance in 1977 and presented a set of rehabilitation programmes to the CILSS/Club du Sahel.

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(1) Livestock requires the sub-products of agriculture for fattening cattle, and for hog and sheep breeding, i.e., molasses, the white stems of sugar cane, and straw and flour derived from rice and bran. Two beef fattening centers have been in operation since 1971 and marketed a maximum of 1,922 heads of cattle in 1973. In addition to oxen for ploughing, settlers rear animals to meet their meat and milk requirements. The rice fields are used by nomads as pasture land for their herds in the dry season.

(2) 13,260 hectares of rice fields developed but uncultivated in 1976/77; more than 17,000 hectares in 1979.

(3) With a maximum yield of 1,650 tons of paddy harvested per hectare (1976/77).

In November 1978, a meeting between donors and Malian authorities delegated by the Ministry for Rural Development, was held at Segou (Office du Niger headquarters), sponsored by the CILSS/Club du Sahel. This meeting was especially useful: its results are presented in Chapter III, 3.4 (1) below.

It should also be stated that activity begun in December 1978 by the World Bank, in the framework of phase I (end 1978 - end 1980) involves a two-year technical assistance programme, a test survey of 1,500 hectares to be rehabilitated and the preparation of the technical data for phase II.

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(1) See the minutes of the meeting held at Segou, 13th to 16th November 1979. Club du Sahel report No. SAHEL CR(78)15.

1.3 - IRRIGATED CROPS AND NATIONAL NEEDS

Cereals such as millet, sorghum and rice play an essential role in the Sahel population's food supply. Rice is particularly essential, as Mali is the first producer among Sahel countries: 262,000 tons of paddy in 1976 and 209,000 in 1978/79.

Production of sugar, fruit and market gardening crops is rising slowly.

1.31 A VARIABLE ANNUAL RICE CROP

Mali has the largest area cultivated to rice among CILSS countries. It was assessed at 223,000 hectares in 1976 against 81,000 hectares in Senegal, which is classified by WARDA (1) as the next largest country in terms of land cultivated and output.

Production fluctuated from year to year. The figures for the crop years 1967-78 to 1978-79 are presented in the table below.

	67-68	70-71	71-72	72-73	73-74	74-75	75-76	78-79
Est. production in thousand tons	171	137	157	116	130	250	280	209
of which, marketed	35	40	52	47	59	85 (2)	83	?

(Data submitted by the Ministry of the Plan)

Production is dependent on rainfall and more particularly on the rising of the river floods for perimeters under controlled or natural submersion. These systems are still used on 81% of the irrigated area in Mali (201,000 hectares out of a total of approximately 248,000 hectares in 1979).

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(1) WARDA (West African Rice Development Association, with headquarters at Monrovia, Liberia). See WARDA Yearbook July 1978.

(2) During the 1974-75 crop year, the volume marketed suddenly rose to 85,000 tons when the price per kg of paddy was increased to 40 Malian francs. It had been unchanged at 25 Malian francs per kg since 1970.

By reason of these fluctuations, Mali launched a major hydro-agricultural programme which consists mainly of consolidated perimeters under controlled submersion.

1.32 GROWING DEMAND FOR SUGAR AND CEREALS

The trend identified by the Working Group in Irrigated Farming in 1976-77 has been confirmed: there is growing demand for rice, corn, millet and sorghum, and for sugar.

In 1976, the deficits were estimated at:

Paddy rice	:	35,000 tons
Wheat	:	21,000 tons
Sugar	:	39,000 tons
Other cereals	:	25,000 tons

In December 1978, the Malian Government estimated the cereal deficit at: (1) (1978-79 crop year)

Paddy rice	60,000 tons
Millet,sorghum,corn :	41,000 tons

The cereal deficit in the preceding crop year was 216,500 tons, which corresponds to the food requirements notified in November 1978 at the Amsterdam meeting.

Sugar production in 1978-79 is estimated at approximately 20,000 tons, involving a deficit of 30,000 tons.

Wheat production in 1978-79 was almost negligible and is still at an experimental stage. The deficit may amount to some 24,000 tons.

1.33 CEREAL PROGRAMME OBJECTIVES

The cereals policy adopted by Mali in 1974 is characterized by three basic objectives:

- independence vis-a-vis foreign sources, to be achieved by increasing agricultural output in order to avoid any imports in average years (elimination of the "structural deficit").
- better secured supply, whatever the climatic conditions.
- equal status for all consumers as regards cereal prices and security of supply. This entails a marketing

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(1) Document of the Ministry for Rural Development, presented at the CILSS/Club du Sahel meeting in Amsterdam.

policy under which the OPAM (Agricultural Production Bureau of Mali) controls at least 50% of all transactions, and stores 70,000 tons as a safety reserve.

The basic means for obtaining these objectives were:

1.331 A policy of producer prices such that producers can mechanize with a balance between cash crops and cereal.

1.332 An ambitious hydro-agricultural development programme involving mainly:

- the renovation of infrastructures and the extension of irrigated areas with full control over water of the Niger Bureau.
- consolidation and extension of areas developed under controlled submersion (the Segou and Mopti rice projects).
- a substantial programme of small low ground developments in the South.
- experimental development of activities in the Kayes, Tombuctou and Gao regions.

1 333 Actions to raise productivity carried out by institutions created for each particular ecological zone ("Projects" or "Activities").

- increase in output of rainfed crops: intensification, generalization of cash crops, cereals rotation, to derive benefit from the residual effect of fertilization, improvement of dressings (soil preparation and weeding), use of selected seeds and fertilizers.
- consolidation of rice fields, with an increase in the size of the areas irrigated with full control over water, which is a precondition for the security of extension of technical methods such as the preparation of furrows for seeds, the use of selected varieties, linear replanting, fertilization, etc.

1.334 A complementary programme including:

- follow-up of agronomic research on the improvement of varieties and farming methods suitable for each zone.

- experiments: two-harvest irrigated farming, participation of producers in the management of machinery, etc.

- supply of seeds by a specialized organization.

- preparation of projects at an adequate pace.

1.34 PRODUCTIONS: RESULTS OF THE CEREALS PROGRAMME (1974-78)

Overall, agricultural statistics and the follow-up of projects have been inadequate and given the lack of reliable data, the three following crop years are taken as a basis: reference year, 1971-72, year 0 of the Plan, 1973-74 (which was particularly bad climatically) and 1978-79, the last year of the Plan.

1.341 Cereal production: aggregate figures

The production forecast and out-turn in these last three crop years is summarized in the table below, for irrigated rice and rainfed millet, sorghum and corn.

in 1000 tons		Crop years 71-72	73-74	78-79	Trend in 1000 tons	Production 78-79 in %	
Paddy rice	Forecast	194		330	+136	+70	
	Produced	194	159	209	+ 15		+ 8
Millet-sorghum-corn	Forecast	808		1139	+331	+41	+
	Produced	808		1387	+513		+72
Total cereal crop (millet, sorghum, corn and rice (1)	Forecast	934		1354	+420	+45	
	Produced	934		1523	+589		+63

(1) 100 kg of paddy = 65 kg of manufactured rice.

These figures call for the following remarks:

As regards rainfed cultivation, the increase in production is slightly higher than forecast, in part because of the abundant rainfall of 1978 but mainly through the extension of cereal perimeters (1,777,000 hectares in 1978-79 as opposed

to 1,361,000 hectares in 1971-72.) Yields are still generally low: 751 kg per hectare in 1978-79, compared with 627 kg/hectare in 1971-72.

Paddy production has only risen by 15,000 tons. However, it may well be that the low yield obtained by the Office du Niger in 1978-79 (65,000 tons as opposed to 85,000 tons) is accidental, and that normal level of national production is in the vicinity of 230,000 tons, with an increase of 36,000 tons, i.e., 18% of 1971-72 production, but only 25% of Plan objective (+135,000 tons).

1.342 Trend of paddy production by major zones

The official figures on the increase in the area under cultivation (a in thousand hectares), yields (y in kg per hectare), production (p in thousand tons) and marketing (m in thousand tons) are as follows for the 3 crop years studied, of which two fall in the 1974-78 five year plan period.

Zones and projects	CROP YEARS												Change from 1971 to 1978			
	71/72				73/74				78/79							
	A	Y	P	M	A	Y	P	M	A	Y	P	M	A	Y	P	M
Southern Mali Sikasso rice project	15	1,100	17	-	15	1,000	17	-	15	1,385	21	-	0	+285	+ 4	-
Segou rice project	32	1,000	32	-	(1) 5.2	1,560	8.0	3.1	24.2	1,600	39	(8.0)	(2) -8	+600	+ 7	+ 8
Upper Valley Upper Valley project	2	600	1	-	3	800	2.5	-	6.8	(3) 300	2	-	+5	-300	+ 1	-
Delta																
Mopti rice project	5	1,394	7	2	(1) 3.9	948	3.7	0.5	18	1,000	18	(3.0)	13	-394	+11	+ 1
Other projects	61	754	46	-	31	750	23	-	60	750	45	-	-1	- 4	- 1	-
Sub-total	66		53	2	35		27	0.5	78		63	3.0	+12		+10	+ 1
Office du Niger	40.5	1,564	63	46	40.1	2,071	83.1	54.8	37	1,756	65	(50.0)	- 2	+192	+ 2	+ 4
Lake Zone	16	1,200	19	-	(16)	(1,000)	(16)	-	14	920	13	-	- 2	-280	- 6	-
Sahel Zone V.S.T.M. project	2	500	1	-	(2)	(500)	(1)	-	2	500	1	-	0	0	0	-
7th Region	11	700	8	-	(7)	(700)	(5)	-	7	700	5	-	- 4	0	- 3	-
GENERAL TOTAL	184	1,054	194	48	123	1,292	159	59	184	1,135	209	61	0	81	+15	+13
Indexes A	100				67				100							
Y		100				123				108						
P			100				82				108					
M				100				123				127				

(1) Land harvested in years of low flood levels

(2) There is a reduction by comparison with the theoretical rice-growing area (supervised and unsupervised) in the zone. In practice, the perimeters receiving technical services from the ORS increased from 11,000 hectares in 1971-72 to 30,000 hectares of rice fields in 1978-79.

(3) Yield calculated on basis of area sown, not area harvested (cessation during flood season).

The rise in production stems from the increase in productivity, not an increase in the area developed. The aim of the programme of large projects was that Mali would have developed in part or in full 225,000 hectares; in 1979, just half of this figure had been reached, i.e., 112,000 hectares. Some developed areas were abandoned, in particular by the Office du Niger, or were not harvested by reason of low floodwater levels.

Average yields have risen by 81 kg per hectare but are still generally low on average, at 1,135 kg per hectare in 1978-79, and there are substantial differences between regions: almost 2 tons per hectare is reached by the Office du Niger, 1.5 tons per hectare for the "Sikasso and Segou" rice projects, but less than 1 ton per hectare in the rest of the country.

1.343 Trend of yields in rice farming

The increase in production is real, but very low, with a tendency to reach a ceiling at the Office du Niger and in the Segou rice project, which had produced excellent yields.

Trend of average yields over 7 years for the main projects is summarized in the following table:

Kg/ha

	71-72	73-74	74-75	75-76	76-77	77-78	78-79
Mali, total	1,054	1,292					1,135
Office du Niger(1)	1,807	2,071	2,109	2,254	2,385	2,662	1,700
Segou rice project	1,000	1,560	1,750	1,730	1,400	1,316	1,600
Mopti rice project	1,394	500	1,397	1,149	1,475	884	1,000
Sikasso rice project	1,100	1,550	1,728	1,883	1,880	1,280	1,385

(1) A diagram in the Annex gives the trend of "harvested production" at the Office du Niger between 1933 and 1979.

It should be observed that no attempt has been made to increase productivity through double annual harvests in Mali.

1.344 Marketing of Paddy

In 1978-79, the percentage of total cereal production sold by producers at official prices was only:

- 3% of millet, sorghum and corn production
- 7% of paddy production, other than the Office du Niger
- 73% of the Office du Niger production (in 1976-77) . (1)

The OPAM was thus only able to market 72,000 tons of paddy - of which close to 60,000 tons grown by the Office du Niger, i.e., 29% of all transactions and only 60% of the Plan objective of 120,000 tons.

In addition, only 17,000 tons of the projected reserve of 70,000 tons was actually stocked, which is much too little to face up to problems of supply during droughts, whereas it has been estimated that almost 50,000 tons were exported by Mali in the last few years.

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(1) A diagram in the Annex gives the trend of "harvested production" at the Office du Niger between 1933 and 1979.

CHAPTER II :

II - CONSTRAINTS TO THE DEVELOPMENT OF IRRIGATED FARMING

2.1 REGIONS AND GENERAL IRRIGATION POLICY

2.11 CONSTRAINTS ASSOCIATED WITH PARTIAL WATER CONTROL

At present, irrigation under controlled submersion covers close to 70,000 hectares, natural flooding 130,000 to 150,000 hectares, and approximately 47,000 hectares are irrigated with full water control.

Depending on the year, almost 2/3 of national paddy production originates in perimeters which do not enjoy full water control.

In these circumstances, the importance for the rice crop of rainfall and of the timely arrival of the floods can be readily understood, as well as the emphasis laid by the Authorities on consolidating the perimeters operating under controlled submersion.

The table on the next page illustrates the importance of these elements in the last 6 crop years.

2.111 Evolution of rainfall in the main ecological zones in Mali

	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79
Sudan and Sahelo-Sudan zones: CMDT - OACV - OHV - ORS zones	Very low	Average to fair	Just adequate	Quite good to good	Just adequate	Average to strong
Sahel zones Millet in Mopti - CEDIK - OUSTM Mopti rice project	Poor	Average to fair	Poor to just adequate	Poor to just adequate	Poor to just adequate	Just adequate
Sahel zones on the loop of the Niger river, lake zone and 7th region	Poor	Average	Fair	Fair	Fair	Fair

2.112 The floods of the Niger and Bani rivers in rice plantations under controlled submersion, from 1973 to 1978

Segou rice project	Very low	Average	Average to strong	Low to average	Very low	Average
Mopti rice project	Very low	Strong	Average	Low to average	Low	Average to strong

In summary, it may be said that the 1973-79 period was:

- normal in the Sudano-Sahelian zone with good years making up for the bad ones.
- difficult in the Sahel zone where continuous drought conditions persist.
- reasonable in the "loop of the Niger".
- below average for the Segou rice project and acceptable for the Mopti Rice Project.

2.12 CONSTRAINTS ASSOCIATED WITH PRICE POLICY

Between 1974 and 1978, paddy producer prices rose by 46%, reaching 50 francs a kg in 1978, and 60 francs a kilo in 1979; these are real prices, i.e., the weight average of prices as between the icial and parallel markets.

During this period, the price of agricultural equipment rose by more than 200%, and fertilizers by 62 to 75% (see the table on the trend of prices in the annex).

This price policy induced a fall in groundnut production and the extension of cereal planting at the expense of the objectives of intensification. Official producer prices do not act as incentives.

This was particularly felt at the Office du Niger where settlers are obliged to market their produce in excess of the family's food supply at "official prices", which are much lower than on the free market, in spite of the fact that inputs are not subsidized as they are in projects. Settlers do not make enough money to complete their equipment; this is one of the reasons for the ceiling on and the recent decrease in yields.

Moreover, the difference between the official price for paddy (50 f a kg in 1978) and on the parallel market (90 f a kg in 1978) has greatly reduced the amounts marketed through official channels, except for the Office du Niger zone:

11,000 tons in 1978/79 for paddy other than fice du Niger (i.e., 7% of production).
39,000 tons in 1978/79 for millet, sorghum and corn.

REAL CEREAL PRODUCER PRICES IN 1971 and 1978
(Production: 1,000 tons) (Price: Malian francs)

	MILLET - SORGHUM - CORN						PADDY											
							Other than Office du Niger						Office du Niger					
	1 Total produced	2 Officially mktd.	3 2/1 (%)	4 Official price	5 Parallel mkt. price	6 Weighted average price	1 Total produced	2 Officially mktd.	3 2/1 (%)	4 Official price	5 Parallel mkt. price	6 Weighted average price	1 Total produced	2 Officially mktd.	3 2/1 (%)	4 Official price	5 Parallel mkt. price	6 Weighted average price
71/72	798	32	4%	18	27	27	132	2	2%	25	35	35	63	46	73%	25	35	28
78/79	1000	29	3%	40	70	69	143	11	7%	50	90	88		52		50	90	61
(76/77)													89	65	73%			
79/80										60						60		

Note: The prices on the parallel market are average prices (the average as between the harvest and the intervening period). Furthermore, they are representative of an average year, but can vary by 50% around this average, according to the seasons and crop years (leaving the rate of inflation out of account).

Source: Official prices: OPAM - ORSP. Parallel market: CP /IER

Finally, the earnings of farmers from their labour rose less fast than the minimum wage earners consumer price index of the State sector, which can hardly incite producers to intensify crops on which there is a very limited return.

2.13 INADEQUATE COMPLEMENTARY ACTIVITIES

These include in particular: research, experiments, general surveys and training.

2.131 Research and experimentation. On-site testing programmes have been greatly reduced. It appears that early or average cycle varieties of rice suitable for different types of rice plantations have been discovered. Nevertheless, high yield and short cycle varieties (105-115 days) grown under irrigation with full water control (experiments yielded 8 to 10 tons, while farmers have harvested 5 to 6 tons) are not in current use. Similarly, dual annual harvesting was experimented with in the San perimeter only, although explicitly scheduled by the plan, and with very poor results. There is a delay in production in regard to major infrastructural work, such as the Selingue dam which by 1981 will regulate the Niger river to a flow exceeding 150 cu. meters per second, and which should permit dual harvesting on several tens of thousands of hectares.

2.132 General surveys and studies

Rural engineering studies (feasibility and execution studies) are reasonably in advance of financing arrangements for the central zones (Upper and middle Niger valley, Southern Mali zone, Office du Niger developments and the Mopti region).

By contrast, the programme of general surveys has fallen considerably behind schedule as regards, in particular:

- surveys on planning and development of the territory: agricultural statistics, study of outline development schemes and of use of water (Niger and Bank River region) or land allotment (Lake region and the Delta.)
- implementation of a central agricultural statistical department and of an organization to follow up and coordinate projects.

- investigations to improve knowledge of natural resources and the human environment: general hydrological studies, pedological surveys on a 1/200,000th scale, study of production systems, socio-economic enquiries, etc.

2.133 Training

The training program is seriously behind schedule (postponed credits, reduction of projected extensions), which has resulted in a decrease in the numbers of executive personnel envisaged -- which fact has nevertheless sometimes been viewed as an advantage, as the national Malian budget is already heavily burdened by the payments made to executives already working on projects.

Two remarks should be made on the personnel of hydro-agricultural projects:

- the limited incentives for low-level executive staff to persevere in their task, involving large turnover, and even more serious, producers' disillusion, as they rapidly know as much as their advisers do.
- the shortage of project leaders, who it would seem must not only be trained at university or in courses abroad, but also on-the-job, to gain experience of action and responsibility.

2.14 CROP PROTECTION

Birds and insects still attack rice fields and inflict serious losses. Invasions by rhizome-carrying wild rice are one one of the factors accounting for the low yields obtained by the Office du Niger.

In-line seedling transplantation is not widely used, so that weeding cannot be performed using a weeding machine.

2.15 THE COMMUNICATIONS PROBLEM

The main rice growing areas in Mali - the Office du Niger developments, the Niger live Delta, the loop of the Niger river and the Lake zones - do not have any rural access tracks, or an adequate and permanent

road network, which is a precondition for the supply of inputs and transportation of agricultural production.

The construction of roads and tracks and their maintenance is indispensable for the development of irrigation projects. This infrastructure must be embodied in the design of hydro-agricultural development projects.

2.2 PROBLEMS OF THE OFFICE DU NIGER

These problems were described and discussed at length during the Segou meeting in November 1978, on the basis of statements by Malian authorities and the World Bank identification report.

The main problems will be discussed below.

2.21 THE PRICE OF PADDY

One of the basic constraints on the development and intensification of production at the Office du Niger is the paddy producer price, which is generally acknowledged to be too low and is formed more as a "social consumption price" than as a cost price. The official price of a kg of paddy rose from 12.50 F to 50 F in 1978 and 60 F in 1979. Even after the recent increases, this last price is still much lower than the parallel market price, estimated at 90 Malian francs in 1978 (see part 3.32). In spite of fairly strict rules (an allowance for own consumption of 300 kg per member of a family), official collections of paddy are not increasing at the expected pace and the settlers' incomes are too low to enable them to purchase suitable equipment.

2.22 DETERIORATION OF PRODUCTION EQUIPMENT

Inadequate maintenance of the main hydraulic structures (the task of the Office du Niger) and of the terminal networks (the farmers' task) has led to marked deterioration, such that control over water has been lost in several cases. Through defective leveling and lack of suitable drainage, over 16,000 hectares have had to be abandoned, more particularly in the Kolongotomo and Kouroumari areas. Intensification of production subsumes that water is everywhere fully under control. The full repair of infrastructures is assessed to cost $43 million (1977 prices).

2.23 LACK OF A TRANSPORT NETWORK

There are no tarred roads in the area covered by the Office du Niger developments and communications between the producing zones and the outside world are very difficult in the rainy season. New problems are raised by the need to market crops very quickly using trucks of over 20-ton carrying capacity instead of barges going to

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(1) See "Diagram of the trend of paddy collection by the Office du Niger since 1938" in the Annex.

Segou, generating rapid wear of roads. The FED is expected to allocate 8.5 million U.C. towards the Markala-Nioro road, but a further 5 to 7 million U.C. must be found if it is to be constructed.

2.24 FARMERS' EQUIPMENT IS INADEQUATE, in particular for the soil preparation. This aspect is associated with the size of farm units, reaching 8.5 hectares, or 3.5 hectares per person occupied, making difficult intensification through improved methods of farming which involve heavy labor requirements. Two teams would be needed together with the corresponding equipment for each unit, i.e. approximately twice the current figure (see the specification sheets in the Annex).

2.25 ADMINISTRATIVE STRUCTURES

In the light of present regulations, it is difficult to increase the number of advisory personnel, who cannot expect any major improvement in their position for statutory reasons, whatever their competence and dynamism.

2.26 CROP PROTECTION

Several thousand hectares were invaded by red rice, in particular in the Kolongo area. In 1978/79, the ravages of birds could not be resisted and were in part responsible for the fall in production. Efficient measures will have to be taken in the field of crop protection.

2.27 SPONSORSHIP OF COMPLEMENTARY ACTIVITIES

"Complementary activity" programmes, in particular for training, health, livestock and research, are under the direct responsibility of central departments and do not seem to be meeting needs efficiently. As regards applied research and experiments, only limited results have been obtained in the last few years.

2.3 SOME CONSIDERATIONS AND RECOMMENDATIONS

2.31 In 1979, irrigated farming played an important but not exclusive role in the economy of Mali. It consisted mainly of paddy (230,000 tons equal to 150,000 tons of rice), sugar (20,000 tons) and wheat (several thousand tons) growing.

There is also major scope for rainfed farming, especially below the isohyet 600 mm, which is guaranteed 8 years out of 10. This type of farming has been greatly extended in the last few years for food crops (over 1 million tons

of millet, sorghum and 100,000 tons of corn) and cash crops (over 120,000 tons of seed cotton). Furthermore, it has excellent development prospects, with economical production conditions and no need for large investments.

In addition, livestock is traditionally raised in the Sahel zones receiving between 150 and 600 mm of rain. The value of production was estimated at 40 million Malian francs in 1975, i.e., twice the value of irrigated crops, estimated at that time at 15 billion Malian francs. (1)

2.32 Notwithstanding, irrigation is the only way of producing certain foods which are considered as a priority today and the need for which will increase progressively, in particular with the generalization of the urban life-style. These foods are: rice, wheat and sugar, and aggregate requirements are assessed at 800,000 tons by the year 2000, i.e., a necessary increase in production of some 600,000 tons and an average annual increase of 30,000 tons, of which 20,000 tons of rice (corresponding to more than 30,000 tons of paddy per year).

Truck gardening products and fruit should be added to these foods. The growth of production is still very slow, in spite of the emergence of some exports to Europe (mangos).

Sugar production has now been better mastered and the yields obtained by the Office du Niger are adequate. Another sugar perimeter is programmed in the Bankoumana area. Results obtained on wheat do not provide a basis for estimating projects: research and experimentation on irrigated wheat farming must be intensified (2).

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(1) Production estimated at 15 billion for 200,000 tons of paddy at 60,000 francs/ton = 12 billion.
10,000 tons of sugar at 300,000 francs/ton = 3 billion.

(2) See the note on wheat in the Annex: experimental research in the Sahel.

2.33 The increase in paddy production which should be at least 30,000 tons per year, could be achieved in either of two ways:

2.331 By extension of the areas planted, which was done between 1970 and 1976, with yields for crops under controlled submersion of 1.5 to 2 tons per hectare. Close to 20,000 hectares per year, or 300,000 hectares would have to be developed in 20 years, which would raise problems as regards the basic infrastructures to be installed and of competition with pastoral agriculture. The cost, other than structural work, can be estimated at 10 billion Malian francs a year in 1979 prices (20,000 hectares at 500,000 Malian francs).

2.332 Through intensification of production, installing equipment for controlled submersion only in areas with a guaranteed water supply (which involves the presence of major structures). The increase in yields achieved through the generalization of double annual harvesting would enable 8 to 9 tons per hectare to be grown over the year on perimeters with full water control, using the Selingue and Markala dams. If annual yields of paddy of 8 tons could be obtained through complete rehabilitation of the Office du Niger developments (50,000 hectares), the required production increase would fall to 200,000 tons for new perimeters, i.e., 10,000 tons per year. This corresponds to the development of 1,200 hectares annually with full water control, at a cost in 1979 prices of 4.8 billion Malian francs (1,200 hectares at 3 million Malian francs), excluding the cost of the necessary structures.

These two extreme hypotheses are schematic, but choices, based on solid studies and experiments, must be made as to the types of development to be performed and the method of exploiting land resources to the best effect.

CHAPTER III

III - STATUS OF THE CILSS FIRST GENERATION PROGRAMME

3.1 PRELIMINARY REMARKS

There is some ambiguity in the contents of the CILSS first generation programme which was somewhat vaguely defined in 1977 and is not homogeneous. It comprised 14 development and 4 training projects. However, their contents have changed since.

We will describe the progress made with these 18 projects and their present status, and discuss the general problem of hydro-agricultural developments scheduled in the Plan.

3.2 EXECUTION OF HYDRO-AGRICULTURAL DEVELOPMENTS INCLUDED IN THE PLAN

The Plan had provided for hydro-agricultural development of 158,000 hectares, with a further 45,000 hectares to be "consolidated". Effective completion has been achieved of less than 50,000 hectares, as shown in the table on the next page.

1,000 hectares

		Fully developed	Partially developed	Small developments (low ground)	TOTAL	Consolidation work
Anticipated:	5 years	37.2	105.9	15.1	158.2	44.9
	Annual rate	7.4	21.2	3.0	32.0	9.0
Executed	5 years	6.4	40.0	1.4	47.8	0.0
	Annual rate	1.3	8.0	0.3	9.5	0.1
% of Execution/Target		17 %	38 %	9 %	30 %	2 %

The only projects to be implemented were those which had already been fully financed or studied by 1974. The main reasons for this delay appear to have been:

- underestimation of the time required: at least five years elapse between the formation of an idea of a project and its material execution.
- underestimation of costs by reason of a 15 to 17% annual rate of inflation, associated with the additional time factor.
- overestimation of the annual work capacity and the mastery of supply channels by the organizations responsible for work or acting as prime contractors.

3.3 STATUS OF HYDRO-AGRICULTURAL DEVELOPMENT STUDIES IN 1979.

Studies were heavily behind schedule, in particular for:

- the Terekolle, Kolombine and Lake Magui valleys,
- the low grounds of the western zone (Kita),
- the second extensions of the Segou and Mopti Rice projects,
- the whole of the Lake zone and the Kessou Killy area (Dire),
- the whole sugar programme.

The overall review of the status of studies of hydro-agricultural developments by the IER provides an idea for the 1978-84 period.

STATUS OF HYDRO-AGRICULTURAL DEVELOPMENT STUDIES

RELATING TO WORK TO BE DONE IN THE 1978-84 PERIOD

	Zones or Projects	Full Developments	Partial Developments	Small developments (low ground)	TOTAL
Studies completed, work under way	1. Upper Valley	-	-	-	-
	2. Niger Bureau	-	-	-	-
	3. Segou rice project	-	5,500	-	5,500
	4. Mopti rice project	-	8,800	-	8,800
	5. Lake zone, of which:	2,250	2,250	-	4,770
	. small perimeters	2,400	-	-	2,400
	. Dire plain	120	-	-	120
	. Ponds	-	2,250	-	2,250
	6. 7th region (Korioume)	600	-	-	600
	7. OVSTM	-	-	-	-
	8. Sikasso rice project	-	-	900	900
SUB/TOTAL		3,120	16,550	900	20,570
Studies in progress	1. Upper Valley, of which:	1,350	600	-	1,950
	. Selingue	1,100	-	-	1,100
	. Bankoumana	-	600	-	600
	. Samanko	250	-	-	250
or completed	2. Office du Niger (1)	1,500	-	-	1,500
	3. Segou rice project	-	24,000	-	24,000
Work not yet start ed	4. Mopti rice project	-	30,000	-	30,000
	5. Lake zone	1,660	15,000	-	16,660
	of which				
	. Kessou-Killy	1,500	15,000	-	16,500
	. Dire plain	160			160
	6. 7th region	1,500	13,000	-	14,500
	7. OVSTM	2,500	-	-	2,500
	8. Sikasso rice project	-	-	1,500	1,500
SUB/TOTAL		8,510	82,600	1,500	92,610
GRAND TOTAL		11,630	99,150	2,400	113,180

(1) Minimum estimate

3.4 OFFICE DU NIGER: STATUS OF THE REHABILITATION PROJECT

In 1977, the Malian Government had requested assistance from the executive secretariat of the CILSS in the form of activity to promote the rehabilitation of the Office du Niger developments.

In September 1977, the CILSS organized a first meeting In Ouagadougou on the rehabilitation of irrigated perimeters, in the framework of the Club du Sahel Working group on irrigated farming.

In November 1978, a donors' meeting was held at Segou by the CILSS/Club du Sahel. It was the occasion for a broad exchange of views between Malian authorities and donors interested in the rehabilitation activities of the Office du Niger (see the summary record of the meeting).

3.41 Foreign aid already secured by the Office du Niger

a) Aid from IBRD

This is scheduled to cover three years (end 1978 to end 1981), for $4.5 million and comprising essentially:

- an engineering and technical assistance programme,
- urgent infrastructure repair work,
- implementation of a pilot programme for levelling 1,500 hectares of rice fields, with the purchase of necessary equipment,
- preparation of plans and reports necessary for the evaluation and execution of the redevelopment programme,
- assistance for research and experimentation.

This first phase has been under way since November 1978 and progress has been normal so far.

At the end of Phase I and in the light of the results obtained, the Bank might participate in financing the rehabilitation programme. Phase II will comprise the study of an extension and development scheme by the Office du Niger.

b) Aid from the People's Republic of China

China committed herself to finance 4 projects relating to the hydraulic network in the Southeastern zone:

- repair of the Markala dam, whose foundation base is affected locally by underwashing,

- dredging the Macina canal, without widening it,

- rehabilitation of the whole irrigation and drainage network of the Macina hydraulic system (Kolongo).

c) Aid from the Netherlands

The Netherlands committed itself to finance two projects at the Segou meeting:

1 - Study of water requirements for the two main crops grown by the Office du Niger: rice and sugar cane,

2 - A project for training middle level executives (technicians, irrigated farming assistants) for the Office du Niger.

These two projects have already begun. The commitment for the first project (water requirements) is $340,000.

In addition, the Netherlands have shown their interest in farmers' activities: equipment, advisory staff, training, and social infrastructures.

3.42 Expected aid

France attaches special interest to the Office du Niger as a major element of development in Mali and West Africa. It will contribute actively to the rehabilitation project.

In the near term, France is willing to participate in financing the Costes Canal, in the framework of the rehabilitation of the Office du Niger and its present sugar plantations (1).

A recent mission of the French Ministry of Cooperation agreed with Mali that the FAC would finance part of the work on the Costes Canal. Earthwork is presently under way.

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(1) Final communique of the Segou meeting.

AID has shown special interest in the livestock project of the Office du Niger, which has already developed breeding to some extent, as well as an interest in training projects.

Germany has expressed interest in the two rice mill and storage tank projects.

IFAD "could perform activities corresponding to the criteria applied by it in the course of phase II: projects for an increase in foodcrop production concerning a large number of farmers." (1)

Finally, Japan has shown interest in the "long silk cotton" project and the excavation of the Molodo channel.

Canada is interested in functional literacy and training projects. (2)

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(1) Final communique of the Segou meeting.
(2) See also table in part 4.3.

3.5 - STATUS OF FIRST GENERATION PROJECTS

CILSS/
CLUB DU SAHEL

I. Preliminary interest; under study
II. Marked interest; cofinancing
III. Firm commitment

Republic of Mali
Irrigated Farming
October 1979

Project	Estimate of costs		Financing		Remarks
	Million Malian Francs	1,000 $	Source	Type of Interest	
1. Perimeters irrigated by pumping in Niger river: Gao region					
a) 1,400 hectares	842		AID	III	Rice-sorghum operation, cost est. at $3528 million until 1980
b) Study of 1,300 hectares under controlled submersion & 1,000 hectares with full water control	470		SDF	III	470 million MF, incl. 15,000 hec. for cultivation in subsidence season & 1,000 hec. with full water control in 6th region Timbuktu)
c) Study of 1,500 hectares irrigated with full water control	160		FAC	III	Study in course
2. Perimeters irrigated by pumping in Niger river:Timbuktu region					
- 2,420 hectares irrigated wheat (605 pumps)		4,426	AID	III	Dire wheat project: amount financed: $1501 million
- extension of 1,000 hectares irrigated with full water control (see project 1 b)			FSD	III	Project under study. Financing included in project 1 b.
3. Korioume perimeter (Timbuktu region), improvement of 600 hect. of wheat & sorghum by pumping		1,064	NGO (Belgium)	III	"Island of Peace" development under way
4. Hydro-agricultural development of the Dire plain					
- Phase 1 & 2: development of 100 hectares with full water control	1,300		FAC	III	Operation scheduled for October 1979
Solar pump testing	1,000				
- Phase 3: completion of scheduled activities					The pilot perimeter is envisaged to cover 315 hectares
Korientze-Niafunke road surveys	450				
- Study of 1,500 hectares irrigated with full water control	See proj. 1.		SDF	III	Study under way
- Dire wheat project		4,400	AID	III	
5. Hydro-agricultural development of Lake Horo (phase 1: 500 hect.) 13,000 hectare survey	66 mil. Belgian Francs		IBRD) Belgium) Japan)	I	Interest of principle by IBRD. Request presented to Belgium in Feb. 78, incl. reinforcement of local structures, and study of technical and financial specifications
6. Hydro-agricultural development studies; ponds in lake zone					
- Tagadj pond (5,000 hectares)	?	?	USAID) CANADA)	I	
- Kaboro pond (2,000 hectares)			Netherlands) Japan)	I	
- Kessou-Killy ponds (1500 hect.)	470		SDF	III	Development survey covering 15,000 hect. of ponds for subsidence season crops and floating rice, under execution by FSD in frame of proj. 1b. Cost: 470 million Malian francs.
7. REHABILITATION OFFICE DU NIGER Developments					See record of Segou meeting 13-16 Nov. 78. See also "Afrique Agriculture," No. 43, Mar. 79.
a) Phase I: end 78 end 81 . pilot rehab. proj. 1,500 hectares . technical specifications, Phase II. . technical assistance		4,500	IDA/ IBRD		The intervention of IBRD began in Nov. 78 with technical assistance.
b) Phase II: starting in 1982 1) 1st rehab. proj. & study of devel. scheme & extension est. by Office du Niger		40,000	IBRD	I	
2) Costes canal			FAC/CCCE	II	Construction of canal began in 1978, executed by Office du Niger, using its own funds
3) Construction 2 rice mills & 3 grain storage tanks			Germany	I	

c) Other activities undertaken					
. Study of water requirements for rice and sugar cane		340	Netherlands	III	Study started in 1979
. Training of mid-level personnel		?	Netherlands	III	Activity started in Sept. 1979
d) People's Republic of China who committed herself to finance 4 projects:		?	China	?	- repair of Markala Dam - entry into service of supply-main canal - dredging of Macina canal - Kolongo drainage and irrigation network (rehabilitation)
e) Other donor organizations interested in Niger Bureau projects					USAID, IFAD, UNDP
- long silk cotton project	1,425		Japan	II	Estimate to be confirmed
- livestock project: project studies	-		IDA/IBRD	III	
execution	-		USAID	I	
- functional literacy	?		Netherlands)	I	
- road network	?		USAID)		
			ADF	III	5 million UC shortfall; figure to be updated
- projects for increasing food crop production			IFAD	I	
8. Securing and extending rice fields under controlled submersion in the Segou region	4,795		FED	III	This concerns phase II of the Segou rice project (CRSII), consolidation. Rapid progress of work (5,020 hect.). The remainder is being implemented.
9. Securing and extending rice fields under controlled submersion in the Mopti region (35,000 hectares: MRP II (Phase II of Mopti rice project	6,300		IDA	III	- Work on terrain under way for the 3 projects financed.
	200		FAC	III	
	2,520		AFD	III	- FAC made a commitment for 1 billion Malian francs for the duration of the project.
10. Development of the upper valley of the Senegal, Terekolle and Lake Magui					
Phase I: (until 1981)					
. Development and provision of advisory personnel	440		FAC	III	Several small market gardening perimeters
	90		USAID	III	Operations for "accelerated impact" $215,000 for the length of the project.
. Studies					
500 hectares in Senegal Valley (Maloum-Kounta)	24		FAC	III	
2000 hectares in Senegal Valley	147		Koweit	III	
Terekolie-Kolombine-Magui axis	698		Germany	III	
Phase II (from 1982)	?				Not estimated
- completion of projects (studies) mentioned above			Germany	I	
- completion of development studies for most of the possibilities identified in the study by SCET-International			)FAC)Koweit)USAID	I I II	Pilot extension project under study (to be carried as far as Kenieba)
11. Hydro-agricultural developments in the upper valley of the Niger river					From Baguineda to the Guinean border.
Phase I: 1400 hect. with full water control					
. Market gardening crop and canning factory at Baguineda	220		FAC	III	beginning
	310		CCCE	III	
. project in the upper valley (rehabilitation of Bankoumana perimeter	630		USAID	III	beginning
. development of Semanko perimeter	?		North Korea	III	in course, 50% of work completed
. perimeter downstream from Selingue dam:					
- feasibility study cov.1100 hect.			Germany	III	study completed
- implementation study of Selingue perimeter	120		FAC/ Germany		completion scheduled for October 1979
Phase II; from 1982					
- studies and work on the Selingue perimeter	4,000		(Belgium (ADF	I	
- Study & development of 1,500 hect. with full water control					
- Study & development of 4,000 hect. under controlled submersion					
12. Improvement and extension of the perimeters in the Bougonni-Sikasso region:					
- Devel. of additional 2,000 hectares	650		FED	III	under execution
- Hydro-agricultural development plan of Southern Mali (4,000 hectares over 8 years)	500				to be financed as an urgent matter
13. Long silk cotton)					See project 7 "Office du Niger" above (IRA-7)
14. Cortes canal)					

15. Reinforcement of the Katiebougou higher agricultural institute					Included in Project no. 6, "Human Resources" 'Reinforcement of the Katiebougou Rural Polytechnical Institute"
Phase I:					
- Establish a programme at ISPRA		1,019	Netherlands	III	- under way
- Technical assistance for the preparation of the programme and participation in its start-up		5,555	ADF	III	- under way
Phase II:					
- Continuation and reinforcement of the ISPRA project					
- assistance to and reinforcement of traditional departments of the IPR		1,000	UNESCO) Netherlands) ADF)	I	- Commitments made at the Niamey human resources meeting
			Germany	I	
			Japan	I	
16. Training in Agricultural training centers (ATC) and Agricultural specialization centers (ASC)					
Phase I: (until 1980)					
- reinforcement of the ATC in Same and M'Pessoba	2,100		USAID	III	- Work starting
- reinforcement of the Samanko center	504		IDA	III	- 2nd educational project in Mali (total: $10 million)
Phase II: (1980-83)	(2,900)				
- building of new ATC	1,500		Netherlands	I	Interested in training at the Office du Niger
- construction of new ASC	1,300		FAC	I	" " " " " "
- creation of a national Directorate	100		USAID	I	Request submitted to finance the Baguineda center (in the framework of the AIP project)

CHAPTER IV

IV - PROPOSALS FOR A SECOND GENERATION PROGRAMME (1980-85)

4.1 OVERALL DIRECTIONS

They were not settled in the Plan, but flow from various general reports, special project proposals and on-site analyses by authorities, taking account of possibilities and existing constraints.

4.11 Regional distribution

In every region (except perhaps Southern Mali, which has major agricultural development potential), there should be at least one development project based mainly on irrigation. Zones which do not have adequate road access having suffered from substantial delays in the implementation of projects, a special effort must be made to complete basic inquiries, studies and experiments in the field. The success of such operations is linked in large part to the improvement of communications, which should thus be considered as a priority investment.

4.12 Consolidation of irrigation

The last drought years stressed the vulnerability of controlled submersion developments. Therefore for the past few years major activities have been undertaken to consolidate irrigation.

- increase in the size of dams,
- improvement in the quality of construction, which had sometimes been downgraded in order to render the operation more economical,
- construction of structures (threshold dams),
- renovation and rehabilitation of developments which had suffered from inadequate maintenance.

4.13 Improvement of farmers' equipment

Farmers consider that equipment (animal teams, the set of tools for working the soil, conservation and storage) and the different inputs are indispensable, as they increase their use of them. The intensification of production thus obtained is welcome, but it is at the cost of markedly higher prices.

There are two preconditions for farmers to be able to purchase these inputs:

- the alignment of official prices of agricultural products on market prices, to allow farmers to pay for the services provided,
- creation of an appropriate agricultural credit system.

4.14 Integration of complementary activities, in particular applied research, experiments, training, health, etc.

Applied research and experiments: it seems that enough basic results are available, in particular on varieties, to lay emphasis on on-site experiments, in real operating conditions: multi-local tests, design of farming techniques, a working calendar, etc.

Training: There is already quite a large number of graduates and demands basically concern local training and specialization relating to water foremen, mechanics, blacksmiths, etc.

4.15 Further basic investigations, surveys at two levels: development in general, and projects as such:

- A land development survey to identify the best uses of national resources, including in particular an inventory of soils, water resources and their mobilization for irrigation. A general survey of the Niger river, in particular, seems to be indispensable.
- Project studies, in order to have enough feasibility studies in store, based on satisfactory knowledge of conditions in the field, which implies that all the basic topographical, pedological, geotechnical and

socioeconomic investigations should already have been undertaken, the implementation study then being limited to the engineering aspects.

4.16 Reducing dependence on foreigners

A major effort has been made to use national resources as much as possible, in particular for studies (Rural Engineering Study Office), work (OTER), and supplies. Standardization would however be desirable to determine what could be supplied by the national market in the long term, and what should be provided by the foreign sector in the way of training or specific services.

4.2 PROJECT PROPOSALS FOR THE 1980-1985 PERIOD

These proposals have been established in liaison with Malian authorities and, especially, the Rural Engineering Directorate.

The proposed projects are listed by region. The corresponding technical specifications are given in the annexes and summarized in table 4.4.

4.21 KAYES REGION (1st region)

Farming on small irrigated perimeters, growing market gardening crops and cereals (rice), has been expanding since 1971. At present, approximately 50 hectares are irrigated on the banks of the Senegal river upstream and downstream from Kayes.

a) A feasibility study covering 500 hectares net is presently under way in this zone; it is financed by the FAC. 60 hectares could be farmed to grow two harvests a year.
200 to 700 million Malian francs are sought for the execution of the work, the exact cost to be appraised in the study in course.

b) An identification study is available covering 2,000 hectares under controlled submersion in the Senegal valley; it was financed with funds from Kuwait and the development of 400 hectares is scheduled in the short term.

c) Terekole-Kolombine zone: Examination of a general development blueprint for this zone should begin soon, financed by Germany, including perimeters under controlled submersion and plantations growing subsidence season crops (information presently at pre-identification stage).
Work - whose cost is still to be appraised - could begin in 1982.

4.22 KOULIKORO REGION (2nd region)

a) In the 1930s, the Baguineda perimeter was developed over approximately 3,000 hectares. Less than 400 hectares are farmed today, of which 100 to 150 hectares intensively.

A study financed by the FAC/CCCE is under way for intensive production on 200 hectares (tomatoes, export products).

In the longer term, it is intended to develop 3,000 hectares and install an agro-industrial plant: the study is available up to the stage of prefeasibility.

Financing of approximately 1,500 million Malian francs will be needed for the 1980-85 period.

b) Sugar perimeter: the Malian Government is envisaging the creation of a sugar perimeter covering approximately 5,000 hectares (1), but whose location has not yet been chosen. Reconnaissance has been performed at Bankoumana, Koursali and Madina.

The feasibility study for this sugar perimeter, estimated at 400 million Malian francs, would be financed by the FAC/CCCE.

The sugar complex as a whole would cost 50 billion Malian francs. Its construction will probably last beyond the CILSS second generation programme (1980-85).

c) Selingue perimeter: A perimeter of 1,000 hectares net irrigated with full water control is scheduled downstream from the Selingue dam (under construction). It will be farmed to grow two harvests annually. The implementation dossier will be available at the end of 1979.

The implementation work on the perimeter between 1980 and 1983 is estimated at 4 billion Malian francs. Financing is sought.

d) Other: prefeasibility studies of small perimeters under controlled submersion.

4.23 SIKASSO REGION (3rd region)

In this region, the 1980-85 programme should cover the development of rice fields under controlled submersion over approximately 3,000 hectares: the plains of Faramisoin, Sinkilo (760 hectares), Taniena (2,000 hectares) and Labouala (200 hectares); plus a few fruit and market gardening perimeters.

Studies exist up to the stage of prefeasibility. The programme could be financed by the FED. Necessary studies are estimated at 120 million Malian francs and implementation would cost 1.5 billion Malian francs (2).

(1) There are other sites in competition with this one, especially at the Office du Niger.

(2) The preliminary estimate of cost is based on:
- development work under controlled submersion: 500,000 MF per hectare
- feasibility and design studies: 30,000 MF per hectare

4.24 SEGOU REGION (4th region)

a) In this region, priority will be given to consolidating perimeters under controlled submersion and the completion of developments:

- securing the Farako (+ 2,000 hectares) and Tamani (+ 800 hectares) perimeters.

- completion of the Dioro (+ 7,000 hectares) and Macina (+ 865 hectares) perimeters.

- completion of the West San perimeter, to be harvested twice annually (+ 940 hectares).

Two projects can be added:

- access roads to the Farako and Babougou perimeters,

- a 15,000 ton rice mill at Konodimini.

as well as studies (hydrology, hydraulics, topography, execution dossiers of the above projects) which can be carried out by the Rural Engineering Directorate. (1)

The above development studies are estimated at 500 million Malian francs and the implementation programme at 15 billion Malian francs. (2)

b) Study of the Talo threshold-dam on the Bani. This dam will allow 1,500 hectares of rice fields to be irrigated.

The Rural Engineering Department is presently studying the topography and geotechnological aspects.

The establishment of the feasibility and implementation studies is estimated at 150 million Malian francs.

c) General development survey of the Segou zone. Irrigable land potential is estimated at 200,000 hectares in this zone which would warrant conducting a general survey during the 1980-85 period.

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(1) The Rural Engineering Survey Office has at present a staff of 14 engineers.

(2) The FED would be interested in financing this programme.

4.25 MOPTI REGION (5th region)

a) The Djenne threshold-dam on the Bani, which has been the subject of a prefeasibility study.
The cost of the feasibility and execution studies is estimated at 400 million Malian francs (1980-81).
The cost of implementation would amount to 20 billion Malian francs, with completion dates set for 1983-86.

b) 40,000 hectares of perimeters under controlled submersion, for which the Rural Engineering Survey Office has already undertaken identification studies.

- the cost of feasibility studies is estimated at 500 million Malian francs over the 1980-81 period.
- work covering 40,000 hectares is programmed between 1980 and 1988, at a cost of 20 billion Malian francs, of which approximately 15 billion over the 1980-85 period which corresponds to the CILSS second generation programme.

c) Macina-Tenankou highway (85 km), which is of capital importance to the development of the area. The feasibility study is done. The complementation study which still has to be drawn up is estimated at 200 million Malian francs. The work could be executed between 1980 and 1984, and is provisionally estimated at 4 billion Malian francs.

d) Small dams in the Dogon district. (see the project sheet).

Prefeasibility studies are available. Establishing the feasibility and execution studies of 20 dams is estimated at 60 million Malian francs (1980-83).

The construction of 20 dams and the renovation of 8 is envisaged over the next 10 years (1980-90).
Estimate of costs:

20 new dams at 80 million.....	1,600 billion
8 renovations at 30 million ..	240 billion
	1,840 billion Malian francs

which corresponds to an investment of 1.2 billion Malian francs over the 1980-85 period.

4.26 TIMBUKTU REGION (6th region)

The development of this region necessitates:

- building an access road (Kona-Korientze-Tonka), linking Niafunke to Korientze,
- drafting a development scheme for the zone, with systematic reconnaissance of ponds, establishing the terms of reference for subsequent studies, and setting orders of priority.

a) These studies should be carried out within the 1980-83 period and are estimated at 400 million Malian francs. Short missions could be undertaken to help the Rural Engineering Department in preparing the terms of reference of the main studies.

b) Implementation studies for the Korientze-Tonka highway (100 km) are under way, financed by Belgium, and should be completed by 1981. Construction of this highway is scheduled over the 1981-83 period, and estimated at 4 billion Malian francs: this is a first priority for releasing the area from its isolation.

The second priority is to improve the track linking Kona to Korientze (70 km). Study is estimated at 100 million and implementation at 1.75 billion.

c) Development of 1,000 hectares of irrigated perimeters, presently defined up to the stage of prefeasibility.

Cost of studies: 100 million Malian francs (1981-82)
Estimate of work: 2 billion Malian francs (1982-85)

d) Development of 10,000 hectares of ponds for growing subsidence season crops, defined up to the stage of prefeasibility.

Cost of studies: 50 million Malian francs
Estimate of work: 1.5 billion Malian francs (1980-85).

4.27 GAO REGION (7th region)

The projected developments are located in the Niger valley only, with 4 different types of development, from 1 (submersion) to 4 (full water control).

a) General development surveys of the zone, comprising systematic reconnaissance of potential development sites.

Estimate of cost: 100 million (1980-81)

b) Development of 1,000 hectares with full water control (1980-88).
   - The feasibility study has been financed.
   - Estimated cost of work and development with technical assistance over 4 years: 7 billion Malian francs, of which 4 billion during the 1980-85 period.

c) Development of 5,000 hectares of types 1, 2 and 3

Estimated cost of studies: 100 million Malian francs (1980-81)
Estimated cost of work: 2 billion Malian francs (1981-85)

4.28 OFFICE DU NIGER PROJECTS

At the donors meeting held in November 1978 at Segou, Malian authorities outlined seven priority projects whose technical specifications had been defined, as well as a set of specific projects. This programme is in addition to the present activities of the World Bank and the commitments of the People'sRepublic of China (see chapter III).

4.281 The 7 priority projects presented by the Office du Niger

Project titles	Brief description and objective	Estimate (million Malian F.		Interested donors
1. The Costes Canal	Canal 19.4 km long with a flow of 41.5 m^3/second allowing gravity irrigation of an area of more than 40,000 hectares net	Canal Structures Total 1 =	3100 1600 4700	Self-financing FAC/CCCE
2. Rice mills	2 rice mills, each processing 6 tons per hr., with a total annual capacity of 60,000 tons. To be executed in 1980/81 & 84/85.	Civil engineering Equipment Total 2 =	700 1200 1900	Germany
3. Grain storage tanks	Construction of 3 20,000 ton silos.	Civil eng. Equipment Total 3 =	600 3600 4200	
4. Third section of Molodo	Construction of a canal in the third elevation-level section of Molodo to evacuate the drainage of the Kouroumari, which necessitates excavating more than 360,000 m^3 of earth.	Total 4 =	600	Japan
5. Fattening & industrial fodder programme	Development of 1000 hectares of fodder and project for industrially fattening 80,000 head of livestock.	Infrastruct. Construction Agric. Eqpt. Livestock Working cap. Total 5 =	1200 100 800 1000 200 2800	USAID FED
6. Study of water requirements	Rational management of water, in particular by regulating the Selingue river.	Total 6 =	150	Netherlands
7. Training and functional literacy	Training of advisers on irrigated farming at Niono (IRA 17) and creation of 500 centers for functional literacy.	Training projects Literacy Total 7 =	800 80 880	Netherlands Canada USAID

TOTAL of the 7 projects = 15,230 million Malian francs

4.282 Other projects

Other projects are envisaged better to meet the needs of the Office du Niger, in addition to the projects financed by the World Bank and the People's Republic of China and the seven priority projects for which descriptive sheets were presented at the donors meeting in 1978.

a) Highways to make regions accessible: the project for a highway linking Markala to Niono (70 km) for which a promise of a credit of 8.5 million UC has been made by the ADF. An additional 5 to 7 million UC is needed: the total estimate of cost is between 8 and 9 billion Malian francs. Lengthening of this road by some 50 or 60 km to bring it to Diabali and Kogoni would be indispensable in the long run.

b) Long silk cotton project: the construction of the third section would not only allow drainage of the Kouroumari, but in addition the Mema and Farikema perimeters could be developed over 100,000 hectares. The long silk cotton project established at the beginning of the 70's and whose cost had been estimated at 15 billion Malian francs for an annual production of 100,000 tons of cotton grown on 4,000 hectares, could thus be reimplemented.

c) Dredging and widening the Macina canal: by increasing its section to raise the flow from 55 to 80 m^3 per second - which would involve dredging 350,000 m^3 over the 14 km canal, the irrigable land area would be raised to over 25,000 hectares. The operation would cost approximately 500 million Malian francs.

d) Improving the rice fields in Kolongotomo. Almost 9,000 hectares have been abandoned out of 14,400 hectares developed in the Kolongotomo area, and stand in need of either complete redevelopment (cost 800,000 Malian francs per hectare over 6,000 hectares), or leveling to improve the soil (cost 400,000 Malian francs over 3,000 hectares), i.e. an aggregate cost of 6 billion Malian francs.

e) Settlers' equipment. Inquiries into yields have revealed that they increase very markedly in line with the degree of equipment of the farmers (span of oxen and tools for working the soil): 1,000 kg per hectare for one span, 2,000 kg per hectare for two.

The project should cover the 5,000 farms over three years in order to ensure availability, given the existing stock of machinery, of:

- 2 teams per farm, i.e. 10,000 oxen at 90,000 MF — 900 million MF

- 1 set of machines per farm, i.e.:

5,000 ploughs at 50,000 MF	250
2,500 harrows at 40,000 MF	100
2,500 carts at 60,000 MF	150
5,000 planters at 40,000 MF	200
5,000 multi-purpose tractors at 90,000 MF	450
	1,150

- collective equipment, i.e.

400 sowing machines at 700,000 MF	280
400 harvesters at 2,000,000 MF	800
135 warehouses (300 m^2) at 6,000,000 MF	870
135 storage premises (200 sq. meters each) at 6,000,000 MF	870
	2,820

That is, an aggregate cost of 5 billion MF which should be financed with a suitable loan.

f) Agronomic experiments and research. Research is presently undertaken at national level, in particular at the Kogoni station in the Kouroumari, but cannot be developed to meet such requirements as:

- research into the suitable short straw varieties
- stubbling fields
- optimization of manuring
- soil dressing and use of machinery
- the struggle against adventices, which has not yet been mastered
- plant diseases
- insect and bird control

A new station should be envisaged and the corresponding structures incorporated into the Office du Niger.

As an indicative figure, 500 million Malian francs are necessary to cover the probable cost of the project.

RECAPITULATION OF THE COST OF THESE ADDITIONAL PROJECTS

	Millions MF
a) Roads to render the region accessible:	
. Phase I: Markala-Nioro (in addition to the 8.5 million UC allocated by the FAC)	3.5
. Phase II: Niono-Diabali-Kogoni	6.0
b) Long silk cotton project (4,000 hectares of cotton fields)	15.0
c) Dredging and widening the Macina canal	0.5
d) Improving rice plantations in Kolongotono over 9,000 hectares:	6.0
e) Equipment for settlers	5.0
f) Agronomic research	0.5
	36.5

That is, some 36 billion Malian francs.

It should be noted that detailed technical specifications must be drafted for all these additional projects.

4.3 RECAPITULATIVE TABLE OF OFFICE DU NIGER PROJECTS

Project	Cost in Million Malian F.	Interested Donors
1. Projects in progress:		
- engineering work and experiments ($4.3 million)	1,800	IBRD
- Costes canal: earthworks	3,100	self-financing
Total 1	4,900	
2. The 7 priority projects outlined at Segou in November 1978		
- Costes canal: work	1,600	FAC-CCCE
- 60,000 ton rice mills	1,900	Germany
- 60,000 ton grain-storage tanks	4,200	Germany ?
- Third section of the Molodo Canal	600	Japan
- Livestock fattening and industrial fodder programme	2,800	USAID/FED
- Study of water requirements	150	Netherlands
- Training of advisory personnel and literacy	880	Netherlands Canada USAID
Total 2	12,130	
3. Additional projects		
- access roads. Credit additional to the 8.5 million committed by the ADF	3,500	
- Phase II: Niono-Diabali-Kogoni	6,000	
- Long silk cotton project	15,000	
- Dredging and widening Macina canal	500	
- Improving rice fields in Kolongo-tomo	6,000	
- Equiping settlers	5,000	
- Agronomic research	500	
Total 3	36,500	

4.4 - RECAPITULATIVE TABLE OF PROJECTS IN THE SECOND IRRIGATED FARMING PROGRAMME IN MALI (1980-1985)

(credit sought)

Region	Project titles	Status of existing studies	Estimated cost (million Mf, 1979)		Period
			Studies	Work	
1. Kayes	a) Devel. of 500 hectares in Senegal valley, of which 60 ha. producing 2 harvests annually	feasibility	-	200 to 700	81-85
	b) 2,000 hectares controlled submersion	Identification	Kuwait	-	-
	c) Terekolle-Kolombine	Pre-identification	Germany		82-85
2. Koulikoro	a) Extension Baguineda perimeter	Pre-feasibility	?	1,500	80-85
	b) Sugar plantation over 5,000 hectares	Reconnaissance	400	50,000	80-85
	c) Selingue perimeter	Implementation dossier	-	4,000	80-83
	d) Small perimeters under controlled submersion	Reconnaissance	p.m.	-	80-85
3. Sikasso	Devel. 3000 hectares controlled submersion + small mkt. gardening perimeters	Prefeasibility	120	1,500	80-85
4. Segou	a) Securing & extending perimeters	Feasibility	500	15,000	80-85
	b) Study Talo threshold dam	Reconnaissance	150	-	80-81
	c) Gen. survey Segou region	-	p.m.	-	80-85
5. Mopti	a) Djenne threshold dam	(Prefeasibility	400		80-81
		(	-	20,000	81-84
	b) 40,000 hectares controlled submersion	Identification	500	15,000	80-85
	c) Macina-Tenenkou Hwy.	Feasibility	200	4,000	80-84
	d) Small dams Dogon Dist.	(Prefeasibility	60	-	80-83
	Work	(		1,200	80-85
6. Timbuktu	a) General devel. surveys of area	-	400	-	80-83
	b) Korientze-Tonka highway: Study	(Identification	financed		80-81
	Work	(-	-	4.000	81-83
	c) Irrigation 1000 hect.: Study	(Prefeasibility	100	-	81-82
	Work	(-	-	2,000	82-85
	d) 10,000 Hect. of ponds for farming subsidence period crops	(Prefeasibility	50		80-82
	Work	(-	-	1,500	80-85
7. Gao	a) Gen. devel. surveys of the area	-	100	-	80-81
	b) Devel. 1000 hect. with full water control	Feasibility	financed	4,000	80-85
	c) Devel. 5000 hect. under controlled submersion & type 2 & 3 irrigation methods	(Reconnaissance	100		80-81
	Work	(		2,000	81-85
8. Office du Niger	a) Projects under execution (IBRD + self-financing for the Costes Canal)	Identification		p.m.	
	b) 7 priority projects	Technical applications	?	12,130	80-85
	c) Additional projects			36,500	80-?

- Total for studies + 3,080 million Malian francs
- Total for work 175 billion Malian francs

4.5 OBSERVATIONS ON PROJECT PROPOSALS

4.51 Cost of the 1981-85 programme

In aggregate, the programme is estimated in 1979 francs at 175 billion Malian francs and 3 billion for studies, of which close to 50 billion for the Office du Niger and 50 billion for the 5,000 hectare sugar plantation, whose site has not yet been selected.

This total is high compared to the budget for the rural development sector in the last Plan, which amounted to approximately 100 billion Malian francs.

This is explained by the fact that several large projects envisaged will probably extend beyond 1985: the Office du Niger projects, the sugar cane plantation and the major projects of the Segou and Mopti zones.

4.52 Structural work

These expensive structures - the Djenne threshold dam on the Bani river and the country road linking Korientze to Niafunke - are a precondition for the development of the following zones: Mopti, Goundam, Dire and Timbuktu. The terms of reference of the corresponding feasibility and execution studies have been prepared by the Rural Engineering Directorate.

4.53 Office du Niger projects

Present World Bank activities cover the first phase of an overall rehabilitation and extension study of the Office du Niger developments and should be completed by the end of 1980. The technical records of the first rehabilitation project, whose cost is estimated at approximately $40 million (18 billion Malian francs), will be available at this date. Many projects scheduled in the present programme are covered by detailed technical specifications (feasibility).

4.54 Complementary activities

These are often mentioned in projects and technical specifications, but are rarely given in detail or explained. It would be of interest to lay down frame arrangements dealing with training, health programmes, tests and experiments, marketing and supply problems.

4.6 GENERAL SURVEYS PROPOSED

Three types of general surveys should be defined, if necessary with the help of short expert missions.

a) inventory of soils suitable for irrigation: general reconnaissance, present use, pedological characteristics, cultivation potential, behavior under irrigation and the definition of complementary investigation programmes.

b) an outline development scheme for the Niger River, with account taken of structural work in Mali and abroad, existing irrigation developments, uses other than irrigation, the pattern of regional economic activity, etc.

c) Thorough socio-economic inquiries, to determine the impact of developments on the population's behavior and on production.

ANNEXES

A N N E X A

INFORMATION ON MALI

1.1 GEOGRAPHIC LOCATION

Mali is located in West Africa, extending over 1,700 km from East to West and 1,600 km North to South, between the following parallels and meridians:

Latitude 10° N and 25° N
Longitude 12° W and 4° E

Access to the country is difficult. Its area is 1,240,000 sq. km and it is almost 1,000 km away from any outlet to the sea; it is bordered by Senegal on the Western side, Mauritania and Algeria to the North, Niger to the East, Upper Volta, Ivory Coast and the Gambia to the South.

1.2 CLIMATE

Three main climatic zones can be distinguished schematically according to rainfall:

- a desert zone covering close to half the country, North of the average 200 mm isohyet, which corresponds approximately to the northern boundary of cultivation
- a Sahelian zone between the average 200 mm isohyet and the 600 mm isohyet guaranteed 8 years out of 10, where small millet dominates other than in irrigated areas.
- a Sudan zone, restricted to the Southern fringe of the country which receives more than 600 mm of rain between June and October.

1.3 POPULATION

The December 1976 census yielded an estimate of 6,308,000 inhabitants, i.e., an average density of 5.1 per sq. km.

The largest towns are Bamako, the capital (400,000 inhabitants) and the regional capitals of the Kayes region (1st region), Koulikoro (2nd region), Sikasso (3rd region), Segou (4th region), Mopti (5th region), Timbuktu (6th region) and Gao (7th region).

The main ethnic groups are the Bambara, the Senoufos, and the Sarakolle in the centre and southern regions, and the Tuaregs in the North. Most are Moslems.

The modern sector (other than the civil service) employed only 27,886 in 1974, of which 19,329 were working for State enterprises.

In 1974, 260,000 children went to primary school, i.e., less than 30% of the school age population.

Needs are only partly covered in the health sector, even where there is service. In 1974, 126 doctors were practicing in Mali, i.e., 1 per 50,000 inhabitants, and there were 4,252 hospital or maternity beds, i.e., 7 per 10,000 inhabitants.

1.4 INDUSTRY, MINING, INFRASTRUCTURE

Industry is developing slowly and consists basically of processing of intermediary goods, so that value added is quite low.

In 1975, the turnover and value added of the modern sectors were appraised as follows:

in billion Malian francs

	State Industry	Private Industry	Construction	Total
Turnover	30.3	22.9	5.0	58.2
Value added	8.3	9.7	2.0	20.0

Many projects and mining prospections are being implemented in the Kayes region (bauxite, iron), Sikasso (gold) and Gao (manganese).

75 million KWH of electricity were produced in 1975; the annual rate of increase has been 10%. 2500 W of thermal power capacity and 1100 W of hydraulic capacity are installed (Sotuba). The entry into service of the Selingue dam in 1981 should allow 180 GWH of electricity to be produced, which is enough to meet near-term needs in the Bamako region.

The transportation network is still inadequate, with only two tarred highways which can be used all year round.

- Bamako-Segou-Mopti running over 680 km with a branch to Koutiala and Bobo Dioulasso
- the Bamako-Sikasso highway, which continues to the Ivory Coast.

The railway from Bamako to Dakar via Kayes has a limited carrying capacity, and its operation is difficult. It is meeting increasing competition from the Bamako-Abidjan axis for the haulage of imported goods.

The Niver river is suitable for navigation only a few months a year from Koulikoro to Gao, and navigation development projects for the Senegal river are still at a preliminary stage.

1.5 AGRICULTURE

Most of the population is in agriculture and output just barely fulfils national needs; however, the years of drought led to a deficit which had to be mitigated by imports and massive food aid.

The main crops are:

- millet and sorghum. 800,000 to 13,000,000 tons are produced per year with average yields of 600 to 800 kg per hectare. This figure is still low, but is increasing regularly in areas with extension services.
- rice is grown with full water control in the Office du Niger developments and under controlled submersion in the Niger valley. In spite of efforts made in the last few years, average production only barely exceeds 200,000 tons per year; marketing of crops never reaches 100,000 tons a year.
- corn, whose production is increasing, 100,000 tons per year.
- groundnuts, whose production has fallen from 200,000 to 100,000 tons since 1960. Efforts to restore the position have been made in the last few years (OACV project), but so far with meagre results.
- cotton, whose production increased very rapidly from 40,000 tons in 1967-68 to 140,000 tons in 1976-77.
- The Office du Niger sugar cane perimeter, whose production was 20,000 tons of sugar which is still not enough to satisfy national needs.

Major progress in farming techniques has been achieved in the last few years, in particular with the rotation of cotton and food crop production in the Southern zone; nevertheless, agricultural production is lagging behind demand, especially in urban areas which are large wheat, rice and sugar consumers. The needs for the year 2,000 have been estimated on the basis of the FAO prospective study as follows:

Rice:	495,000 tons
Wheat:	55,000 tons
Sugar:	212,000 tons

The livestock population is estimated at 5 million heads, of which a large percentage is exported on the hoof.

Fishing, which is a major occupation in the Niger river delta yields close to 70,000 tons of fresh fish and some 7,000 tons of smoked and dried fish are marketed annually.

1.6 PUBLIC FINANCE

GDP was estimated at 226.3 billion Malian francs in 1975, broken down as follows:

a) Agricultural sector	Billions Malian francs
Traditional agriculture	38.3
Industrial and export agriculture	9.3
Livestock breeding	40.9
Forestry	5.0
Fisheries	5.4
	98.9
b) Industrial sector	
Energy	3.1
Industry	28.7
Building and public works	11.0
	42.8
c) Services	
Transport	10.4
Trade	65.6
Government	31.4
Other	9.9
	117.3

The 1974-78 five-year Plan had provided for investments of 395 billion Malian francs, of which 97 billion for agriculture.

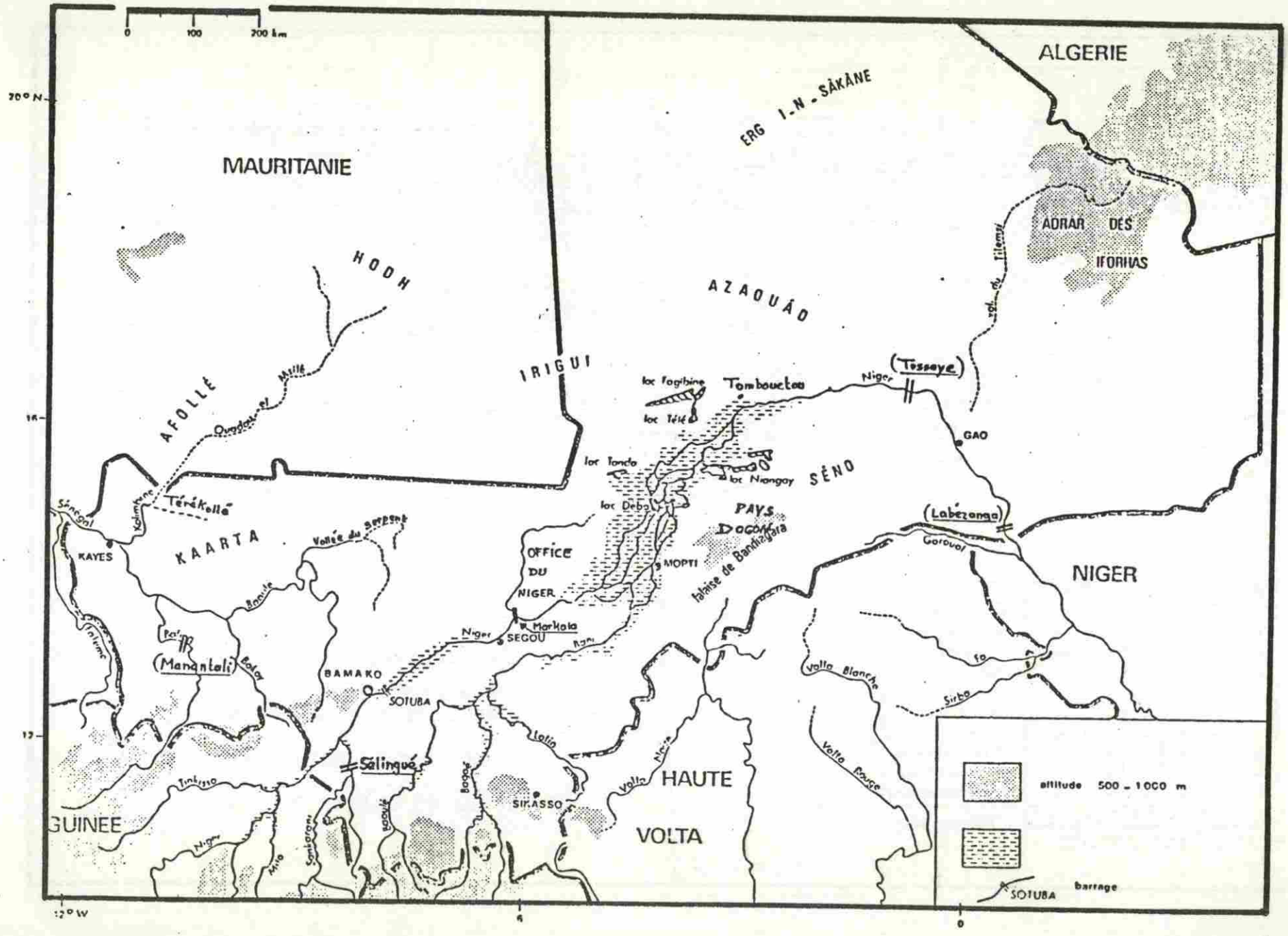
In 1977 budget outlays amounted to 56 billion Malian francs, which was almost entirely spent on current items.

In 1975, imports amounted to 76.6 billion Malian francs of which 17.7 for food products. Exports were only 23 billion Malian francs worth of cotton, groundnuts, cattle and fish.

ANNEX B (B1)

MALI

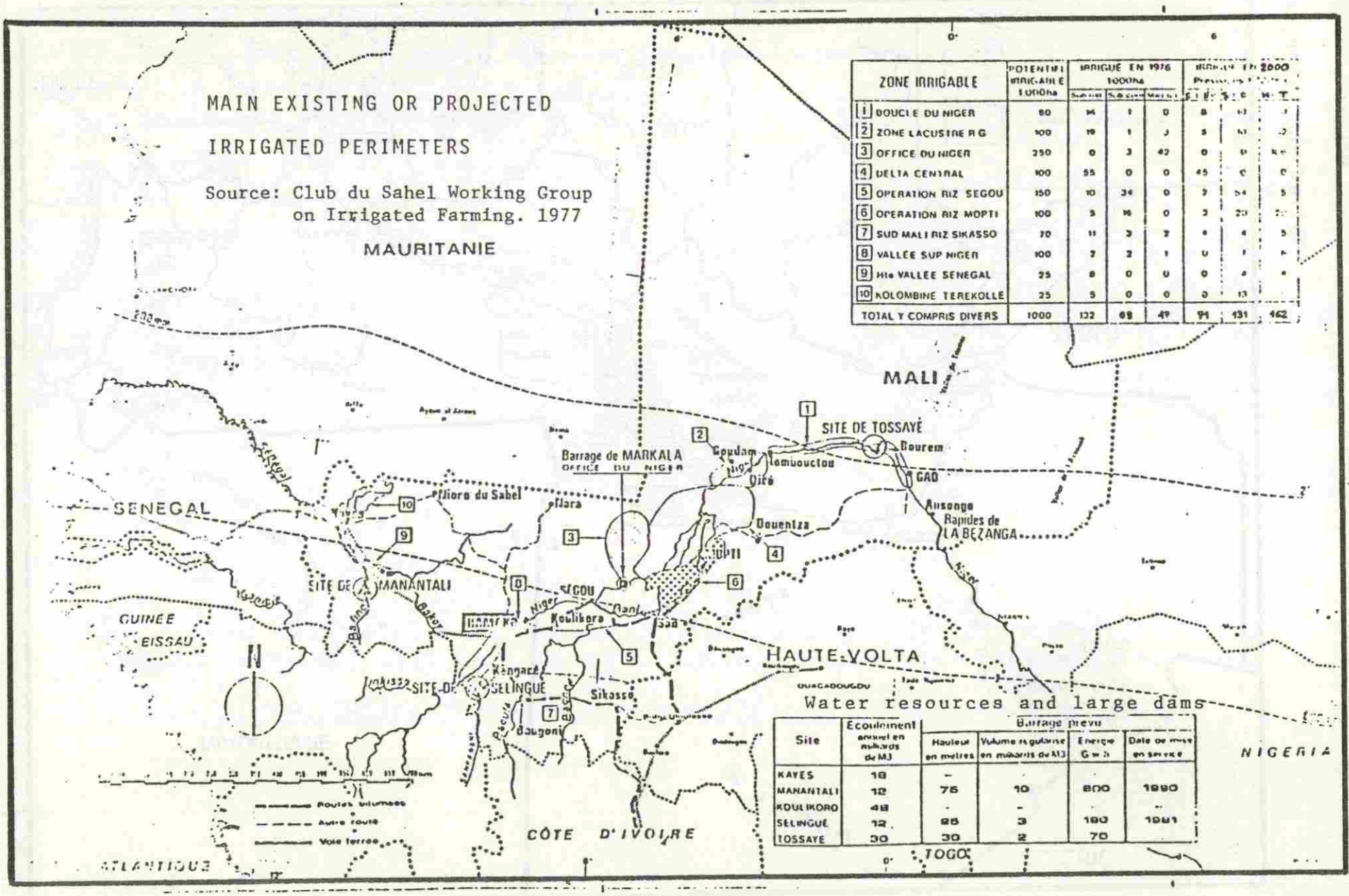
Administrative map



MALI

Relief and Hydrography

(B2)

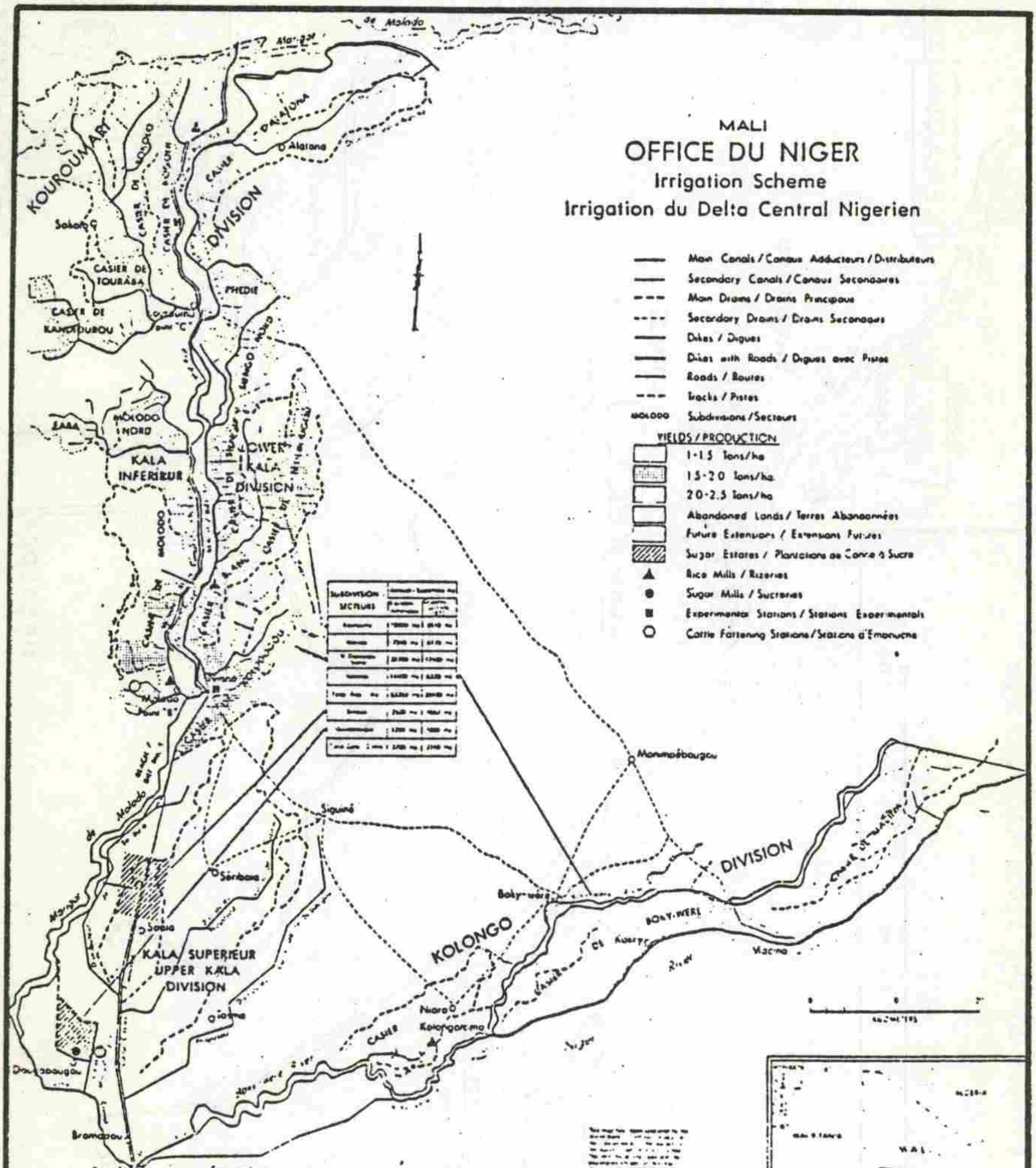


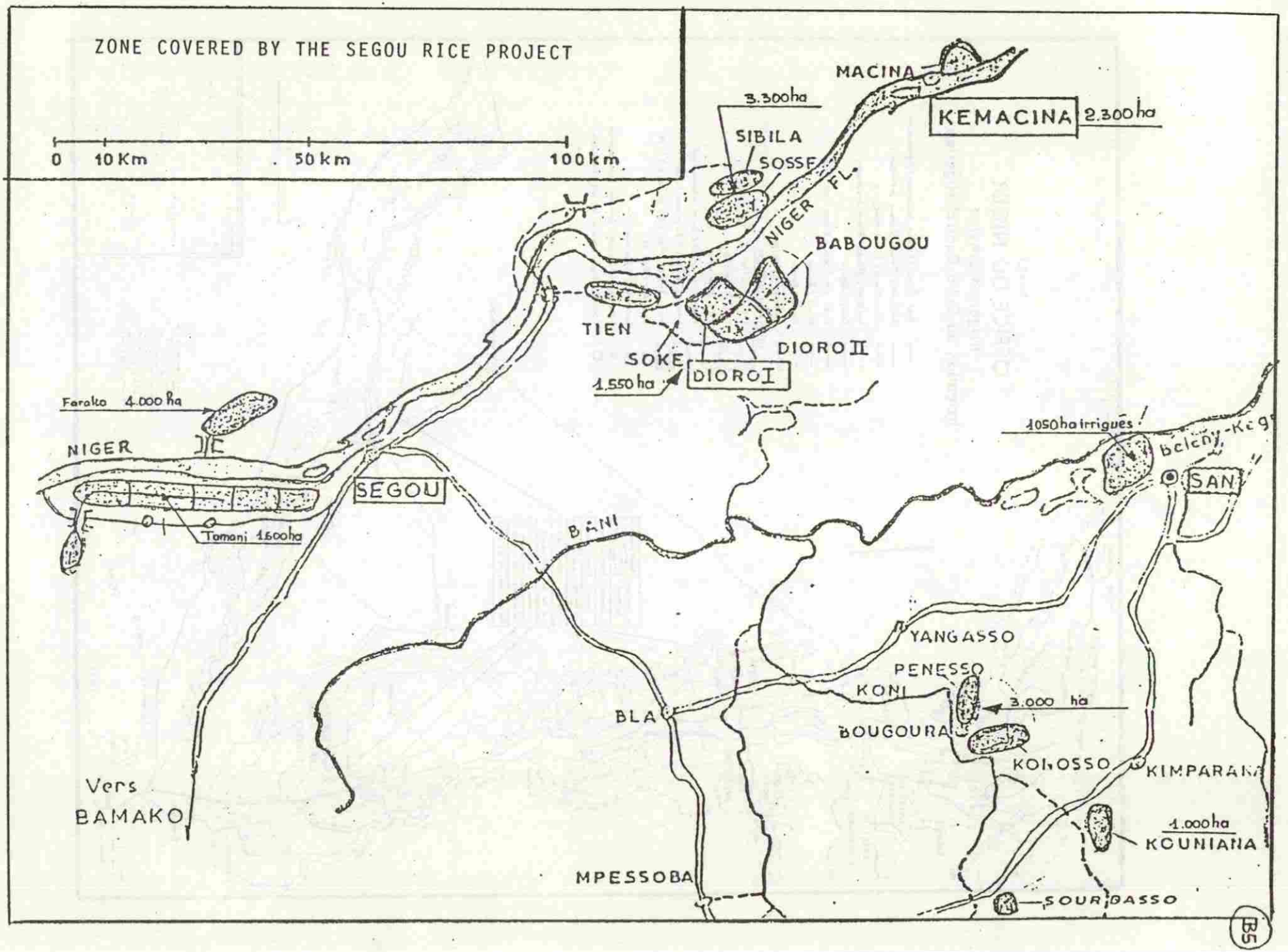
ZONE IRRIGABLE	POTENTIEL IRRIGABLE 1000 ha	IRRIGUE EN 1976 1000 ha			IRRIGUE EN 2000 Previsions		
1 BOUCLE DU NIGER	80	14	1	0	8	13	1
2 ZONE LACUSTRE R G	100	19	1	3	5	11	2
3 OFFICE DU NIGER	250	0	3	42	0	0	42
4 DELTA CENTRAL	100	55	0	0	45	0	0
5 OPERATION RIZ SEGOU	150	10	34	0	3	54	5
6 OPERATION RIZ MOPTI	100	3	16	0	3	23	25
7 SUD MALI RIZ SIKASSO	70	11	3	3	4	4	5
8 VALLEE SUP NIGER	100	2	2	1	0	1	1
9 Hte VALLEE SENEGAL	25	8	0	0	0	4	4
10 KOLOMBINE TEREKOLLE	25	5	0	0	0	13	
TOTAL Y COMPRIS DIVERS	1000	132	69	49	91	131	162

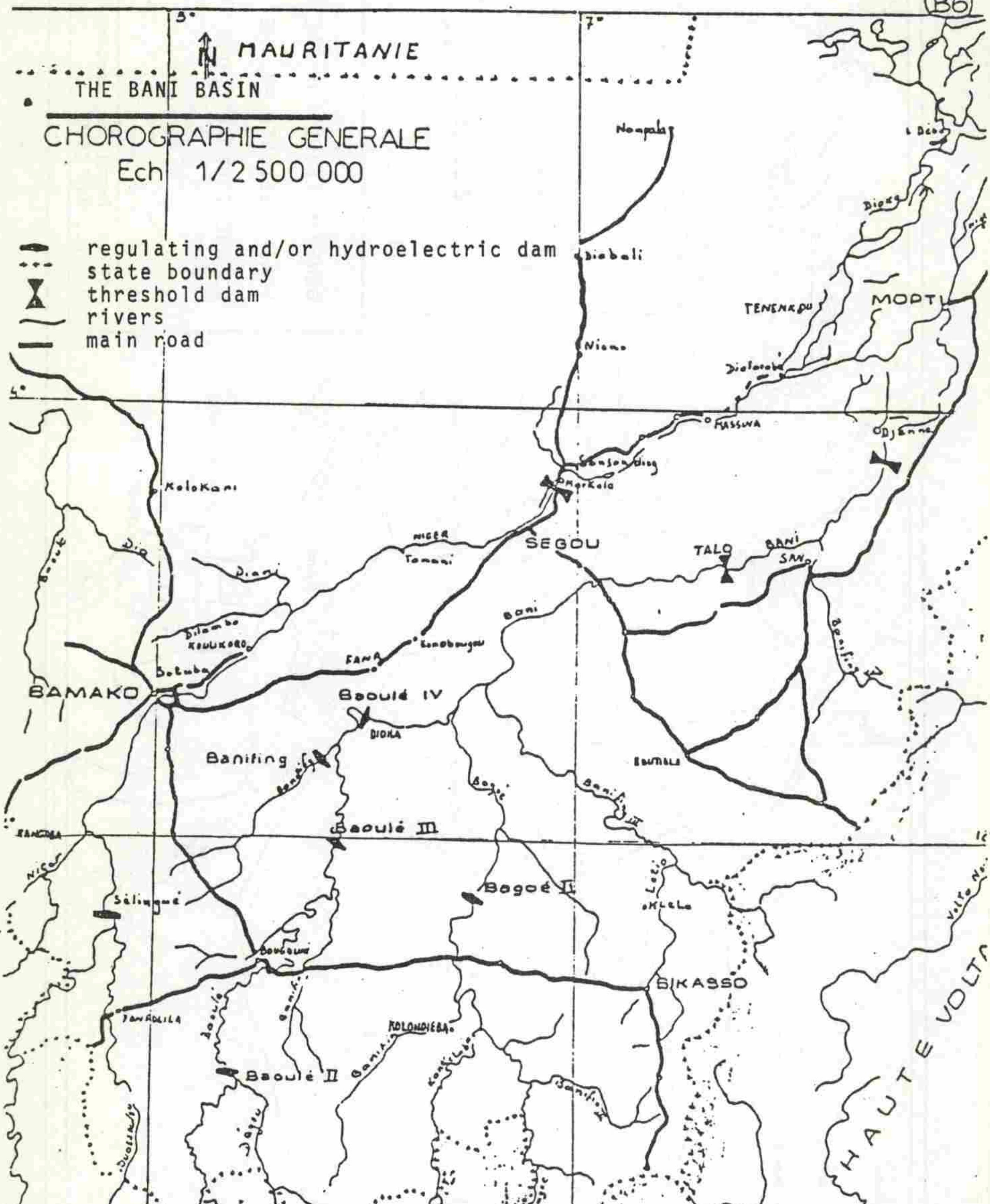
Water resources and large dams

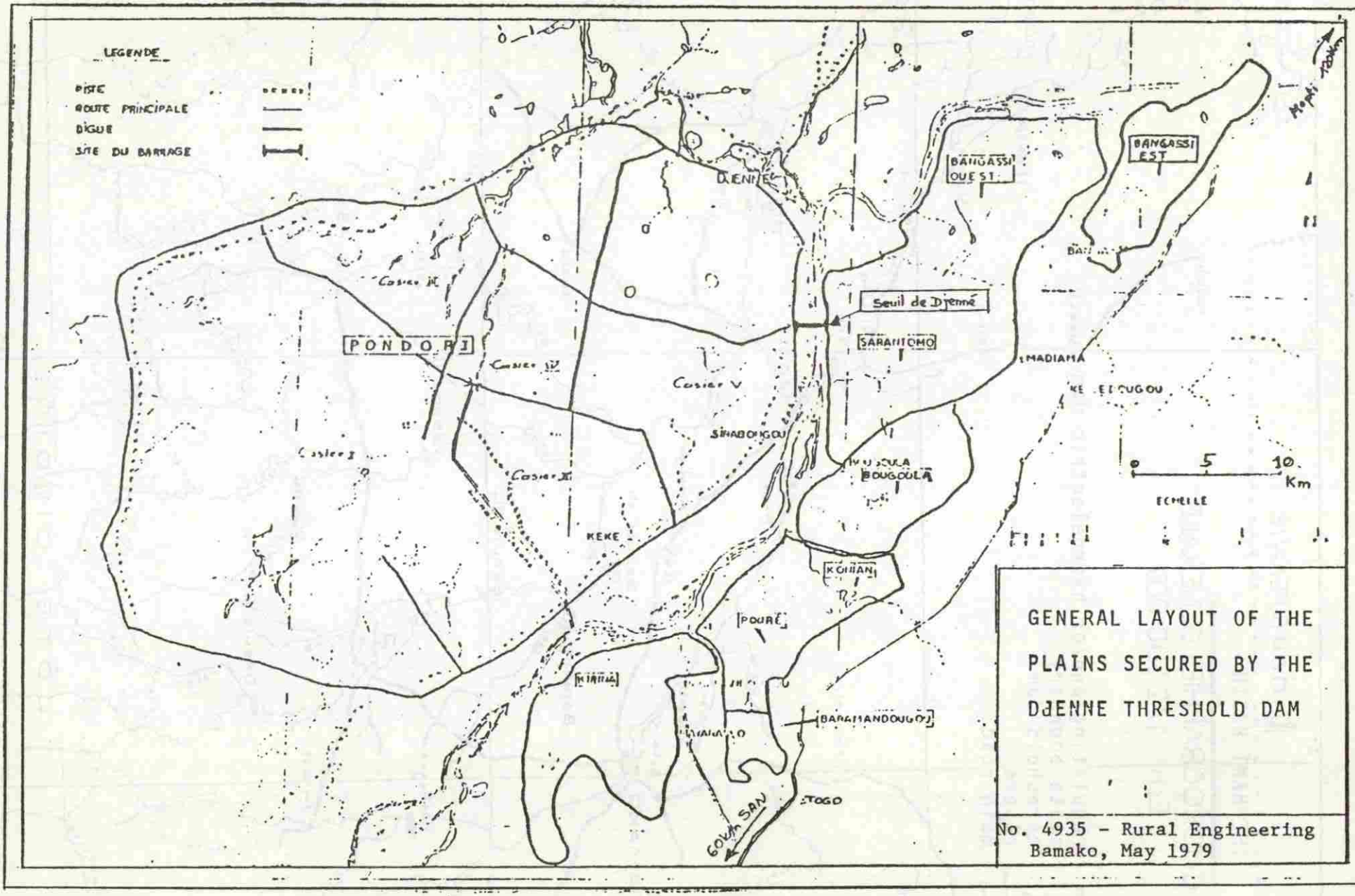
Site	Ecoulement annuel en milliards de M3	Barrage prévu			
		Hauteur en mètres	Volume régularisé en milliards de M3	Energie G W h	Date de mise en service
KAYES	18	-			
MANANTALI	12	75	10	800	1990
KOULIKORO	48	-	-		
SELINGUE	12	85	3	180	1981
TOSSAYE	30	30	2	70	

B2


MALI
OFFICE DU NIGER
Irrigation Scheme
Irrigation du Delta Central Nigerien
Main Canals / Canaux Adducteurs / Distributeurs
Secondary Canals / Canaux Secondaires
Main Drains / Drains Principaux
Secondary Drains / Drains Secondaires
Dikes / Digues
Dikes with Roads / Digues avec Pistes
Roads / Routes
Tracks / Pistes
MOLODO Subdivisions / Secteurs
YIELDS / PRODUCTION
1-1.5 Tons/ha
1.5-2.0 Tons/ha
2.0-2.5 Tons/ha
Abandoned Lands / Terres Abandonnées
Future Extensions / Extensions Futures
Sugar Estates / Plantations de Canne à Sucre
Rice Mills / Rizeries
Sugar Mills / Sucreries
Experimental Stations / Stations Experimentals
Cattle Fattening Stations / Stations d'Embouche
KOUROUMARI
DIVISION
Sokolo
CASIER DE TOURABA
CASIER DE KANDIOUROU
PHEDIE
Point "C"
MOLODO NORD
KALA INFERIEUR
LOWER KALA DIVISION
Molodo
Point "B"
Siguiné
Sériba
Sossé
KALA SUPERIEUR
UPPER KALA DIVISION
Diado
Dougabougou
Bramabou
Point "A"
Sansanding
Markala
Ségou
Niono
Kolongotomo
KOLONGO
Boky-weré
DIVISION
Macina
Monimpébougou
Niger
MALI


ZONE COVERED BY THE SEGOU RICE PROJECT
0 10 Km 50 km 100 km
MACINA
3.300ha
KEMACINA 2.300ha
SIBILA
SOSSE
NIGER FL.
BABOUGOU
TIEN
SOKE
1.550 ha
DIORO I
DIORO II
Farako 4.000 ha
NIGER
SEGOU
Tomani 1500ha
1050ha irrigués
Beleni-Ke
SAN
BANI
YANGASSO
PENESSO
KONI
3.000 ha
BLA
BOUGOURA
KOLOSSO
KIMPARANA
Vers
BAMAKO
1.000ha
KOUNIANA
MPESSOBA
SOURDASSO
B5


B6
MAURITANIE
THE BANI BASIN
CHOROGRAPHIE GENERALE
Ech 1/2 500 000
regulating and/or hydroelectric dam
state boundary
threshold dam
rivers
main road
MOPTI
SEGOU
TALO
BANI
SAN
BAMAKO
Baoulé IV
Baniting
Baoulé III
Bagoé II
SIKASSO
Baoulé II
Sélingué
KOULIKORO
FANA
MASSINA
HAUTE VOLTA
CÔTE D'IVOIRE
NIGER
KOLONDIEBA
DIOILA
Niono
Diabali
Kolokani
Bani
Bagoé
3°
5°
7°
8°
11°



GENERAL LAYOUT OF THE PLAINS SECURED BY THE DJENNE THRESHOLD DAM

No. 4935 - Rural Engineering
Bamako, May 1979

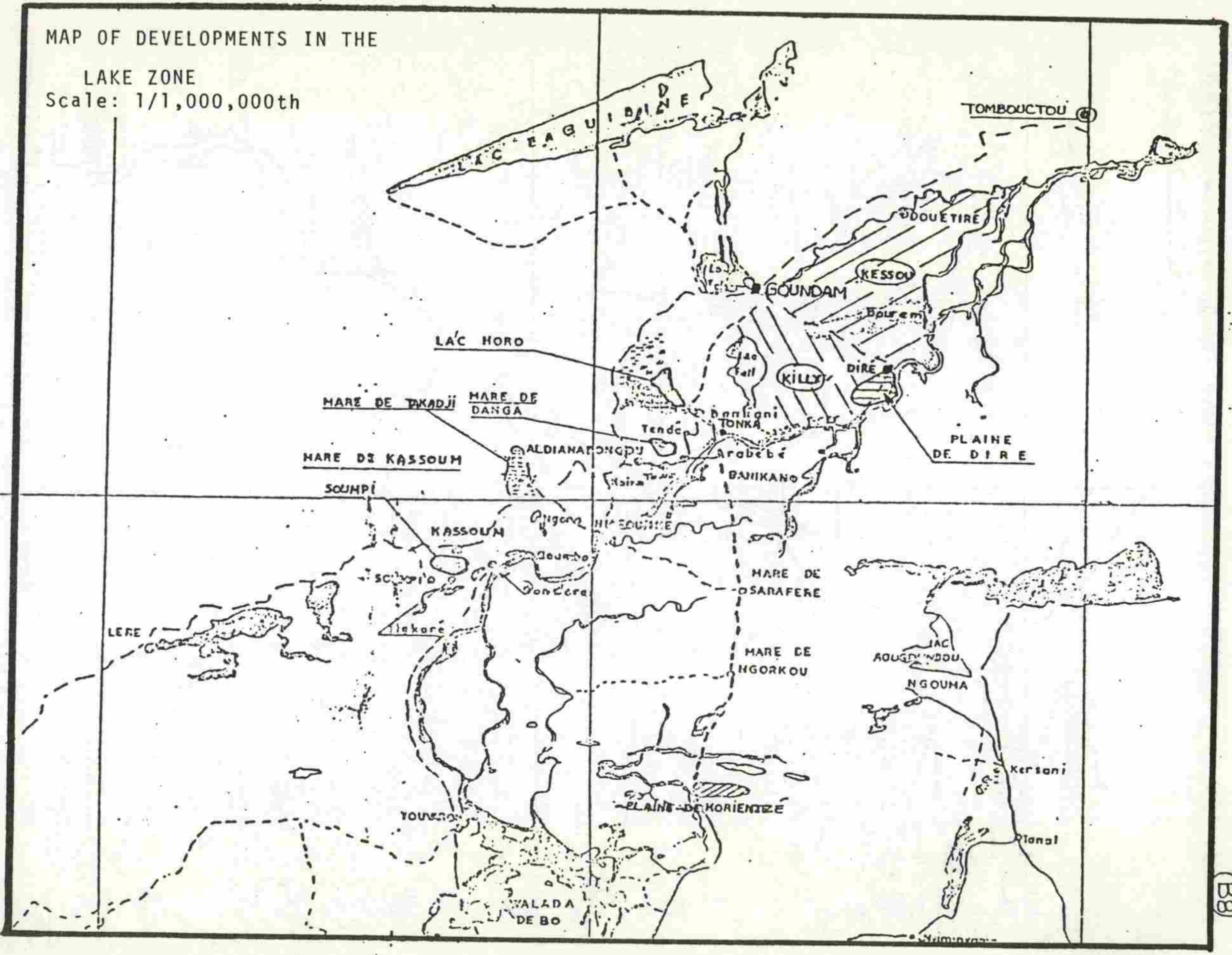
(B7)

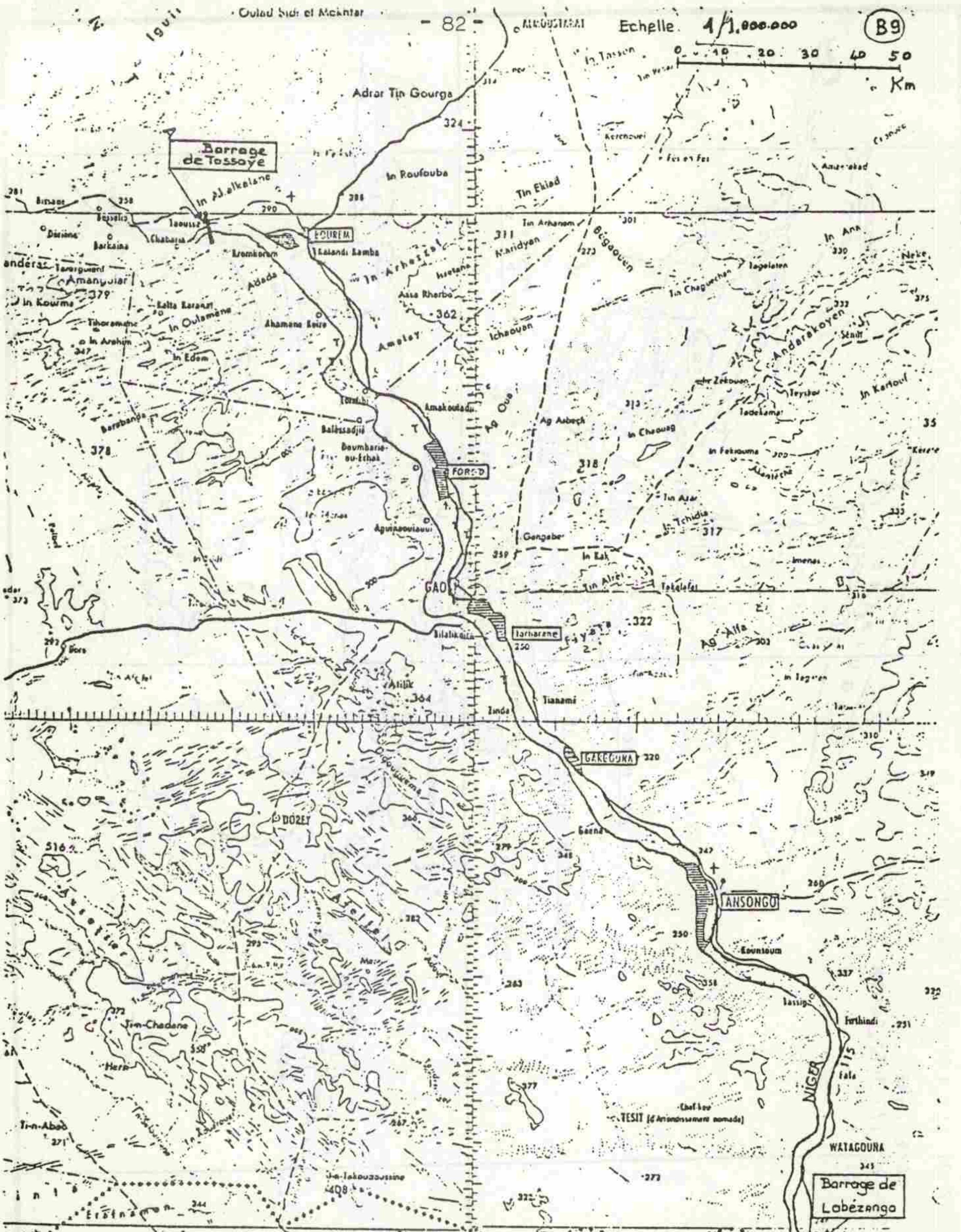
B8

MAP OF DEVELOPMENTS IN THE

LAKE ZONE

Scale: 1/1,000,000th




Echelle 1/1.000.000
B9
0 10 20 30 40 50
Km
Oulad Sidi el Mokhtar
Adrar Tin Gourga
Barrage de Tossoye
In Roufouba
Tin Ekiad
BOUREM
Tin Arhanom
Bégaouen
In Arhezzal
In Chaguechen
Amanyuiar
In Koumo
In Oulamène
Asso Rherbo
Ahamane Koira
Ichaouan
Andarakoyen
In Edem
Amakouladji
Ag Aobech
In Chaouag
In Fekrouma
Ballessadjie
Boumbaria ou-Echak
FORGO
Aguisaouiaoui
Gangaber
In Eak
GAO
Tin Alrel
Tarharane
Ag Alla
Bilalikoira
Tianami
In Tagarten
Atilik
Zinda
GAREOUNA
DOZEY
Gaena
TANSONGO
Eountoum
Tin-Chadene
Forthindi
NIGER
TESIT (cf Arrondissement nomade)
Chef lieu
WATAGOUNA
Barrage de Labézanga
Erafnamon
HAUTE VOLTA
NIGER
Bessé Bangou
Eskdabé

A N N E X C

TREND OF PRICES FROM 1974 TO 1978:

- agricultural equipment
- Inputs
- Producer prices
- Consumer prices

		1974	1978
Agricultural equipment			
(TM) plough	value	23,600	52,870
	index	100	224
Multi purpose tractor	value	30,000	88,795
	index	100	295
Sowing machine	value	18,500	58,010
	index	100	313
Set of wheels	value	32,800	71,060
(1000 kg tyres)	index	100	216
Inputs (kg)			
Cotton	value	55	125
	index	100	227
Super simple	value	40	65
	index	100	162
Urea	value	63	110
	index	100	174
Insecticide (1)	value	400	1,000
	index	100	250
Producer prices			
White paddy	value	60	88
real prices (1)	index	100	146
Cotton	value	73	95
	index	100	130
Groundnuts	value	40	60
	index	100	150
Millet-sorghum-corn	value	48	69
(real prices) (1)	index	100	143
Consumer prices			
Index of cooperatives		100	182
Free market index		100	190

(1) Weighted average of official and parallel market prices.

TREND OF DAILY EARNINGS FOR AGRICULTURAL WORK BY MAIN CROPS

Sources: ORSP - SCAER - IER - General Statistics Division (Values in M.F.)

		At official producer prices		At real prices (weighted average of official and free prices)	
		1971/72	1978/79	1971/72	1978/79
Cotton	Value	280	496	-	-
	Index	100	177		
Groundnuts	Value	224	448	-	-
	Index	100	200	-	-
Millet-sorghum					
Cotton zone	Value	215	516	368	1,008
	Index	100	240	100	273
Groundnut zone	Value	152	342	261	692
	Index	100	225	100	265
Millet zone	Value	147	347	230	615
	Index	100	236	100	267
Paddy					
Mopti rice project	Value	213	484	400	1,196
	Index	100	227	100	299
Office du Niger	Value	206	670	337	718
	Index	100	170	100	213

INDEX OF CONSUMER PRICES FROM 1971 to 1978

Cooperatives		Market	
1971	1978	1971	1978
100	240	100	270

THE MINIMUM WAGE (index) FROM 1971 to 1978

State bodies		Private concerns	
1971	1978	1971	1978
32	73	un-known	un-known

Hourly value index

RICE IN WEST AFRICA (1)

1976 figures

	Area in 1000 hectares	Production (3)	Yields ton/ hectare	Net imports 1977 (1,000 tons) (4)	Cost of imports ($1000)	Stocks at end year (tons)	Consumption per inhabitant (kg)	Self sufficiency (%)	Paddy producer price ($/kg)	Wholesale price ($/kg)
The Gambia	27.1	35.0	1.290	31.9	6.322	10,493	84.2	38.9	0.18	0.28
Upper Volta	40.0	36.4	0.910	12.1	3.829	00	5.7	62.3	0.15	0.34
Mali	223.0	264.0	1.184	-20.0	- 582	31,000	25.3	94.8	0.08	...
Mauritania	1.3	5.1	3.898	52.0	4.288	4,403	28.7	5.5	0.20	0.40
Niger	21.7	28.7	1.322	7.4	1.400	1,383	3.5	80.1	0.16	0.34
Senegal	81.0	112.0	1.383	276.8	67.361	14,000	55.8	22.6	0.17	0.31
CILSS countries	394.1	481.2								
Benin	10.2	18.4	1.805	20.0	3,410	00	5.5	33.2	0.15	0.40
Ghana	81.0	50.8	0.627	43.0	111	...	3.8	99.0	0.32	1.03
Ivory Coast	364.0	425.0	1.168	159.0	-5.546	21,890	47.4	77.6	0.27	0.36
Liberia	200.3	245.0	1.223	55.8	12.897	00	102.5	77.4	0.27	0.49
Nigeria	278.0	534.0	1.921	427.4	32.046	...	4.4	86.5	0.56	...
Sierra Leone	463.4	642.0	1.385	16.5	1.085	7,377	125.1	94.1	0.15	0.47
Togo	22.3	20.8	931	18.2	1.743	1,000	9.6	49.0	0.15	0.40
(2)										

Note: 00 - Nil or negligible
... - not available

(1) Statistics drawn from WARDA Yearbook, July 1978, MONROVIA (Liberia)
(2) The Guinean Republic joined WARDA in June 1978. The Cape Verde Islands, a member of the CILSS, do not grow rice.
(3) The average yield in processing paddy is 66% of rice.

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. General overview of cereal operations in the 1974-78 five-year period (IER, May 1979)
. Consolidation of the Segou rice project (Rural Engineering, October 1978)
. Preliminary study of the Djenne threshold dam (Rural Engineering, April 1979)
. Development of and accessibility to the Dire plain (Rural Engineering, February 1979)
. Small dams in the Dogon district (Rural Engineering, March 1979)

OFFICE DU NIGER

. Technical specifications of rehabilitation projects
. Identification report of the IBRD (June 30, 1978)
. WARDA: June 1974 identification mission report
. Internal Office du Niger documents

B - CILSS/Club du Sahel documents

. Documents of the Working Group on Irrigated Farming, May 1977
  - General report on irrigated farming
  - National Malian report on irrigated farming
  - Technical specification sheets of irrigated farming projects
. The Office du Niger rehabilitation project (J. Le Bloas, D. Diamoutene, September 30, 1977)
. Office du Niger: record of the Segou meeting (November 1978)
. For the rehabilitation of the Office du Niger (J. Le Bloas, December 1978, published in No. 43 of "Afrique Agriculture", March 1979)

C - Other documents

. Mali: statistical data (French Ministry of Cooperation, July 1977)
. The agricultural sector in Mali (Center for Research on Agricultural Development, University of Michigan, December 1976)

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(1) Various unpublished working documents submitted by Malian departments should be added to this list.

- Study of water uses in Selingue (Courtoy Office, 1976)
- Mopti rice project: Evaluation report of the IBRD (December 1977)
- Monograph on the Niger River, ORSTOM (1968)
- Documents of the OMVS
- Documents of the Rural Engineering Directorate

ANNEX D

NIGER AND SENEGAL RIVER DEVELOPMENTS

A - THE NIGER RIVER

The upper Niger, fed mainly by the Fouta-Djalon foothills, has an average flow of 48 billion cu. meters at Koulikoro, downstream from Bamako. Then, in spite of further large inflows originating in particular from the Bani, it loses a substantial amount of water in the interior delta which covers almost 800,000 sq. km between Mopti and Timbuktu. As a result, its average annual flow at the top of the loop declines to 30 billion cu. meters.

Many developments have already been studied individually but no general investigation into hydro-electrical potential has been performed as for the Senegal river. They are:

- the Sotuba run of river dam, installed in 1966, which can produce 33 GWH per year.
- the Selingue dam on the Sankarani river, which is under construction and is designed to produce 180 GWH per year.
- The Tossaye dam at the top of the loop of the Niger river.
- the Labezanga rapids which could be equipped, but would run the risk of being flooded by the Kandadji dam
- the Kandadji dam site in Niger, which is a very large multipurpose project
- the "W" rapids which can be harnessed by a run-of-river plant
- the Baoule and Bagoe sites on the Upper Bani river

1. The Selingue dam

The project includes the construction of the Selingue dam on the Sankarani, which is a tributary of the Niger river, located 130 km Southeast of Bamako; the construction of a hydro-electrical power plant at the foot of the dam and the installation of a 140 km long 150 KV high voltage line connecting the plant to Bamako and to the electrical sub-stations. The construction of several other plants

on the Niger river (Kenie, Markala and Tossaye) could be envisaged later to complete this first development. An access road to the dam site was built from the Bamako-Abidjan national highway 5, 54 km away. The reservoir area covers two river valleys, each 65 km long.

- Status of the project: work began end 1976. Civil engineering work and the hydro-electrical power plant were contracted to a consortium of firms, including SATOM, the consortium leader, Sainrapt-et-Brice, SNTP-Fougerolles (France), SAFRICAS (Belgium), ABU (Germany) and SONETRA (Mali).
- Scheduled date of entry into service: 1980 for the four turbo-generators; connection of the first unit to the line is scheduled for July 1981.
- Dam specifications: Total length at crest: 2,500 m. Dam capacity: 2,256 million cu. meters. Storage reservoir covering 415 km at elevation 348.5 m.
- Installed capacity: 44,400 KW at the final stage (using 4 Kaplan 11.1 mW turbo-generators.)
- Expected production: 181 million KWH in normal production (159 million KWH in dry years).
- Outlets: in addition to the electrical supply of the plant, the construction of the dam will allow agricultural output to be improved (irrigation of 55,400 hectares: irrigation of 1,100 hectares of the projected perimeter downstream and improvement of irrigated perimeters developed by the Office du Niger for bi-annual harvesting) as well as the suitability for navigation of the river on the section between Koulikoro and Markala.
- Estimated total investment: 60 billion Malian francs, of which 33 billion for civil engineering work on the dam and the plant.
- Financing: loans and subsidies from Arab Funds and Countries (29.4 billion Malian francs), the FED (10 billion Malian francs), KFW (7.2 billion Malian francs), France (7 billion Malian francs, of which 3.5 billion from the CCCE, 2 billion from FAC, and 1.5 billion of export credits guaranteed by the COFACE), CIDA (4.2 billion Malian francs), ADF (3.6 billion Malian francs) and the AFDB (3 billion Malian francs).

2. The Tossaye dam project

The development could include a dam on the course of the river, with a rockfill-protected structure of sand and slate and an impermeable clay core.

Maximum height of foundations		36 m
Length at the crest		275 m
Normal reservoir level		258.50
Volume of reservoir		2.4 billion cu.m.
Low water level	approx.	250

A hydro-electrical line would be supplied by 7 generating sets (one kept in reserve for emergency and maintenance) of 2.8 MW unit power, assembled on three levels, with guaranteed power of 16.8 MW in the final stage for an annual rated power of 67 GWH.

The type of management adopted would allow a level flow of 330 cu. meters per second in average years and 200 cu. meters per second in dry years.

The cost of the dams (in 1976 prices) is estimated at 80 billion Malian francs ($166 million), of which 56 billion for phase I.

The documentation is at "rough draft of project-feasibility study" stage. A feasibility study financed by FAC is under way.

3. The Labezanga dam project

A prefeasibility study was carried out by the SOFRELEC in 1978 for a development located at the Nigerian border. The Labezanga site is characterized by several kilometers of rapids and a change in water level of approximately 5 m. The proposed development involves:

- an embankment dam whose crest is at elevation 246.5 m for a normal reservoir level of 243.5 m. The minimum varies between 224.5 and 229.
- a hydro-electrical power plant and a lock
- a side canal used for navigation

The rated power of the sites equipped would be 65 MW (5 x 13 MW turbogenerators) yielding an annual output of 260 MW with guaranteed power of 29.5 MW; if the Tossaye dam were built upstream from Labezanga, the average guaranteed power would reach 38 MW for an annual output of 380 MWh.

The cost of the dam structures is estimated at 100 billion Malian francs ($220 million).

B - DEVELOPMENT ON THE SENEGAL RIVER

The Manantali dam project

- Nature of the project: construction of a reservoir-dam at Manantali on the Bafing, which is a tributary of the upper section of the Senegal river (Kayes region), with a hydro-electrical power plant at the foot of the dam.
- State of progress of the project: the first studies were drafted in 1970 by the OMVS. In August 1976, the OMVS and the "Euro-African Association of Engineering Consultants" consisting of the RRI (Dortmund), Electricity and Traction Corporation (TRACTIONEL) (Brussels) and the National Development Studies Corporation (SONED) (Dakar), signed a contract for the implementation study of the dam and the hydro-electrical power plant. Work was to begin by end 1979 or early 1980.
- Expected date of entry into service: 1985.
- Rockfill dam with a central core formed by concrete buttresses. For the lowest elevation, 148 m IGN, the

maximum operating level would be 208 m, the crest of the dam being leveled to 212 m. Total length of the dam would be 1485 m and its construction would necessitate 720,000 cu. m. of concrete and 5,500,000 cu. m. of rockfill embankment.

- Specifications of the dam: height 70 m - length 1 km - reservoir capacity 16 billion cu. m.

- Installed power of the plant 200,000 KW (8 "Francis" type 40 KW turbines).

- guaranteed power: 100 KW

- Expected plant output: 300 million KWh in the first year of operation and then 650 million KWh per year (which can be increased to a guaranteed production of 800 million KWh.)

- Outlets: the reservoir-dam is intended to regulate the flow of the Senegal river to 300 cu. m. per second and render it suitable for navigation from June to November between Kayes and St. Louis, opening an outlet to the sea for Mali. The structures will also make it possible to develop the irrigation of fertile lands in the Senegal river valley, i.e., 428,000 hectares, and to work the mineral resources of the region (bauxite, iron).

- investments: 90 billion CFA francs

- Financing: In particular, a contribution from Germany (8 billion CFA francs), and the participation of UNDP (18,750 million Malian francs) are scheduled in the five-year plan.

If the construction of the hydro-electrical power plant was not undertaken, the investment cost would be reduced to 74.3 billion CFA francs and to 50 billion, if the normal reservoir elevation were reduced to 195 m.

ANNEX E

CILSS/CLUB DU SAHEL
Irrigated Farming
October 1979

MALI

PROJECT SHEET NO. 1

DEVELOPMENT OF IRRIGATED PERIMETERS IN

THE KAYES REGION

(first region)

1. HISTORY

1.1 Origin

a) The FAO-UNDP Agronomic Research Programme presented by the OMVS in 1970 aimed for an increase in truck gardening crops in the Kayes region, in addition to the improvement of rice farming techniques and the development of basins. This operation including small perimeters irrigated by pumping was managed by the farmers themselves.

b) The demoralizing effect which the drought had on the whole of Mali, especially in the Kayes region, where it lasted 4 years, until 1974.

1.2 The Kamenkole pilot perimeter was developed in 1971, 3 km downstream from Kayes, and later, led to further developments in Kassonke and Sapou-Kakoulou.

In March 1975, the FAC financed the implementation of an "Irrigated perimeter project for Kayes".

2. IRRIGATED PERIMETER PROJECT

2.1 In December 1975, the irrigated perimeter project included 7 perimeters located downstream and upstream from Kayes, covering 76 hectares, of which 21 hectares of truck gardening crops and 55 hectares of cereals. It was allotted to 206 persons.

2.2 Project for the development of new perimeters

Studies under way, financed by the FAC cover 500 hectares net, divided as follows:

Perimeters	Double Annual Crop Area	Rainfed Crop Area	Total Surface
a) Upstream from Kayes			
Moussa-Guya (left bank)		40 hectares	40 hectares
Gombaye (left bank)	30 hectares	290	320
Maloum (left bank)	10	10	20
Djimekon (right bank)	20	90	110
			490
b) Downstream from Kayes			
Djibril Bougou (left bank)		50	50
TOTAL	60	480	540

b) Funded by Kuwait

2,000 hectares net are scheduled to be developed, of which 400 hectares immediately after the studies.

2.3 Irrigated perimeter short-term programme

At least 4 new perimeters will be created by 1981 at the request of the local population -- and of Malian workers who emigrated to Europe and want to return to their homeland.

These irrigated perimeter projects necessitate foreign assistance for extension and advisory personnel: FAC, USAID, NGOS (CIMADE, SUCCO . . .)

3. OPERATION OF AN IRRIGATION PROJECT

- A group is formed at the village level
- Perimeter development (clearing, weeding, building of irrigation and drainage canals) is undertaken collectively by the farmers themselves.

- Tracts are allotted by drawing lots. The land allotment norms are as follows:

  a) market gardening: 2,500 sq. meters
  b) other crops: 5,000 sq. meters

  Each allottee must develop his tract himself.

- A management committee including a technical adviser, a manager and one or more supervisors, heads the group; the main tasks are: selection of allottees, organization of water supply, crop marketing, effecting payment for production inputs, network maintenance and amortization of collective equipment.

- The Irrigated perimeter project supplies technical advisory staff, installs means of production, determines the pattern of crop rotation, organizes marketing of products and controls group management.

PROJECT SHEET NO. 2

DEVELOPMENT OF IRRIGATED PERIMETERS

IN THE KOULIKORO REGION

(Second region)

I. GENERAL

The development potential of the Koulikoro region is not as great as in Segou or Mopti. Nevertheless, its proximity to the capital has promoted cereal farming and cultivation of specialized crops for local consumption markets. In addition, rainfall exceeds 1100 mm, which makes special types of developments possible.

II. EXISTING PERIMETERS AND PROJECTS UNDER WAY

1 - Irrigated development with full water control

At present private farmers grow a substantial volume of fruit, tobacco and truck gardening crops on more than 5,000 hectares, pumping water from tributaries or wells. Large perimeters irrigated with full water control are located at:

- Baguineda: 3,000 hectares, of which 400 farmed (improvement work is in progress)
- Farakamo-Samanko: 500 hectares, development under way

2 - Developments under controlled submersion, all located in the upper valley upstream from Bakamo:

a) Traditional perimeters drawing water from the river (Guekbo-Figuiratomo)

b) Perimeters fed by a tributary (Krima, Dioulafomalou, Kangabo, Figuirokaro - Nanguila, Kerriegne - Bananbsare)

c) Perimeters fed by a tributary, with the addition of a network; only standing rice can be farmed: Bankoumana

Perimeters under controlled submersion cover approximately 3,500 hectares, of which 700 hectares in Bankoumana. In general, they function poorly, except in Kirina (200 hectares).

3 - Studies under way

They consist of:

- Development of the Selingue downstream perimeter: 1,000 hectares irrigated, producing two crops a year
- Development of a 5,000 hectare sugar perimeter in the Upper Valley at Madina, Bankoumana or Koursali: the site has not yet been selected and is in competition with another at the Office du Niger.
- Redevelopment in the Bankoumana plain for irrigated rice growing with full water control (900 hectares irrigable from August to October). The work is programmed by USAID.

It should be noted that in 1974 the Rural Engineering Department executed a feasibility study of a 2,800 hectare plain under submersion.

Finally, reconnaissance studies revealed certain possibilities:

- Farming of submersible land around the Selingue dam reservoir
- Extensions of the Selingue perimeter downstream of approximately 300 hectares
- Extension of irrigation by pumping at Baguineda: approximately 7,500 hectares
- A similar perimeter at Bankoumana, at Balanyan in the upper valley (approximately 1,000 hectares)

III. PROGRAMMES TO BE PROVIDED FOR (financing sought)

They are, in order of priority:

1°. Development of the Selingue perimeter: approximately 4 billion Malian francs

2°. Development of the 5,000 hectare sugar perimeter: approximately 50 billion Malian francs.

3°. Progressive improvement of the Baguineda perimeters, in the light of demand for truck gardening products.

4°. Redevelopment of the Upper Valley: approximately 1 billion Malian francs.

PROJECT SHEET No. 3

STATUS AND PROSPECTS

OF IRRIGATION PROJECTS IN THE SIKASSO REGION

(Third region)

I. GENERAL

The Sikasso region receives sufficient rainfall, which allows various developments to be carried out, as there are rivers with year-round flow.

Most of the present developments are designed for rice growing. Notwithstanding, the region could grow other crops: tea, citrus fruit, tobacco, sugar cane, etc.

II. TYPES OF DEVELOPMENT

The developments which have been projected so far are of various types:

1°. Development of low grounds, traditionally farmed using small dykes, depending on the contour lines, with throughflow via outfall canals. This type of development was carried out at Gouene (100 hectares) but has been given up.

2°. Low ground development using a single lock dyke downstream, which regulates the water level through a drain network. This system of controlled submersion is difficult to operate. It exists only at Doumanabo (200 hectares) and Sinkolo (500 hectares).

3°. Development of low grounds crossed by a river, with a coffer-dam on the river. When the flood level is low, the dam is locked. The water pours freely on to the plan through openings in the rise of the bank. This type of development is appropriate in perimeters where there is a heavy overflow from the tributary in high flood but for which it would be too expensive to build full dykes. This type of development exists at Bambodougou (200 hectares), Samarossani (200 hectares), and Faboula Tourournasle (100 hectares), but it is difficult to determine the areas which are actually flooded.

4°. In another type of development, the threshold on the river is extended by a canal which supplies a series of tracts at various levels cultivated under controlled submersion. This development exists at Kihela (1,000 hectares), with tracts on which the water level is below 60 cm. It is also found in Kouninana (800 hectares) and Sourbasso (500 hectares) where floating rice is grown, presently as part of the Segou rice project.

5°. The canal supplies a traditional irrigation network instead of a network under controlled submersion. This type of development exists at Kado (150 hectares), Kargouan (200 hectares) and at the tea farm in Farako (100 hectares).

6°. Earlier developments relied on water being available from the tributary throughout the entire growth period of rice. If this is not the case, it can be remedied:

a) by using water reserves stored at night for daytime irrigation, as is done in the tea farm in Farako.

b) by storing fortnightly or monthly reserves of water until October 20th, which is the end of the period for irrigation of rice (project under review for consolidation of Srinkole).

c) by reservoir dams designed to store water all year round.

Type (b) developments are not very expensive. It would be beneficial to undertake them in the northern area of Sikasso, where tributaries dry up very quickly, but cross extensive plains where rice could easily be grown. On the other hand, reservoir dams should not be advised, except for very specialized crops, by reason of the high initial outlay per hectare.

7°. A last type of development would consist of draining the large areas of low ground, especially in the circle of Kontisala, where the tributary is too small to guarantee adequate irrigation. These zones could grow corn, sorghum or cotton.

III. PRESENT STATUS

At present, the Sikasso region is supervised by the Rice Department of the CMDT, apart from the tea farm in Farako and the small-scale truck gardening developments around the town. The Rice Department is assisted by the FED for developments under way in the Samazassani plains (changeover from type 2 to type 5),

Penza (150 hectares) and Sohourale (200 hectares), type 4 or 5. The seeds are supplied by the farm in Dalabani (50 hectares) which needs to be redeveloped. A 10,000 ton rice mill is projected at Sikasso.

With the help of the Rural Engineering Department, the Rice Department has studied:

- the Taniena development (2,000 hectares), type 4
- the Labouala development (200 hectares), type 5, of which 100 hectares could be used to grow tea.

Studies for the redevelopment of Sinkole (760 hectares, type 6b) also exist. Complementary hydrological studies are required.

Many surveys of rice plains have not been followed up by feasibility studies.

Finally, attention should be drawn to two studies:

- the preliminary study of a 4,000 hectare sugar perimeter in Katioroniba. This was provisionally set aside because of drainage difficulties.
- the study of a 70 hectare perimeter at Famako.

IV. FUTURE PROJECTS

Rice farming projects to be undertaken in the next Plan include:

- the redevelopment of the Faboula and Faramisoin plain from type 3 to type 4 or 5
- the redevelopment of Sinkolo (760 hectares)
- the development of Taniena (2,000 hectares)
- the development of Labouala (200 hectares)

The only development which raises technical difficulties is at Labouala, where tea can be grown. Prior missions of specialists in this type of plantation are needed.

It would be useful to complete this work by surveys of new plains covering approximately 3,000 to 5,000 hectares, with a combination of small (100 to 200 hectares) and large plains (1,000 hectares).

In addition to this rice farming programme, which in principle will be financed by the FED, a fruit and truck gardening development programme should be implemented for local consumption: tea, citrus fruit, pineapples, avocados, bananas and possibly fruit flavorings for the export market.

PROJECT SHEET NO. 4

STATUS AND PROSPECTS OF IRRIGATION PROJECTS IN THE SEGOU REGION

(fourth region)

I. GENERAL

1.1 The developments proposed in the Segou region relate strictly to the Niger and Bani river valleys. Only rice has been grown on these perimeters up to now; nevertheless, a diversification of crops should occur slowly, largely because the farmers of the Segou region are among the most advanced in Mali.

Apart from Office du Niger developments which are dealt with separately in the present note, and the San plain, all rice is grown under controlled submersion: it is sown at the beginning of July after ploughing and harrowing. It grows under rain until around August 20th. In principle, the flood begins to spread into the plain at this date. It rises until October 25th and remains level until November 5th. Subsidence of the river occurs after this period. The crop is harvested 15 days after the rice fields have emerged.

1.2 The principle of development is simple: a generally low dyke protects the perimeter against the flood level of the Niger occurring 99 years out of 100. A canal leading from the Niger upstream from the plain crosses the dyke on a concrete structure fitted with gates, coffer dam and flows to the center of the plain. Generally, a second canal and a second structure downstream discharge the water draining off. Auxiliary canals distribute water from the main canal to all the low-lying areas of the plain.

The first developments under controlled submersion were executed in 1948 and their design has greatly changed since. Until 1973, it was thought enough to guarantee filling for the low floods occurring every five years. The recurrent droughts since 1972 have led to a search for a safety margin of at least 95% or even 100% and development programmes have been reorganized accordingly. A security level of

95% to 99% is obtained by storing the excess water from the river flood, and the fill up ratio is improved by the construction of larger canals to lower carrying losses and by displacing the outlet further upstream in order to draw benefit from the higher level of the river. Total security of land is obtained by the use of a threshold dam such as the Markala dam on the Niger: it raises the level of the river to a quasi-constant elevation, making it certain that the reservoir is filled up every year.

1.3 Exception for the Office du Niger, the developments of the Segou region are in the framework of the "Segou Rice" operation which presently manages 34,000 hectares; this figure will be increased to 40,000 in 1980 (work under way). These developments include:

- 100% secure tracts	
. Dioro networks (gravity)	15,200 hectares
. West San tracts (pumping)	900
. Sosse and Sibila (gravity)	3,450
- 99% secure perimeters	
. Macina	2,250
- 80% secure perimeters	
. Tamani	8,830
. Farako	4,000
- 90% secure perimeters (tributaries)	
. Kouniano - Sourbasso	1,300
. Bougoura	2,500
- Double annual crop perimeters	
. San (pumping)	160

1.4 The "Segou Rice" operation manages collective services (sowing in line, mechanical threshing), in addition to the traditional advisory work and a certain number of ancillary services (functional literacy, livestock breeding, community development). It will also have to manage the rice mill under construction at Dioro with an annual capacity of 200,000 tons.

II. STUDIES

Studies in course or completed cover the following:

2.1 Securing existing tracts	
. Farako (safety margin raised to 99%)	6,000 hectares
. Tamani (95 - 99%)	9,600
2.2 Extension of secured perimeters	
. Dioro network (100%)	7,000 hectares
. Marina (99%)	800

2.3 New perimeters

. Mierou (99%)	2,500 hectares
. Kama (99%)	5,000
. Soulaye (99%)	4,000
. Kisina (90%)	3,200
. Sinkolo (95%)	700
. Farfono (90%)	500

To the perimeters already studied should be added the completion of the irrigation network for twice-annual harvests in West San, i.e., an additional 940 hectares.

2.4 Finally, among the studies which are available or in course, the following should be mentioned:

- the Talo threshold on the Bank, designed to flood approximately 1,500 hectares, including the existing 1,000 hectares. The topographical and geotechnical studies of this threshold dam are under way.
- tracks for access to the Farako, Tamani and Dioro perimeters as well as a road-dyke from Macina to Tenenkou designed to protect the perimeters located between the two towns, i.e., approximately 10,000 hectares in the Segou region and 1,500 hectares in the Mopti region.

III. PROGRAMMES ENVISAGED

3.1 Priority projects

The priority "Segou Rice" operation projects consist of securing the perimeters which are not developed as far as possible and completing the developments as they were initially designed.

A first project is being worked up and was to be ready by end 1979. In addition to assistance for the development of rice perimeters, it will include the following:

- securing the Farako perimeters (gain of 2,000 hectares) and Tamani (gain of 800 hectares)
- completion of the Dioro network (gain of 7,000 hectares) and Macina (865 hectares)
- completion of the West San perimeter, growing two harvests annually: an additional 940 hectares
- tracks for access to Farako and Babougou
- a 15,000 ton rice mill in Konodimini

- Studies:
  - the hydrologic and hydraulic characteristics of perimeters fed by tributaries
  - Implementation studies of the Bani threshold project and of the plains which will subsequently be irrigated
  - Renewal of the topographical study of certain perimeters

Two road programmes consisting of national highways should be added to this programme, estimated at approximately 15 billion MF and which received preliminary interest from FED:

- road from "Point A" to Niono (60 kilometers)
- Dioro road

3.2 Second priority projects

These concern the development of the Macina region: Mierou (2,500 hectares), Kama (5,000 hectares) and possibly Soulaye (4,000 hectares) which must be linked to the Macina-Tenenkou road and Mopti region developments.

3.3 Other projects in the area

The Segou region has large irrigated farming development possibilities as its land suitable for irrigation is estimated to exceed 200,000 hectares.

Among the projects which could be selected for the diversification of production, in addition to small truck gardening perimeters around towns, there are:

- the possibility of a 5,000 hectare sugar growing perimeter at Tamani on high ground which is not suitable for rice farming
- the possibility of planting very large fruit perimeters in the Markala zone gravity irrigated by the dam

Feasibility studies on these perimeters could be undertaken during the next Plan.

PROJECT SHEET NO. 5

DEVELOPMENT OF IRRIGATED PERIMETERS
IN THE MOPTI REGION (fifth region)

ALONG THE NIGER AND BANi RIVERS

1. GENERAL

1.1 Basic choices

The 1974-78 five-year Plan and the future 1978-84 Plan envisage the implementation of a hydro-agricultural development programme whose aim is to fulfil national needs for rice and sugar and the maximum flood security of these perimeters.

The fifth region in Mali is endowed with large land, water and human potential and is particularly suitable for rice farming under controlled submersion.

Rice sown under rain is flooded by the Niger or the Bani river. Simple developments such as an insubmersible ring dyke surrounding the plain, internal channels and inlet and outflow structures would grant partial control of the water supply.

Mali's choices for the fifth region consist of following up the implementation of developments, using this technique, which conveys the following advantages:

- low cost: $650 US per ton of rice produced as opposed to $1,500 for a more complex development
- farming under controlled submersion using the river floods is best suited to local conditions as no water is available from the Niger or the Bani from February to July. This status will not be improved even by the Selingue dam on the Sankarani because the water stored by this dam will be used mainly to feed Office du Niger perimeters.

1.2 Possible improvements

1.21 The improvements aim at ensuring flooding of cultivated areas and control of filling up and draining of perimeters by building the canal to its optimum dimensions.

Their purpose is to reduce maintenance costs (clay laterite of the dyke) and easing the management of structures (rack water gates).

However, under controlled submersion as presently practised, bad weather conditions (rainfall and floods) in recent drought years have been very painful experiences.

A guarantee of the flooding of surfaces sown, which is the first step to full water control, requires that the water level be raised to a sufficient elevation either by pumping (whose operating costs turn out to be very expensive when several dozen thousand hectares are involved) or by a threshold dam, relatively costly as to initial outlay, but economical when in operation.

The choices presently made favor threshold dams, especially on the Bank, which is suitable for this type of development. Studies are under way at Djenne (guaranteed flooding of 77,000 hectares) and Talo in the fourth region (13,000 hectares guaranteed).

1.22 Some areas in the fifth region will not be fully developed unless they are accessible by road and ferry: this is the case of the Western zone of the delta, Tenenkou, which calls for the construction of the Macina-Tenenkou track.

Ferry boats are needed in the Mourari, N'Dorobougou and Soye zones. In the eastern zone, development of perimeters along the Bani and the right bank of the Niger river involves building tracks to link them to the main road from Ban to Kona via Mopti.

II. AREAS

2.1 Resources

The intentory of resources was made on the basis of aerial photographic surveys (FAC mission, 71 - Rural engineering studies), and covers the following zones:

1) Tenenkou zone

	hectares	
Tenenkou Norel	5,130)	Detailed draft
Kora-Kana	2,350)	of project made
Kora Dialkera	6,000)	
West Tenenkou (between Diafarabe and Diabozo)	5,000	

2) Mourari zone

Moumbou-Mourari	6,000	Detailed draft of project made
Mourari	9,000	

3) Djenne zone (this zone will be influenced by the future Djenne threshold dam)

Pondori	8,700	
Extension Sarantomet Bougoula	7,500	
Pouri	2,000	
Konlan	3,000	
Baramandougou in 4th region	1,100	Detailed draft of project made
Kirina	3,900	

4) South Mopti zone

Soye	4,000	
N'Dorobougou	2,000	Detailed draft of project made
Sofara	730	
N'Dorobougou (extension)	3,000	
North Sara Mala	5,000	

5) North Mopti zone

Mopti	5,000	
West Ouro Mema		
TOTAL:	131,000	

2.2 Present status: developments completed

- Implemented by	ORM I (IBRD-FAC-MALI)	26,200 hectares
- "	OTER (ADF (1) 76/4)	6,000
- "	ORM 2 (IBRD-FAC) ADF 77 under way:	8,800
(of which deep ploughing: 23,085 hectares)		
TOTAL:		41,000 hectares

Tracks for access to perimeters are projected by ORM 1 and 2.

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(1) African Development Fund

2.3 Obtaining access to these zones involves construction of tracks to remove access constraints:

- for 1) Macina-Tenenkou road (feasibility study performed)
- for 3) tracks linking the main roads from San to
  4) Mopti and Kona to the various plains
  5)

and overcoming access difficulties by use of ferry boats for the Mourari, N'Dorobougou, Soye, Batreni perimeters.

III. CHOOSING NEW TRACTS

3.1 Principles

1) Agreement of the population and of the authorities
2) 100% secure perimeters through threshold dams: this is the case for the Pondoni and the right bank of the Bani from Kirina to Bangassi.
   - Perimeters dquipped with a standby pumping unit in case of low flooding
   - the case of the Mourari region and between Diafaral and Tenenkou
   - The situation is more delicate for the areas of Mopti and Sofora on higher ground.
3) Grouping perimeters by zone to facilitate the provision of advisory and development services. Four zones have been determined:

   Zone 1: along the Bani, upstream from Djenne, to be secured by the future Djenne dam (the Pondo-riet perimeters from Kirina to Bangassi)

   Zone 2: along the Diako (a derivative of the Niger) (perimeters from Diafarabe to Tenenkou)

   Zone 3: along the Bani and Niger rivers on the right bank, downstream from Djenne and close to the San-Mopti-Kona track.

   Zone 4: the Mourari on the left bank of the Niger.

4) Population availability

   This is a limiting factor for the Mourari zone and the future perimeters between Diafarabe and Dia.

5) Preservation of water holes for animals in low zones: this is the case for the zone downstream from Pondori.

6) Avoidance of interference with the Niger and Bani river flows, until a development scheme has been drawn up for the Niger basin, based on methematical flow models of the Niger and Bani. No tracks are envisaged between Diafarabe and Mourari as this would affect the flow of the Niger river.

7) Development costs must not exceed 400,000 Malian francs per hectare (1979 prices) (average cost in current prices of projects implemented up to now).

3.2 Order of priority

1. The Djenne threshold dam on the Bank with the associated development of Zone 1: first installment of 16,000 hectares of new perimeters and 6,000 hectares which exist already: Bougoula and Bangassi plains (possibly Kirina) in the Segou region.
2. Macina-Tenenkou track and the associated development of Zone 2: first installment of approximately 16,000 hectares: North Tenenkou, Kora, Kora Diokera plains and the Segou, Dioro (2,500 hectares) and Karna (3,000 hectares) perimeters.
3. Extensions on the plains in zone 3 on the right bank of the Bani and Niger rivers: first part of Soye and Sofara (approximately 5,000 hectares).
4. Second installment for each zone 1, 2 and 3, and first phase for zone 4 (Mourari).

IV. COST OF THE PROGRAMME (1979 prices)

4.1 Work undertaken under the surveillance of the Rural Engineering Department and with technical assistance.

Zones	Area (hectares	Unit price (4,000 km) (1,000 MF)	Total Cost (1,000 MF)
Zone 1			
Total	77,000	400	30,800,000
First part:	16,000	1,100	6,400,000
(Djenne threshold dam	-	4,000,000	14,000,000
(Tracks			200,000
Zone 2			
Total	19,500	400	7,800,000
First part	13,500	400	5,400,000
(Macina-Tenenkou track	-	4,000,000	4,000,000
Zone 3			
Total	19,700	400	7,880,000
First part	6,700	400	2,680,000
			5,000
Zone 4			
Total	18,000	400	7,200,000
First part	6,000	400	2,400,000
			5,000
	GENERAL TOTAL		88,770,000
	TOTAL of first part		35,000,000

The first part of the development will be spread between 1981 and 1987, i.e., 6 years at an annual pace of 7,000 hectares.

5.8 billion Malian francs per year are thus needed for the Djenne threshold dam and the Macina-Tenenkou track.

4.2 Studies

Summary preliminary specifications - detailed preliminary specifications - Feasibility - invitation to tender. These studies are undertaken by the Ministry for Rural Development - Rural Engineering - IER, sub-contracting to corporations specialized in certain fields: podology, geo-technical surveys, aerial photography, etc.

First phase only

Zones	Type of Studies (1)	Cost (Million Malian F.)
Zone 1	- dam (part APS, part APD, implementation AO)	400
	- perimeters of 16,000 hectares at 13,000 Malian francs per hectare	208
Zone 2	- 15,500 hectare perimeter x 3,000 (already studied, partial APD)	40
	- track FFE	14
Zone 3	- perimeters (already partially studied) APD: 6,700 x 3,000	20
Zone 4	- perimeters (already partially studied) APD: 6,000 hectares x 3,000	18
	TOTAL COST OF STUDIES	700

(1) APS: summary preliminary specifications
APD: detailed preliminary specifications
AO: invitation to tender prepared

PROJECT SHEET NO. 5 bis

PROGRAMME OF SMALL DAMS IN THE DOGON DISTRICT

(5th region)

I. GENERAL

The Dogon plateau is located in the 5th region, east of the Niger river, 80 km from the regional capital, Mopti. It covers 3,000 sq. km. and forms a homogeneous geographical area from a physical, economic and human viewpoint. A development scheme for the plateau is under study. At present, the basic constraint is water. The present note looks at the prospects for hydraulic developments. The other projects (studies and work) for rural tracks, community and agricultural development activities) have not yet been appraised accurately and will be presented later.

II. HYDRAULIC DEVELOPMENTS

The removal of water-related constraints is a precondition for rural development: drinking water and water for agricultural uses are both necessary.

a) Ground water

A programme of prospection is presently being executed by the Catholic Mission at Bandiaga in collaboration with the National Hydraulics Directorate. Resources seem to be relatively limited and it is envisaged that ground water will be used as drinking water for villages.

Financing (work and studies) is being provided by private Swiss organizations over 5 years.

Pumping is performed by hand. Mechanical pumping is projected in the medium term when community management structures have been created.

b) Surface water

This consists of temporary tributaries flowing to the Niger plain, crossing the plateau from East to West. These tributaries have rapids. Upstream from these, truck gardening crops (mainly onions) are grown.

The plateau has little cultivable land. Market gardening enables the population to purchase millet or rice which they cannot grow.

With the active help of the population, the administration has erected many masonry dams in the last thirty years. These dams have the double advantage that water for truck gardening is available from the dam reservoir while the water table is replenished upstream, thereby maintaining the water level in wells.

III. PROGRAMME OF SMALL DAMS

Various surveys performed by the administration have yielded an assessment of several hundred possible sites for small dams.

These dams are expensive: the price per cubic meter of water stored varies between 800 and 1,500 Malian francs. However, with the resources supplied by the dam (intensive onion growing) it can be amortized rapidly: in about 5 years.

Building work is undertaken by the OTER (the Rural Equipment Operation), a sub-division of the Ministry for Rural Development. OTER was created especially for this task, and is supervised by the Rural Engineering Office which designs the dams.

- cost of a typical dam — 80 million Malian francs
- area farmed (double crop) — 4 hectares per dam
- income — 5 million MF per year

Mali is envisaging the rehabilitation of several defective dams in parallel with the construction of new dams. Half of the 43 existing dams do not operate properly. Eight dams were examined for repair work by the Rural Engineering Study Office in collaboration with the French firm of consultant engineers "Coyne and Bellier". The average cost of repairs to a defective dam is 30 million Malian francs.

3.1 Implementation prospects (1980-1990)

The pace of dam construction by the OTER is:

2 new dams per year
2 dams repaired per year

The need for credits in the years 1980-1990 will be:

10 years x 2 dams/year x 80 million +
4 years x 2 dams/year x 30 million = 1,840 million francs

i.e. 184 million Malian francs per year

3.2 Study prospects (1980 - 1990)

Studies are performed by the BEGR which subcontracts technical activities to private corporations. The FAC financed a technical assistance mission to the BEGR to specify the design and choices of dam sites. The projected pace is:

- 4 studies of new dams per year, at a unit cost of 3.5 million Malian francs
- 4 rehabilitation studies of dams per year at a unit cost of 1 million Malian francs

over the next three years (1980-81-82), with an annual requirement for the studies of 4 new dams at 3.5 million per dam; the total involved is 18 million Malian francs per year.

PROJECT SHEET NO. 6

STATUS AND PROSPECTS OF IRRIGATION PROJECTS IN THE TIMBUKTU REGION (sixth region)

I. GENERAL

The Timbuktu region, and particularly its lake area, is very rich in irrigable land potential, part of which has been inventoried. The following types of development can be distinguished:

1.1 Ponds for growing floating rice under submersion

Rice is grown as in Mopti: sown in July under rain, it is flooded in September. It is harvested in the water in December. Little rain falls in July and August, which is a limiting factor on yields.

1.2 Ponds for growing sorghum in the subsidence season

Sorghum is sown or replanted from February to May. It does not grow until July and feeds from the water table. It then grows under rain until harvested at the beginning of October.

The traditional development of ponds consists of building:

- a dyke (usually but not always insubmersible) to protect sorghum or rice fields against early floods
- a canal to improve filling in case of low flood levels
- a concrete structure with water-gates or a coffer-dam and fish screens, to regulate the water level in order to satisfy farming requirements for rice and sorghum.

Such a development costs from 200,000 to 300,000 Malian francs per hectare.

1.3 Terraces for farming using pumped water

Wheat is farmed on terraces; it is just barely above the water during the floods and may be irrigated by a fixed pump, traditionally with a calabash, or by mobile motor pumps.

A distinction is made between:

- small developments using one motorpump which is sold to the farmers on credit. Their cost is not very high (400,000 Malian francs per hectare).
- large developments where a whole network is installed by the State (2 million Malian francs per hectare) and which are designed for all types of crops.

1.4 Irrigated development of basins and lakes

Embanked rice growing basins can be developed for irrigated farming of rice and wheat, with pumping for irrigation and drainage (cost 2 to 3 million Malian francs per hectare).

The special case of the lakes in the area should be mentioned. Some lakes are well below the level of the Niger and could thus be developed for at least partial irrigation by gravity. However, there are serious pedological problems in the case of these lakes.

II. DEVELOPMENTS EXISTING OR IN PROGRESS

2.1 Development of ponds

The following ponds were developed as part of the Lake Area Project operation, whose headquarters are located in Goundam.

- Kobsoun Sounsi	300 hectares of rice fields 300 hectares of sorghum
- Kabara	3,000 hectares of rice and sorghum
- Kanga	2,700 hectares of sorghum
- Lake Horo	8,000 hectares of sorghum, rice and other crops
- Gara	1,200 hectares of sorghum

All these developments suffer from serious imperfections. As a result, the use of these perimeters is well below 100%.

Another 200 hectare rice perimeter at Bourem-Inaly (supervised by the Islands of Peace at Timbuktu) is being completed.

Finally, many sorghum ponds and rice basins were summarily developed from 1950 to 1960. These perimeters are practically all abandoned today. The Mali "Rural Works" project (USAID financing) aims to repair some developments in the Goundam circle.

2.2 Development of terraces

They are located around Dire. There are 2 projects supervised by the "Dire wheat" venture:

- A large perimeter at Dire financed by the FAC. 140 hectares are under way out of 300 envisaged, with a traditional (diesel) pumping station and a complementary solar energy pumping station.
- Small wheat perimeters: 200 to 300 hectares irrigated at present with motorpumps (Bourem Sidi Awar). USAID has financed the preparation and development of 2,400 hectares (first part under way).
- A small wheat perimeter of 20 hectares near Timbuktu (supervised by the Islands of Peace).

2.3 Irrigated lakes and basins

These are limited at present to a 600 hectare plain for which the Islands of Peace have obtained financing (250 hectares completed in 1979). Islands of Peace will effect supervision for five years.

2.4 Studies performed

On the West ponds: Kassoum (600 hectares), Souriqo-Tagadji (5,000 hectares), Kabara (3,300 hectares), Danga (2,700 hectares), Mabi Bani (600 hectares), with the addition of Lake Horo (8,000 hectares) and Gara (1,200 hectares). Socio-economic studies were undertaken in Kessou Killy (SEDES, 1972, IER, 1975 for Tagadji) as well as a development feasibility study (at detailed pre-project level for Kassoum and Danga).

In the East, the Killy reconnaissance study was financed by the FAC.

At present, Kuwait is financing:

a) survey at Kessou

b) As a follow-up to the reconnaissance study, the feasibility study of the development of 100,000 hectares of ponds and basins, and 1,500 hectares irrigated near Dire.

For Lake Horo, the Rural Engineering Department has performed a summary pre-project study for the gravity irrigation of 13,000 hectares, of which 8,500 hectares to be harvested twice annually (drainage by pumping.) Belgium has indicated informally that it would be prepared to envisage financing the implementation study over 2 to 3 years.

Belgium is also understood to have financed a study of a road-dyke linking Korientze and Tonka (98 kolometers) and the developments protected by it (approximately 3,000 hectares).

2.5 Difficulties met by existing developments

Several problems have been encountered:

a) Lack of access infrastructure slows down the work, increases the isolation of supervisory staff and adds to the cost of developments. Present access routes are:

- by boat from September to January, by pirogue from August to March
- the all-weather Niono-Niafunke track, which is very difficult to use in the rainy season
- the Mopti-Niafunke tracks can be used from April to the end of June (all weather track, 5 ton ferry), and the Mopti-Korientze-Tonka track (from May to June).

b) Lack of research into crops grown in the region, which should be dealt with by the establishment of a Research station on Irrigated Farming at Dire (under way, financed by the FAD). Nothing seems to have been done for floating rice and sorghum grown in the subsidence season.

c) The labor force must be fed during implementation. This necessity is met in part by the World Food Aid Programme (WFA).

d) Delicate ownership problems arise in connection with reallotment of cultivated land around ponds.

e) Finally, the Tossaye dam on the Niger river downstream, would have a negative impact on the plains downstream from Timbuktu which would be flooded, and a positive effect on the plains upstream where the water table would be raised.

III. MEDIUM TERM PROSPECTS

3.1 Possible work

The zone has enormous potential: more than 50,000 hectares of ponds and basins, more than 25,000 hectares of terraces propitious for growing wheat and sugar cane (5,000 hectares at Dire) and for fodder farming. The following pace of development over 5 years appears to be reasonable:

- 3,000 hectares of ponds per year
- 1,000 hectares of irrigated crops per year

Subsequently and in the light of reconnaissances and studies already carried out, the following activities could be envisaged for the duration of the five year plan:

- redevelopment of the ponds in the Eastern zone (Kassoum-Soumpi, Kabara and Danga) and the development of Tagadji, i.e. a total of 12,000 hectares.
- development of 5,000 hectares of ponds in Kessou-Killy (including Gare)
- completion of Korioume (600 hectares) and extension of Dire to 1,000 hectares
- development of 2,400 hectares of small wheat perimeters
- development of 1,000 to 2,000 hectares at Lake Horo

The Korientze-Tonka track would obviously be added to this programme and possibly also Kona-Korientze. The aggregate cost of work would be (excluding food supplies):

- for ponds: 150,000 Malian francs per hectare for the Western zone, 300,000 Malian francs per hectare for Kessou Killy, plus 60,000 francs per hectare to bring into production
- for large irrigated perimeters: 2 million Malian francs per hectare for preparation and 500,000 francs/hectare to bring into production
- for the Korientze-Tonka track: 4 billion Malian francs
- for the Kona-Korientze track (second priority): 25 million Malian francs per km.

3.2 Preliminary studies

Studies available or being financed are listed below:

- ponds: 12,000 hectares in the Niafunke zone, 10,000 hectares in Kessou-Killy, 3,000 hectares near the Korientze-Niafunke road
- irrigated farming: 2,400 hectares of small wheat perimeters (of which 1,800 hectares at Dire and 600 hectares at Korioume), and 13,000 hectares at Lake Horo

The following studies lack:

- an updated feasibility record on ponds of the western zone (2 experts for 2 months, plus 10 million) and possibly, the implementation projects for ponds (50 million Malian francs)

- specifications of the invitation to tender and a feasibility study for the Kouna-Korientze track (400 million Malian francs).

The study of future extensions after the five-year Plan would be performed in addition to the studies above:

a) the effect of the Tossaye dam on the plains upstream (would be financed in principle by the FAC)

b) a reconnaissance survey of the ponds and terraces in the Western zone, with a development scheme. This can be divided into several sections and would cost approximately 300 million Malian francs.

c) a development study of Lake Fati(6 to 8,000 hectares) drawing on the old plans drafted by the Niger Bureau. Estimate of cost: 50 million MF.

IV. SECOND GENERATION PROJECTS

In line with the earlier objectives, the following second generation projects can be programmed, apart from Korioume and the small wheat perimeters for which financing has already been secured and recalling that development projects for ponds can be implemented one by one in order to lower the total cost.

3.1 Ponds in the Western zone

Improvement of Kassoum (600 hectares), Kabara (3,300 hectares), Danga (2,700 hectares) and development of Tagadji (5,000 hectares)

- Feasibility study (ready within 3 months) 2 experts for 2 months	10 million MF
- Implementation projects	50
Total studies	60 million MF
- Work 11,600 hectares at 150,000 MF per hectare	1,740 million MF
- Development (advisory personnel, accommodation, technical assistance 11,600 hectares at 60,000 francs per hectare	696
- Contingencies 15%	
Total work	2,800 million MF

3.2 Kessou-Killy ponds

- Studies (Saudi financing, ready in 1980)	(memo)
- Work: 5,000 hectares at 200,000 francs per hectare	1,000 million MF
- Development: 5,000 hectares at 6,000 francs per hectare	300
- Contingencies: 15%	200
TOTAL	1,500 million MF

3.3 Lake Horo

- Studies (financed by Belgium) ending in 1981/82	(memo)
- Work (over 15 years) Estimate	20 billion MF

3.4 Dire plain

- Studies (financed by Saudi Arabia)	(memo)
- Extension of 100 to 300 hectares (study complete)	200 million MF
- Extension from 300 to 1,000 hectares (study completed in 1980)	
- Work: 700 hectares at 2 million/hectare	1,400 million MF
- Development: 700 hectares at 500,000 francs/hectare	350
- Contingencies: 15%	250
TOTAL:	2,000 million MF

3.5 Korientze-Tonka track

- Studies (financed by Belgium) (study complete in 1981)	(memo)
- Work:	
. 100 km. track	4,000 million MF
. 3,000 hectare plain with:	
Work at 200,000 f./hectare	600
Development at 6,000 f/hectare	180
. Contingencies	120
Total for 3,000 hectare plain	900 million MF
Total track + plain	4,900 million MF

3.6 Improvement of the Kona-Korientze track (2nd priority)

- Studies (one year) 100 million MF
- Work: 70 km. at 25 million 1,750 million

3.7 Reconnaissance and studies

- Reconnaissance of the ponds in the western zone and programming of later studies

  Estimate: 300 million Malian francs

- Feasibility study of Lake Fati on the basis of the earlier plans of the Niger Bureau

  Estimate: 50 million Malian francs

PROJECT SHEET No. 7

STATUS AND PROSPECTS OF IRRIGATION PROJECTS

IN THE GAO REGION (seventh region)

I. GENERAL

The existing and proposed developments in the Gao region are all in the Niger valley. Although there are indeed possibilities for irrigation using dams in the ADRAR of IFORAS, there are also several obstacles to overcome: access difficulties, limited manpower available for development work, and lack of prior hydrological studies: All that can be envisaged over the next five years is the reconnaissance of the zone. In addition, study of surface water is of interest only for livestock raising.

In the Niger river valley, only the basins are presently cultivated, apart from a few traditional market gardening crops grown on terraces out of the water. Two types of cultivations are found, depending on the Niger river flood, which is highest in December-January:

a) floating rice which is sown or replanted in July, grown under rain and flooded by the river in September. It is harvested in the water. Lack of rain can be dangerous for rice at the beginning of the growth process, as are early flooding which can drown the young plants, and rice eating fish.

b) Sorghum which is replanted in the subsidence season from February till May. It vegetates until July and grows under rain until harvested in October. It suffers from early flooding which drowns it before harvesting, and low rainfall which prevents it from growing.

After the SATEC and rural engineers had surveyed the Gao region in 1974, 4 types of developments were envisaged for basins in the Niger valley.

Type 1: Small mobile pumps allowing water to be supplied in July and August when rainfall is inadequate. This solution applies to the zones South of Gao where annual rainfall is higher than 250 mm., and is indispensable at Bourem where rainfall declines to 150 mm. Pumps can also be used as a complement to type 2 and 3 developments.

Type 2: Small dykes to delay the entry of water until the rise is strong enough. Small concrete dams fitted with fish screens regulate the water level and protect against rice-eating fish which are very dangerous for crops after October 1st.

Type 3: Wholly or partially insubmersible dykes surrounding a basin. Large dams with internal channels ensure filling, control the supply of water during subsidence of the river, and protect against rice-eating fish.

Type 4: This consists of a traditional irrigated development with pumping for irrigation and drainage within the insubmersible dam, a concrete canal network and possibly smoothing.

II. EXISTING DEVELOPMENTS

2.1 Type 1 developments

Approximately 150 pumps are used in the zone, most which were supplied by Secours Catholique which has a workshop in Gao.As the Secours Catholique has ceased some of its activities, this action is almost at a standstill.

A few pumps are scheduled for the "Rice-Sorghum project" financed by USAID at Gao.

2.2 Type 2 developments

Many of these exist at Gao:

- traditional type with branched screens
- improved by the administrative services with metallic screens, (28 in 1978).
- undertaken by the Secours Catholique (5 per year?), previously by the Rural Engineering Department (approximately 40, of which half are operating), and by the Rice-Sorghum project at Gao (1 or 2 per year).

The Rice-Sorghum project should undertake further development using AID financing.

2.3 Type 3 developments

Only two developments, at Tcharan (2,500 hectares, of which 1,200 hectares of rice) and at Gargouna (600 hectares, of which 250 hectares of rice) are under way, financed by AID (708 million, of which 177 Malian counterpart funding).

Development of approximately 2,000 hectares has been scheduled for 1980 (of which 1,000 hectares of rice, at a cost of 350 million Malian francs), financed by AID. Studies are under way.

2.4 Type 4 developments

As of now, there are only 5 hectares, developed by a private individual with the help of the Secours Catholique.

The construction of a research station at Tcharan has been financed (20 hectares of type 4, 15 hectares of type 3).

The studies covering approximately 4,000 hectares of type 4, of which 500 hectares are reserved for a cattle fattening unit at Tcharan, have been financed by the FAC and Saudi Arabia.

There are also a few hectares of market gardening crops irrigated by pumping near Gao.

2.5 Control

The zone is under the control of the subsidence season "Rice Sorghum project"; headquarters are at Gao, with 3 zone supervisors at Bouren, Ansongo and Gao.

Attention is drawn to the intensive cooperation of the population (project to revive the cooperative movement) helped by several non-governmental organizations.

III. MEDIUM TERM PROSPECTS

The SATEC study has shown that to meet cereal needs of the area the requirements are for:

- 19,000 hectares of type 1, 2 or 3 for rice, or
- 2,500 hectares of type 4

Assuming that the population will increase, and in the light of development problems encountered with type 4, a realistic objective would be to achieve over 5 years the development of:

- 10,000 hectares of type 1, 2 or 3
- 1,000 hectares of type 4

The irrigation of 1,500 hectares of cattle fattening farms would be added to this (programming by the Libya-Mali Corporation for cattle and meat production, the SOLIMA, which has already been created).

The various types of developments would have to be distributed in relation to possibilities and physical constraints:

a) Type 1 (and 4) developments are indispensable in the Bourem zone where rainfall is low.

b) Provisionally, costly developments should not be scheduled until the results of the corresponding feasibility studies come to hand, in zones which could be flooded after the installation of reservoir-dams on the Niger river (Tossaye, Labezanga, and Mandadji).

c) Apart from special cases, type 3 and 4 developments requiring the use of heavy machinery are difficult to implement on the right bank of the Niger river and on the islands, through lack of access routes.

These circumstances limit the possible developments of type 3 and 4 to approximately 10,000 hectares net of rice fields (20,000 hectares gross of rice and sorghum grown in the subsidence season.

IV. SECOND GENERATION PROJECTS

The following credits have already been secured:

- USAID: 1,900 hectares of rice fields in 1979 (type 3)
  1,000 hectares of rice fields in 1980 (type 3)
  2,000 hectares of rice fields in 1979-80 (type 3)
- NGO's: 100 to 200 hectares per year (type 1 and 2), i.e., 500 hectares in 4 years
- Libya (SOLIMA): 1,500 hectares for cattle fattening farms

As the USAID project ends in 1980, another must be devised, entailing development of:

- 5,000 hectares (type 1, 2 and 3)
- 1,000 hectares (type 4)

which could be made a second generation project at a cost which could possibly be divided into several tranches depending on financing possibilities:

- Type 1, 2 and 3 development 5,000 hectares x 400,000 francs per hectare	2,000 million
- Type 4 development 1,000 hectares x 4 million francs per hectare	4,000
- Four-year development to production stage (technical assistance, supervisory staff, agricultural machinery...)	1,500
- Contingencies (10%)	1,500
TOTAL	9,000 million Malian francs

V. PRELIMINARY STUDIES

The following studies need to be undertaken for the second generation projects:

4.1 Completion of the reconnaissance study of possible developments including the position after dam construction.

Financing in course of arrangement by the FAC
Estimate: 80 million Malian francs

4.2 Second generation projects

The feasibility study of the 1,000 hectare plains has been financed. The feasibility study of 5,000 hectares of type 1, 2 and 3 developments should be performed: cost approximately 50 million Malian francs.

4.3 Assessment of the real impact of type 1, 2 and 3 developments on production through full scale investigations, to define a long term policy as regards the choice between the many alternative development possibilities.