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BAKEL CROP PRODUCTION

SENEGAL

PROJECT PAPER

685-208

VOLUME ONE

MAY 15, 1977

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT PAPER FACESHEET

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10. ESTIMATED COSTS ($000 OR EQUIVALENT $1 –)

A. FUNDING SOURCE	FIRST FY B. FX	FIRST FY C. L/C	FIRST FY D. TOTAL	LIFE OF PROJECT E. FX	LIFE OF PROJECT F. L/C	LIFE OF PROJECT G. TOTAL
AID APPROPRIATED TOTAL	1.465	4.394	5.859	1.465	4.394	5.859
(GRANT)	(1.465)	(4.394)	(5.859)	(1.465)	(4.394)	(5.859)
(LOAN)	( )	( )	( )	( )	( )	( )
OTHER U.S. 1.						
OTHER U.S. 2.						
HOST COUNTRY		2.132	2.132	-0-	2.132	2.132
OTHER DONOR(S)						
TOTALS	1.465	6.526	7.991	1.465	6.526	7.991

11. PROPOSED BUDGET APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE C. GRANT	PRIMARY TECH. CODE D. LOAN	E. 1ST FY 77 F. GRANT	E. 1ST FY 77 G. LOAN	H. 2ND FY 78 I. GRANT	H. 2ND FY 78 J. LOAN	K. 3RD FY 79 L. GRANT	K. 3RD FY 79 M. LOAN
(1) FN	122	064		3.358		1.056		942	
(2) PH	500	540		100		182		60	
(3)									
(4)									
			TOTALS	3.458		1.238		1.002	

A. APPROPRIATION	N. 4TH FY ___ O. GRANT	N. 4TH FY ___ P. LOAN	Q. 5TH FY ___ R. GRANT	Q. 5TH FY ___ S. LOAN	LIFE OF PROJECT T. GRANT	LIFE OF PROJECT U. LOAN
(1) FN	101				5.457	
(2) PH	60				402	
(3)						
(4)						
TOTALS	161				5.859	

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BAKEL CROP PRODUCTION PROJECT

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Part 1 - Project Summary and Recommendations

A. Recommendations

Grant - $5,859,000

Waivers - (see section D. Project Issues, p. 9)

1. Noncompetitive procurement of motors, pumps and ancillary equipment,
2. Code 935 Procurement of Vehicles,
3. Noncompetitive, Code 935 Procurement of Technical Assistance Services Consultant for Ongoing Services.

B. Project Description

The project is located in the far eastern region of Senegal around Bakel on the Senegal River. This area is populated almost entirely by subsistence farmers who have survived since time immemorial on a marginal existence basis by planting dry season sorghum and millet and a sorghum crop under recession agriculture following the annual Senegal River overflow in September and recession in November. Rice was traditionally grown by women in swampy areas but suffered total loss four years in five due to the vagaries of the climate. The climate of the area is strongly influenced by the desert with great variations in temperature and high vulunerability to rainfall levels.

Under R&R financing and other donor assistance a small pilot project was started two years ago to develop village-level irrigated perimeters using pumps to draw water

from the Senegal River or from nearby marigots (swamps). Technical assistance to the villagers was provided by a three-man team from the Centre International du Developpement Rural (CIDR), a Paris-based non-profit international voluntary organization, and the Societe d'Amenagement et d'Exploitation du Delta (SAED), the Senegalese agricultural extension agency operating in the Senegal River Basin.

The project proposed in this paper will build on experience gained to date and will finance AID inputs for expansion into other villages of this village-level irrigated perimeter project. The small irrigated perimeters will be worked on a village level cooperative basis in some 23 villages having a combined total population of over 31,000. Based on topographical and hydrological surveys a small amount of diking around each village-level perimeter will be done to protect the perimeter to an acceptable risk of flooding (one year in ten). About half the project will involve little or no diking. In other places minimal diking up to two meters in height will be required. Pumps will be provided for each perimeter to draw water from the river. The combined total of these small, village level perimeters will be over 1,800 hectares but individual perimeters will vary in size with most of them being in the range of 30-50 hectares each.

Technical inputs for the overall project will be provided by SAED and SERDA, a Senegalese consulting firm.

The villagers themselves will provide work inputs and effort on each individual perimeter in accordance with their own co-operative village level arrangements. AID inputs will be financing for central infrastructure, farm development including pumps and dike construction, seven person years of technical assistance, health surveillance and a health component. The project already has a tremendous village level, grass-roots impetus and all technical, environmental, and economic analyses are positive. The crucial components for the development of these village-level irrigated perimeters in the region of Bakel are as follows:

1) Farm Level Construction: 986 hectares of the proposed 1,800 hectares in the project have already been surveyed by SAED and dike plans developed for the 700 hectares needing dikes. The remaining 910 hectares will be surveyed prior to January 1978. Areas which are irrigable using no flood protection dikes or low protection dikes (2 meters) will be identified. Location of needed dikes will be pinpointed. After the detailed plans have been prepared the dikes needed to protect all 1,800 hectares will be constructed under contract with a local contractor. At the same time bulldozers will clear the stumps from 1,800 hectares of paddy fields. SAED will develop detailed topographic maps and plans for each of the small perimeters to be developed in any given year and arrange for double discing of the new lands. Then the farmers, supervised by SAED topographers and

advised by SAED technical agents, will construct the irrigation works necessary in the paddy fields. This work of ditching, leveling, bunding, building of structures, etc., will all be undertaken utilizing village hand labor.

2) Technical Inputs: Seven person years of expatriate assistance and 40 person years of SAED personnel are necessary to advise the farmers in both the development process and the agronomic aspects of irrigated culture. A small field trial station will be established to test the packages before presentation to farmers and some funds for training are included to allow farmers to visit similar projects in Senegal and neighboring countries.

3) Central Infrastructure: Houses, a workshop, a warehouse and assorted vehicle support are for staff support.

4) Farm Inputs: A rotating fund must be established within the SAED budget to allow provision to farmers of the needed agricultural inputs on an annual repayment basis.

Total agricultural inputs are estimated at $7,389,000 with AID providing $5,457,000 in financing for the needed pumps and pump supplies, mechanized construction farm equipment, expatriate technicians and central infrastructure; GOS providing $2,032,000 in the form of SAED staff, administrative operating expenses and a revolving fund for annual farm supply needs and the farmers providing $164,000 worth of construction labor plus all annual production costs.

These inputs of farm level infrastructure and central staff with their respective support costs will allow the development of over 1,800 hectares of irrigated lands for a farm development cost of approximately $1,500 per hectare and an average total cost, including central infrastructure, staff and staff support as well as farm costs, of roughly $3,500 per hectare.

1,800 hectares of irrigated land in 23 different villages will allow an adequate demonstration to the farmers of the feasibility of irrigated crops. This is the first step in an evolutionary process to modernize agricultural production in a rational way with farmers involved from the earliest stages in planning the development.

5) Health: The health component will consist of two separate activities, a health surveillance activity and a health services activity.

The surveillance activity will collect and analyze data relating to the incidence of parasitic diseases such as maleria, shistosomiasis, onchocerciasis and intestinal parasites in 25 villages. This data will permit identification of trends in the incidence of disease in villages along the river including those involved in irrigation and those not involved in irrigation.

The health services component will be functional in all villages involved in the project. Of these, 12 have dispensaries and there is a health center in Bakel itself.

The distance between a village without health facilities and a village having facilities rarely exceeds five or six kilometers.

The effectiveness of the dispensaries is limited by a serious lack of medical supplies and equipment but are staffed by one nurse.

The current AID financed activity will build on this basic health structure focusing on the diagnosis and treatment of endemic diseases and on sanitation and health education. The first focus will be undertaken through upgrading existing dispensaries and the second through developing a cadre of village sanitarians and female health workers.

C. Summary of Findings

Detailed technical analyses for the project are found in Section 3 and the annexes of this paper. In this section a brief resume of the most crucial questions and their resolution are given. The project is obviously technically possible since this type of irrigation project is common throughout the world. The major technical questions which had to be answered were such details as the height of the dikes, size of the pumps, types of crops to be grown, the type of technical package to be used, etc. Experience of previous years in the project area was helpful in developing realistic solutions to these questions. Pump sizes had been tried and what is probably the most feasible pump type, size and location for pumps has

been determined. The mixture of heavy equipment and hand labor used in the construction of the farm level infrastructure constitutes an optimum blend with heavy machines doing the work which is too difficult and impracticable to do by hand and the farmers doing the rest by hand. This allows cost savings and also gives the farmer a direct input into the construction process and a direct control over the size of the village perimeter. Prior experience defined the technical package to be promoted to the farmers and established the basic data the assumptions upon which to base the economic analysis. The project as described is technically feasible and shows a suitable economic return. (IRR of 13-23% depending on the assumptions used).

The crucial question which could not be answered merely by a technical examination was the social acceptability of the project. Therefore, an extensive sociological study was made to determine the motivations and effects of the project on the farmers. The details of this study are presented in Annex K. The sociologist found that the project was indeed changing the social structure of the area but that the changes were those which are needed to move the area into the modern society. He found great support for the project among the villagers and predicted wide acceptance of the project by the target group. He further found that the methodology used by SAED and technical assistance in the project area was the approach most likely to succeed. The

Sarakolle are essentially very independent people and pride themselves on their ability to do things on their own. The basically "hands off" policy of SAED in the area is very appealing to them. A great part of the success of the first two years can be attributed to two things:

1. The great interest of the people in development of a more technologically advanced agriculture; and,
2. The "do it yourself" approach used by CIDR in introducing the new technologies.

The question of environmental and health impact of the project has received an extremely careful assessment. It was studied first by the original PP team, second by an environmental consultant and finally by a full-scale team fielded by the American Public Health Association (APHA). This team included a health administrator/planner, a social anthropologist, an environmental health engineer, a malariologist and an environmental health specialist. The team was guided in its field work by the ADO/Dakar Regional Health Officer, Dr. Marc Vincent, M.D. and spent three weeks in the field studying all aspects of the environmental/health impact of the project. The conclusion of all this study is that this village-level small irrigated perimeters project will not produce any serious harmful effects and the APHA team recommended that the project proceed. Nonetheless a health component is included in the project along with periodic health monitoring of the villagers. Further detail on the environmental aspects of the project are set forth in Section 3 and in Annex L.

In summary the project offers an extremely promising approach to development in the area. It is technically, economically and socially feasible to implement the project as planned.

D. Project Issues

A. Provision of non-U.S. technical Assistance:

This project already has momentum underway based on the earlier work done with R&R financing and other donor assistance. Thus, the traditional startup problems and the time involved in initiating the project are avoided. A three-man team from CIDR has been working in Bakel since 1974 and has developed an excellent rapport with the people, and a knowledge of the area and its problems which would take a new group of people a year or more to attain. In addition, the replacement of these people at this stage in the development of the area would destroy the confidence that the people have in the organization and halt the present momentum that has been built up.

Although CIDR has dropped out of the project, the former CIDR staff is still available through a Senegalese consulting firm, SERDA, at a cost far below the cost of similar U.S. technicians. SERDA likewise has a working arrangement with SERDI, a European (Franch/Belgian) consulting firm. The cost per man year of technical assistance through SERDA-SERDI is less than one-half of the cost of one man year of U. S. technical assistance. The Peace Corps could not recruit

staff which is as qualified or as experienced technically as the former CIDR staff and any staff which they recruited would not have the trust and respect of the people which is so important if this project is to expand as rapidly as is planned. The PP team and ADO/Dakar have investigated the possibility of finding another donor to fund the former CIDR technicians but the other donors are fully committed to their own projects in the river valley and do not have funds available.

Therefore, to fill the objectives of a technically competent, locally accepted and experienced staff at the lowest possible cost it is recommended that the SERDA-SERDI group be kept in Bakel as the technical assistance portion of the project and a source and origin and sole source procurement waiver be authorized to allow direct contracting with a non-American firm. The PP team recommends that a condition precedent initial disbursements be the execution of a contract for the provision of Technical Assistance with a firm acceptable to AID.

B. Non-Competitive Procurement of Equipment: Pumps and Irrigation Equipment

SAED has embarked upon a program of standardization for their small perimeter projects. Experience with several different types of pumps has shown that the Lister pump is the most reliable. Furthermore, the Lister pump comes in several different sizes each size being very similar

mechanically to the other sizes, thus simplifying mechanics training. Also NOSOCO-MATFORCE, the local distributor of Lister pumps will train mechanics and provide refresher courses through a mobile audio-visual training unit to upgrade mechanics and familiarize them with the motors and pumps. In addition it is planned that the Bakel perimeter will enter into a standard service contract available through NOSOCO-MATFORCE for the first project year while their mechanics are gaining experience to provide monthly service on each pump. Lister manufactures pumps in the United States, and the parent Lister Company is British.

The PP team has discussed the purchase of these pumps and motors with both the MATFORCE manager and the regional representative for Lister pumps in West Africa. The team was assured of the availability of the motors from Lister's factory in Mansfield, Ohio which, coupled with a pump manufactured by the U. S. manufacturer, Gorman Rupp, will supply the needed 170 cubic meters per hour. The remaining ancillary equipment (pipes, etc.) will also be of U. S. manufacture and the orders will be placed so that a complete unit will come from the United States. The floats for the pumps will be fabricated in Dakar and thus will be of local source and origin. All orders will be placed through the Dakar office of NOSOCO-MATFORCE which will guarantee the service and parts supply.

The PP team therefore recommends non-competitive procurement of the pumps and motors from NOSOCO-MATFORCE and a waiver allowing this procurement is requested.

C. Code 935 Procurement of Vehicles for the Project:

Vehicles of U.S. manufacture are extremely rare in Senegal. In the Bakel area, which is the most remote area of Senegal, there are no facilities for repairing U.S. manufactured vehicles. There are no companies in the country which are willing to or can provide reliable maintenance capability, and there are no spare parts nor service capabilities for U.S. manufactured vehicles. The AID office in Dakar has received a waiver allowing the purchase of non-U.S. vehicles for its own use due to the repair and spare parts problem. Therefore a waiver is requested to allow Code 935 Purchase of Vehicles included in the following list:

4 Landrovers
3 Peugeot 404s
1 Peugeot 504
1 5-ton truck
1 10-ton truck
10 Mobylettes

In all cases these will be purchased from the local supplier for each type of vehicle. The boats and motors required for the project can be procured in the U.S. since Johnson Marine motors are common in Senegal and the boats themselves do not pose any great service problems.

D. Contracting:

Construction of buildings for the central infrastructure and the dike construction and clearing will be

accomplished through local contracts in a form and substance acceptable to GOS and AID. Local construction contractors are available and the contracting capabilities of SAED have been reviewed by the PP team which finds that SAED is very qualified to undertake the contracting process. The REDSO/WA contracting officer will review with SAED particular AID requirements prior to beginning the contracting procedure. AID will approve all construction contracts.

Part 2 - Project Background

A. Background

1. General

If on the African continent a stand is to be made against further encroachment of the Sahara into the region of the sub-Sahara, the first line of defense will be the river basins of that region. There are three such major basins in the Sahel area revaged by the unprecedented drought of 1972-1973: the Senegal River Basin, the Niger River Basin, and the Lake Chad Basin. Of these three, the Senegal River Basin on the westernmost periphery of the Sahel area most readily lends itself to schemes to stabilize its ecology and increase local production of staple food crops.

The three riparian nations of the Senegal River: Mali, Mauritania and Senegal, formed, in 1971, a cooperative organization to plan and carry out the coordinated development of the Senegal River Basin under an agreed plan. This is the "Organisation de Mise en Valeur du Fleuve Senegal"

Under the O.M.V.S. auspices, various studies and projects are now underway to realize this river basin's fullest potential as an integrated river system. The principal mainstream components of this system will be two dams operating in concert: one low-level dam in the river Delta to arrest salt water intrusion during the low water season, and a major storage dam on one of the principal tributaries of the river in Mali to assure sufficient flow for irrigation and navigation on a year-round basis. The $30 million low-level Delta will be financed by France and Iran. It is now in a final design stage and could be constructed in 2-3 years. The $230 million upper basin regulatory dam is under study. Its construction will probably require 10 years from design through completion, once financing is assured.

In the meantime various food production schemes are being initiated to prepare the villagers of the Senegal River Basin for their eventual participation in irrigated farming in place of the low-yield and uncertain post-flood recession cropping on the river banks. In the 40-year projection of the coordinated development of this basin, some 420,000 hectares will eventually be brought into an irrigated double-cropping system. Only a few thousand hectares within this vast potential area have been developed to date, mostly through joint funding of large schemes by the Governments of Senegal and France.

In accordance with the O.M.V.S. policy, agricultural projects totally within the boundaries of any of its riparian members are to be negotiated on a bilateral basis between that riparian and the prospective donor. To provide much needed capital to accelerate this process, the European Development Fund (F.E.D.) and the World Bank (I.B.R.D.) have agreed to finance the development of large irrigated perimeters adjacent to the mainstream, and the United States has been asked to join in this effort.

Prior to the severe drought of 1972-1973 in the Sahel, most of the agricultural development efforts in the Senegal River Basin were concentrated in the Delta in sizeable, highly capital-intensive schemes where assurance of water and proximity to markets and transport systems minimized risks. More recently emphasis has shifted to projects in the middle and upper reaches of the river basin, and more account is being taken of traditional family and village social and economic structures. Two approaches are being developed: (1) large-scale perimeters divided into small, family-sized plots such that all inputs can be provided by the traditional family unit, (eight to ten persons), living and working on its own land; and (2) an evolutionary approach of small-scale perimeters developed and cultivated by a cooperative grouping of all families in one village to increase their food production and introduce the improved

technology. An example of the first type is a 7,250 hectare perimeter in Matam, which was studied by the Bechtel feasibility team under A.I.D. contract. The present project deals with the second approach, small scale, village level irrigation in the vicinity of Bakel while at the same time working to improve traditional culture to increase food production in the region.

Both the lower and upper portions of the Senegal side of the River Basin historically have been largely neglected in pre-independence colonial and post-independence national development schemes. The result has been a traditional exodus of young people from the basin due to the lack of the wherewithal to earn a livelihood and the consequent lack of growth within the region. At present, the prime market for laborers from the villages involved in the project area is France. However, severe unemployment in France has put the future of this labor market in doubt. This project, which will increase local production of foodstuffs on both irrigated and dry land farms, will provide an alternative livelihood for those persons who, in the past, would have immigrated to France as laborers.

The GOS, which historically has attached greater importance to the agricultural development of other areas, now accords priority to this river basin within its development planning. The villages which the A.I.D. team has selected for detailed investigation have climatic, soil and

water conditions which will allow cultivation of rice, sorghum, wheat, millet, corn, cowpeas and vegetables. All of these crops are elements of the local diet, and none is being produced locally in adequate supply.

2. Project in Bakel

This project is unique in two ways. First, it is already underway and the development potential has been identified and demonstrated in both the human and technical realms. Second, and even more important, the project is a direct result of actions initiated and requested by a resident farmer of the area. At the risk of sounding like a fairy tale we would like to present the story of the Kounghani development and how this moved into an area development program following a truly grassroots developmental process.

The project was begun at the initiative of one farmer from Koughani village. During the time he was working in France and travelling in Europe, he noted the improved agricultural methods applied there and upon his return to Koughani he bought a pump and a rotatiller to use on his land. Because of insurmountable technical and logistical problems (no mechanics, lack of fuel, no spare parts available, etc.) his equipment was not useable. Realizing the need for expert assistance he wrote to the Director of CIDR, whom he knew because he used to work in the same building in France that CIDR has its offices, requesting assistance.

CIDR was happy to assist but did not have financing. Therefore, CIDR contacted various donors and private voluntary organizations and eventually OXFAM and "War on Want" in Britain agreed to provide initial financing for the project.

CIDR sent its first man to Koughani in 1974. He and his wife lived in Koughani for several months learning the way of life and organizing the first farmer group. He then moved to Bakel to begin activities in other villages. Two other CIDR volunteers arrived in 1975 to assist with the extension effort and SAED began contributing some assistance in the form of pumps and technical advice. The CIDR group moved into irrigation work in addition to traditional culture in 1975. As a result of this move to a more advanced technology, War on Want withdrew its support. In the meantime AID had begun to support the project with R&R funds, providing additional pumps and tools. The following table shows how the project developed and the inputs of various groups from 1974 to the present.

YEAR	VILLAGE No.	HA TOTAL	HA TRADITIONAL	HA IRRIGATED	FINANCING
1974	9	32	32	-0-	War on Want
1975	15	76	54	22	War on Want/ SAED
1976	19	210	95	115	USAID/SAED

AID through the R&R program assisted with financing the 1976 program and in 1977 provided preproject funding of $124,000 to keep the SERDA/team in the field thus avoiding a complete loss of momentum. The total AID contribution to date is $294,000 and financed pumps, tools, studies and costs of the CIDR/SERDA

staff in 1976 and 1977. In 1975, 1976 and 1977 SAED financed dikes and clearing, pumps, farm inputs and staff having a value of approximately $225,000. OXFAM and War on Want assisted with staff, tools and studies having a value of approximately $50,000. The total investment for the first three years was $569,000 from all sources plus considerable farmer labor.

The SERDA group (formerly CIDR) has overcome the ever-present "start-up" problems inherent with the introduction of a new technology and has established a working relationship with the farmers of the area. This process, which is time consuming and not very spectacular took over three years to accomplish. A.I.D.'s entry into the project now, when project needs are higher and the program is accelerating after having proven itself, is very sensible,

The villages in the Bakel area receive a sizeable income from laborers in France. Based on the best estimates available at the present time approximately 20% of the 5,000 farm families have one worker in France. This one worker sends back approximately $1,000 per year making a total of some $1,000,000 per year flowing into those villages. The PP team has not programmed these funds as a local contribution because: 1. The risk factor of investing in a totally unknown agriculture is too high to be acceptable to the villages; 2. This money is used in other community and private projects such as pharmacies, schools, houses, etc.; and 3. If the farmers were to rely on this money, financila control would lie in the hands of the select 20% of the village which is most wealthy thus raising serious equity problems.

Therefore, the PP team finds that the project offers an opportunity for AID to provide the needed capital inputs on an equitable basis in a time frame which meets AID's criteria.

When the PRP team studied the project in October, 1975, it was planned that the project would develop very slowly from its modest beginnings. However, due to the strong interest of the people and a push by SAED the program greatly accelerated. SAED, from its own budget provided bulldozers to clear stumps from fields and to build a nine km dike around the Bakel perimeter and a tractor and disk to break ground on 115 ha as a stimulus to the farmer groups. The farmers responded admirably to this stimulus and the PP team noted that their portion of the work: canals, bunds and leveling on 115 ha proceeded well. It was obvious that by utilizing a blend of mechanized and hand construction, an accelerated development schedule can be undertaken. The PP team carefully analyzed the labor requirements and availability (see section 3-A.(1) for construction and 3-A.(2) for agricultural) and reached the conclusion that an accelerated program is possible.

Request for Financing

The request for financing for the project in Bakel was received in July, 1975, from SAED. Conceptually there is no difference between the present project and the project as envisioned in July, 1975. Both this and the project request deal with the idea of small, village level, communally operated and managed perimeters.

However, over time, the scale of the project has changed considerably from a level of $3,100,000 for a 1,320 ha project defined in the PID of Spring 1975, to $2,600,000 for a 915 ha project in the July 1975 request from SAED to $1,345,000 for a 200 ha pilot project in the PRP of October 1975 to the present project of $6,671,000 for 1,800 ha. The evolution of thinking behind these changes is as follows:

1. 1975 PID - This was basically an identification of a potential project without a firm idea of what was feasible or likely but served to stimulate thinking about the project.
2. 1975 request - This request was submitted as a result of the PID team investigations. Costing and technical details were not precisely worked out and there was a very high investment in central infrastructure.
3. 1975 PRP - This team, while in the field discovered a potential flooding problem on several of the identified perimeters. Without any data on topography in the area the team was forced to consider a smaller project on areas where the farmers were able to say that floods rarely occurred.
4. 1976 PP - During the interim between the PRP and the PP, SAED got down to serious work on the project. They sent topographic teams to the field to determine diking needs and to perform detailed topographic surveys and mapping of areas being planned for the

1976 season. SAED contracted for bulldozers to construct one protection dike and to clear stumps from the lands to be farmed in 1976. It provided tractors with discs to break up the new lands. These activities allowed the PP team to judge the feasibility first, of providing flood protection with a reasonable chance of success at a reasonable cost, and secondly, of utilizing a mixture of heavy equipment and hand labor to accelerate the development process. As aresult of their review of the engineering, economic and human aspects of this accelerated development the recommendation to proceed with the 1896 hectares identified by SAED was made.

This evolutionary process took place both within SAED and A.I.D. and both are in agreement that the present project reflects the proper approach now. The current plans are backed by enough data and experience to allow confidence on both sides in the ultimate success of the project.

B. Detailed Project Description

1. Sector Goal - The development problem which this project addresses is how to maximize utilization of water resources, the scarcest resource in the Sahelian region, in order to increase food production. At the same time the project addresses a local development problem, that of immigration.

Better use of water resources is essential if food production in the Sahel is to be increased and agricultural development is to proceed. The rational and proper development of the resources of the Senegal River Basin is one of the highest priority items of the GOS, which views this development as a step toward alleviating a chronic cereal deficit situation while at the same time providing an attractive alternative to immigration. The problems associated with immigration are well understood by both the GOS and the people who are immigrating. Both can foresee in the future that this labor market may be closed to them and they are interested in developing an alternative to replace migration to France as a source of income for the area. They feel that agricultural development based upon a more technologically advanced methodology will provide a suitable alternative.

In order to reach the goal of maximizing utilization of water resources, considerable investment will be required beyond the present project. Larger scale projects keyed to the total development of the River Basin will be installed. The O.M.V.S. and the GOS plan future ventures in the Bakel area and the present project's impact upon the population in terms of introducing irrigation technology is extremely important to future development activities.

There are numerous improvements in the quality of life which will be necessary if agriculture, no matter how

advanced its technology is to be an attractive alternative to immigration. Health facilities, education facilities, access to the social and economic life of the rest of the country, etc., must be improved if the Bakel area is to be a more attractive place to live. The PP team did not contain the skills nor have the time to precisely identify all the activities needed on a priority basis to complement the agricultural activities. However, in discussions with farmers and officials in Bakel the following priorities appeared evident:

1. Transport and communications,
2. Education,
3. Health.

FAC is presently addressing the first priority and is considering an improved all weather road to Bakel from Matam. Further small investments in rural roads to improve dry season access to villages are also necessary but require close investigation to evaluate economic and social impact and define proper standards of improvement.

Education interventions, both formal and nonformal, are crucial to accelerated development in the area. At the present time any formal education beyond primary level is available only in St. Louis or Tambacounda. In order to encourage more advanced education for the youth of the region, a secondary and technical school should be considered. In the nonformal education areas, adult literacy,

hygiene, agricultural development and how the people relate to development need to be addressed. Promotion Humaine can provide the human resources to begin this nonformal education.

The health component of this project will serve as a pilot to indicate the potential for a widespread health intervention in the future.

2 .Purpose - The purpose of the project is to introduce the technologies of irrigated culture in 23 villages along the river in the Bakel area and to demonstrate the feasibility, both technically and economically, of irrigation in the area.

Small village-level perimeters of the type included in this project are considered to be phase I of the three phase development process. The process is based on an evolutionary approach to introducing improved technologies so that the farmers can understand and participate in the development process. The three phases are as detailed below:

I. Development of small perimeters (20-300 ha) based on village cooperative groups. These small perimeters will demonstrate the feasibility of irrigation and train the farmers in the management of the irrigation enterprise. The small perimeters are replicable with minimal outside assistance once the techniques are entrenched.

II. Development of middle sized perimeters (800-1,500 ha) based on inter-village groupings with each village having their own lands but with the need for some central management. These perimeters will provide the opportunity for villages not having suitable lands of their own to participate but will not require major resettlement of populations. Due to increased investment costs and more intricate organizational requirements these perimeters will require some outside assistance for replication.

III. Development of large (10,000 ha) perimeters utilizing advanced technologies and central management. These large perimeters may require some relocation of populations and will require intricate management organizations. Due to the advanced technological and managerial characteristics of these perimeters, they will require extensive outside assistance for implementation and management.

Present plans for the Bakel Area call for supplementing phase I actions which are underway now with possibly a medium sized perimeter within four to five years leading to a large perimeter ten years or more thereafter.

In the past SAED has concentrated on phase III developments and very large scale operations. However, during the past two years SAED has shown increased interest in the evolutionary approach. The Bakel region shows great promise as a testing ground for this concept as the social

organization and worldliness of the people lends itself to rapid adaption of the technology at village level. Also, the likelihood of village investments in replication and expansion of the phase I perimeters is high due to the availability of investment capital in the area. It is expected that the 1,800 hectares developed under the phase I program will be adequate to demonstrate the technology and its feasibility on a large enough scale over a big enough area to thoroughly acquaint some 20,000 persons with the potential.

3. Outputs - Three outputs are necessary to achieve the purpose of the project:

1. Introduction of improved practices for dry land crops,
2. Development of 1,800 ha of irrigated small perimeters in 23 villages, and
3. Improved understanding of the health situation in the area.

The first output is crucial, not only for achieving the purpose but also for achieving the second output. SAED is well aware that the people involved in the project put primary emphasis on their traditional subsistence crops and that, in the medium term, any irrigation works will be supplementary to traditional culture, not a replacement for traditional culture. Therefore, SAED wisely decided to work with the traditional culture as well as with the

village level irrigation system. Until such time as the people have faith in the irrigation system as having a lesser risk factor than traditional culture, they will not give up traditional culture for irrig ion. Therefore steps to reduce the labor requirements and increase the yields of traditional crops are a necessary complement to irrigation activities.

The second output is a direct step to the project purpose. The creation of small village-level irrigated perimeters as a basis for developing the management capabilities within the village group is essential if the farmers are to be able to manage their own activities in the future.

4. Inputs - A) The major inputs for the agricultural portion of the project are as follows:

1. Technical assistance,
2. Land clearing and conditioning,
3. Village labor,
4. Pumps and hand tools,
5. Agricultural supplies,
6. Animal traction equipment,
7. Administrative infrastructure,
8. Administrative operating costs.

The detailed description of what is included in each of these headings is given in section 3.F of this paper dealing with the financial plan. The PP team agrees with SAED that these are the minimum inputs necessary in order to achieve the desired outputs.

5. Health Component:

Despite the American Public Health Association Team's and AID PP Team's findings that no serious impact on the health or the environment is likely to occur due to the project, it is proposed to include two activities parallel with the production project, namely a health surveillance program and a village health program.

The health surveillance program can be conducted by the combined services of the Department of Parasitology at the University of Dakar and the Anti-malarial Service (Service de lutte anti-apaludique) based in Thies. Both of these services are under the direction of the Chief of the Department of Parisitology, Professor Samba Diallo, who is responsible to the Director of Health in the Ministry of Health. Thus, the surveillance portion of the project will be well integrated into the official ministerial and academic Senegalese system and the project will tend towards an institutionalization of such a health monitoring capability within Senegalese development projects. It is also proposed that an institution in the U.S. provide back-up assistance through periodic consultation to check field results and make statistical and other types of analysis of them.

The village health services program will be built upon the basic health structure now in place and will receive technical assistance from the AID Regional Health Office in ADO/Dakar.

a.) Description of Surveillance Program

The Parasitology Department is headed by Dr. Samba Diallo, a Senegalese parasitologist, who has within his Department which is part of the University of Dakar four physicians, specialists in parasitology, and four laboratory technicians plus secretarial support. This Department has all equipment and expertise necessary to monitor intestinal parasites, schistosomiasis and onchocerciasis. The Anti-malarial Service in Thies, which is part of the Senegalese Ministry of Health, is also headed by Dr. Samba Diallo. It has 40 personnel, 30 of which are technicians of various kinds, an entomologist, senior nurses, nurses, sanitary agents, laboratory technicians, etc. and has the capability of carrying on a malarial surveillance program. Indeed the service was created for that very purpose with a mandate to work on development projects, but is hampered by a lack of operational resources. Thus, the AID assistance for this program will be a happy marriage between the needs and capabilities of the anti-malarial service and the Bakel agricultural production project.

Both services under Dr. Diallo can provide surveillance teams which would make surveys for schistosomiasis, maleria, onchocerciasis and intestinal parasites in some 25 villages (23 villages in the project plus two other villages for control purposes). Out of some 12,000 people in the main villages,

a sample of 2,000 persons would be selected after making an initial census of the populations family by family. This will allow the surveillance regularly of the same persons and considering an average of 25 persons per carré, the team would take a sample of some 80 to 100 carrés, some participating in the irrigated field coops and some not.

After the initial survey, two surveys would be made each year, one at the end of the rainy season and one during the dry season. An institutional contract will be established with a U.S. institute or university to provide:

1) consulting assistance to set up the surveillance program;
2) yearly consultation to monitor field surveys, and analyze results; and
3) at the end of the fifth year to make a health evaluation of the project.

b.) Description of village health services program:

The village health services program will build upon existing Ministry of Health services in the Bakel area and will be implemented in the project villages.

At the present time there are about 10 dispensaries in these villages and a Health Center in Bakel. The distance between a village having no dispensary and a village with a dispensary rarely exceeds 5-6 km.

The program to be implemented under this project will aim at strengthening existing medical services to improve diagnosis and treatment of endemic diseases and to provide health and sanitation training in the villages.

In order to accomplish this the following activities are called for:

1. Retraining dispensary nurses in microscopy,
2. Purchase of 12 microscopes,
3. Training of 23 village sanitarians and 23 Maternal/Child Health Workers,
4. Training of village health workers for those villages lacking dispensaries,
5. Provision of basic drugs and medicines for each of the 23 villages.

c. Funding of Health Component

Funding for the health and surveillance activities are provided in the project budget (p 89). These activities will be managed by the ADO/Dakar Regional Health Officer (Dr. Vincent) and training of health workers can be coordinated with the Sine Saloum Rural Health Project which has a similar village level health delivery services emphasis. ADO/Dakar and the Regional Health Officer believe that GOS services under Dr. Diallo have the capability of carrying out the surveillance program outlined. Project implementation plans for these activities will be finalized on receipt of the final APHA Team Report, and funding adjustments will be made as necessary.

6. Peace Corps Involvement

ADO/Dakar has discussed with the Peace Corps Director in Dakar the provision of one Peace Corps Volunteer (PCV) for the project. His role would be coordination between the SAED activities and health activities. He will assist in making arrangements for the health surveillance and health services program, helping Senegalese counterparts to explain the purpose of these activities to the villagers and to popularize the recommendations of the health workers. For example, the PCV will promote canal clearing and lining as a preventive health measure. In cooperation with SAED he would attempt to identify and reduce ponding. Through regular contacts with villagers he can provide background helpful for the surveillance activity and follow up on items such as: setting traps for mosquitoes which the entomologist from the Thies based anti-malarial service under Dr. Samba Diallo will be programming; promoting improved sanitation practices; and helping villagers to budget for amortization of equipment. Both ADO/Dakar and the Peace Corps/Dakar are in agreement in principle to recruiting a PCV for this kind or role in the project.

Part 3 - Project Analysis

A. Engineering Analysis

1. General: The irrigation possibilities for the Bakel area are divided into three phases:

- Phase I : Small village-level perimeters 20-300 ha each,
- Phase II : Medium perimeters 800-1,500 ha each
- Phase III: Large perimeters 4,000-10,000 ha each.

The present project deals only with Phase I of the SAED program, small perimeters of 20-300 ha each based on

village management. The Phase I activities can in turn be divided into two parts:

a) Perimeters where no flood protection is needed,

b) Perimeters where flood protection is needed.

Several perimeters (290 ha) have been surveyed which do not require flood protection to meet the "threshold feasibility" standard established by SAED of flood free four years in five. 100 ha of these perimeters are planned for development in 1976. SAED has also surveyed a number of perimeters together totalling 700 ha which could meet "threshold feasibility" if protected by low dikes (less than 2 meters). These perimeters needing diking plus more of the ones not needing diking are planned for development in 1978.

At the same time SAED has identified another 910 ha in parcels located in other villages which show potential for irrigation either with no dikes at all or with low dikes. A detailed survey will be made of these perimeters to determine dike requirements in late 1977.

The present project plans to include about 1,800 ha of land in small village-level perimeters. The details of the status of plans for these hectares is shown in Table 1, Annex H. 986 hectares located around several villages have been surveyed for diking of which nearly 700 ha require less than 2 meter dikes and 290 hectares do not require dikes.

The remaining 910 hectares located around other villages will probably require about the same proportion of diking so for planning purposes we have used 700 ha to be diked and 210 hectares not requiring dikes.

2. Hydrology

Since the height of the flood and the amount, duration and extent of inundation is the basis for identifying areas for perimeters, and determining need for and determining the height of dikes, the methodology of determining the effects of the river flow hydrology on the land is of interest. The only stage recorder for the river in the Bakel region is the ORSTOM maintained stage located at Bakel. The topographic surveys are tied to that flood stage record. During the topographic surveys, SAED engineers interviewed farmers to determine probable flood heights and correlated the farmer opinions with the known flow elevations at the Bakel stage. The correlation of the Bakel perimeter farmer data, which lies close (about 5 km) to the Bakel flood stage guage, were very good. This generally confirmed that the farmers' memories were approximately correct. For those perimeter irrigation areas lying some distance from Bakel, it was assumed that the farmer memory data was similarly correct. The farmer experiences also indicated that the flood height elevations in the flood plains lying inland from the river were about one meter

lower than the flood flow elevations on the river. This is explained in part by the assertion of SAED engineers that the river crests for a short period, 3 or 4 days, after a precipitous rise, and the amount of flood flow up the marigot channels would not permit filling up the lower lying areas to flood crest height before the maximum flood crest elevation had receded. Thus a lesser flood level elevation would occur in the inland flooded areas. SAED engineers indicated that the main river would crest for about 3 to 5 days and thus confirming that the crest period may be too short to permit filling up of the inland flood plains. The flood flow hydrologist working for A.I.D. felt that a differential of one-half meter between flood height in the river and flood height in the marigots was more reasonable. (See Annex E.)

During an interview with Mr. Mohammed Curtin, a 40 year resident in Bakel, it was stated that up to 1966 the Bakel flood stage reading was about 13.5 meters and from 1967 to 74 or since the drought, the flood stage reading has been 7 or 8 meters. This indicates that during the drought period and up to present the river may be flooding at lower elevations than would occur during a normal flood flow year. Mr. Curtin also stated that a similar drought and lower water stage elevation had occurred in 1939-45.

The discrepancy between SAED theories and the farmer interview data indicated that the PP team needed more

firm information before determining that the chances are good that the irrigation perimeters to be selected can be adequately protected from floods at a cost which is economically feasible.

The success of expanding the activity depends largely upon the probability that at least four years out of five the proposed irrigation areas will be free of inundation and damaging floods, or can be diked with low (2 meter) dikes. Therefore, AID contracted a hydrologist whose report is attached as Annex K. As a result of the hydrologist's findings and discussions with the SAED engineers and the economist on the PP team, it was decided that designing the dikes to a one year in ten flood level would be preferable in order to reduce the risks. Since the dikes are only a small part of the project, the increase in total cost was minimal and helps assure proper use of the remainder of the investment.

3. Plans and Specifications

The PP team visited the SAED headquarters engineering office in St. Louis where detailed topographic surveys for 12 perimeters totaling about 227 hectares have been completed. The topographic surveys were made to 10 cm contour intervals and are correlated to mean sea level elevations and the Bakel flood stage guage records. This permits a determination of the areas that may be free of floods based on the known hydrological flood level data.

The 10 cm contour intervals provide a suitable topographic map on which to plan and design the rice paddy irrigation systems. The SAED engineers are designing the individual paddies so that there is a maximum of 10 cm (4 inches) difference in elevation between field dikes. Under this design criteria, very little field leveling will be required. A 10 cm difference in levels of an individual rice paddy is tolerable to rice even at the maximum water depths. The field paddy design is an acceptable practice.

The SERDA (former CIDR) staff, as a result of experience in growing rice on these soils, determined that a 300 square meter paddy size is optimum and will adequately permit hand or animal traction cultivation (just being introduced). If mechanical tillage should be utilized, the paddy areas may need to be enlarged to permit efficient mechanical cultivation. For the present, the relatively small paddies will tend to reduce the amount of required field leveling. Since the soils are good, but more permeable than desirable for ideal rice lands, the small plots will help promote more efficient irrigation water application practices.

SAED engineers have planned and designed the main ditches and laterals to take advantage of the natural topography. The main canals are aligned along the general level of the contours and will require few major drop structures. The laterals cut across the contours and small

drop-turnout structures will be required in the laterals to prevent channel erosion and to provide water control. The water flow in the laterals will be relatively small. The SAED engineers will need to develop a small standard precast concrete drop and turnout structure that can be readily installed as required in the laterals. SAED is conducting a credible engineering job.

4. Pumping Stations

The majority of the irrigation systems will be supplied water from the Senegal River. Pumps will be installed on small rafts. This set-up has been tested for two years in the Bakel area and is operating satisfactorily. SERDA staff have recommended that two standard size Lister Diesel powered pumps (15 hp and 32 hp delivering about 150 and 300 M 3/h4 respectively) be used. As the areas to be irrigated expand or are adjusted, an appropriate sized pump or pumps may be used. A 15 hp pump will serve about 15-20 hectares and similarly a 32 hp pump will serve about 30-40 hectares. It is recognized that a specific pump should be designed to serve a specific sized area, but due to the flexible nature of the expanding activity, an exact sized pump cannot be fixed. Experience over two years indicates that the two sizes of pumps noted above will provide for most anticipated conditions. Under operation, this means that for smaller than ideal areas, the pump will not be operated for a normal period; for larger than optimal areas, the pump will need to

operated overtime. The systems are designed to be operated daytime hours only; thus there is reserve time for pumping additional water. When the irrigated areas expand beyond the largest optimal pump capacity, two pumps may be operated in tandem. The activity will have sufficient flexibility and spare equipment to provide for this "modus operandi."

5. Construction Methodology

The villagers are constructing all the facilities (canals, laterals, field bunds, drains and small perimeter dikes) by hand. Table 2, 3 and 4 Annex H show labor requirements and compare labor availability and requirements during maximum development. The villagers usually turn out in labor gangs of 35 to 100 about 5 or 6 o'clock in the morning and usually work for three or four hours. SAED recently provided two rented D-8 bulldozers which were employed to stump 115 hectares of proposed perimeters areas. The SAED equipment was utilized to remove the heavy stumps remaining after the villagers had conducted the light clearing and burned the small brush. The SAED stumping activity has encouraged the villagers to increase their irrigated hectarage.

It is planned that the dikes for the project will be constructed by a contractor arranged through SAED. SAED is experienced in contracting procedures and has demonstrated its ability to supervise construction activities in other projects in the Basin. The dikes will be constructed as "semi-compacted" dikes. Special compaction equipment will not be brought in to compact the dikes but

work will be done in such a way that the dike will be constantly traversed by the dozer. Since it is not expected that the dikes will be in serious danger from current erosion, rip-rap will not be used. The dikes will be made one meter wide with 2:1 slopes on the sides. The height of the dikes will vary from one meter to 2.5 meters depending on the contours of the land. Plans have been developed by SAED which are sufficient for construction.

SAED has three engineering technicians assisting the villagers with the field engineering layout of ditches, laterals and field bunds. The field engineering is adequate. The water delivery systems are being staked out and constructed according to the planned designs in eleven perimeters inspected by the team. The villagers, under SAED field technical supervision, were monitoring construction progress on schedule and it was asserted that the targeted planned hectarage for cultivation will be achieved. The villagers are conducting a satisfactory ditching and field bunding job. Experience will teach them that good initial ditching and bunding will significantly reduce maintenance.

6. Cost Estimates

Cost estimates are dealt with in detail in the financial section of this paper. The PP team determined the amount and labor requirements of construction of the main canal, laterals, field bunds, and drainage ways and the results are shown in Tables 2 and 3, Annex H.

It is noted that the amount of field work as estimated in SAED plans and designs are less than those estimated by SERDA staff. This confirms the statement of the SERDA staff that extra field bunding work will be conducted. The team believes that SERDA estimates are a bit high, but have weighed the average amount of work in their favor.

The average labor requirements data as collected from villages by the team correlates very closely with SERDA estimates as shown in Table 2, Annex H.

7. 611A Certification

SAED has developed plans and specifications for housing, warehouses and shop and has surveyed and designed over half of the irrigated perimeters in a very professional way. Based on this, a 611A certification can be given from both an engineering and management standpoint.

8. Detailed Analysis of Capability of SAED to Implement Activity from Planning, Design and Supervision Standpoint

SAED as noted above is carrying on adequate engineering plans and design program for the activity. SAED's chief designer is an expatriate Frenchman. He is overworked and has a small Senegalese staff. However, they are getting the assigned tasks completed. Management studies of SAED have been undertaken by Bureau d'Etudes et methodes (BOM - part of the GOS Presidency) and SATEC. These studies will indentify SAED's management strengths and weaknesses and develop recommendations for strengthening the management aspects. A Project Paper for an AID training project in SAED is being prepared.

In the Bakel area, SAED is sponsoring three SERDA technicians, a SAED representative, a field supervisor and three technical assistants. It is planned to increase the staff to provide a technical assistant to each village. For the moment, the staff is able to adequately stake out and supervise the initial construction work. Later, the technical assistant workload will increase as they are expected to assist with agronomic as well as irrigation practices. In addition to the supervising engineering staff, SAED has two mechanics in Bakel that have been trained by MATFORCE in Lister Diesel Motor maintenance and operation. The mechanics are training village employed pump drivers, who will be running the pumps. The SERDA staff is of the opinion that SAED staff will be adequate. This aspect will need to be evaluated as the activity is expanded this season and the next, to determine if in fact they can adequately conduct the necessary work. An initial small SAED staff will promote the villagers to do more of the necessary work and this will be good. The villagers must eventually be in full control and

and manage and run their irrigation systems without too much technical assistance from SAED if the activity is to be fully successfully installed and running.

9. Detailed Analysis of Capability of People to Implement Construction Portions of Activity

The field operations have been dealt with in detail above. The villagers are demonstrating the capability and will to conduct all necessary field construction activities except the larger dike construction which is beyond their capability and will need to be constructed with heavy equipment. Farmer construction activities are engineered and supervised by SAED staff. The PP team's analysis of the labor requirements indicates that adequate village labor is available to conduct all the construction activities envisaged in the initial years of the activity. (See table 4, Annex H).

10. Timetable for Implementation of Construction and Analysis of Whether Time is Reasonable

The timetable for implementation of the construction activities appears reasonable particularly in view of the adequate village labor supply. Two to three months is adequate time to implement the planned construction activity during the initial beginning years. These estimates are predicated on the basis that SAED will continue to provide heavy stumping and construct the major dikes. It is assumed that SAED's management capability will expand with progress of the activity.

11. SAED Phase II - Medium Sized Perimeters

The project under consideration only concerns Phase I. However, for purposes of future planning it is noted that SAED has identified for future irrigation perimeter development about 2,000 ha or more area of land lying along the river

adjacent the bridge about 1.5 kilometers north of Diawara. The land appears to be suitable for irrigation development. Land elevations determined near the area indicate that relatively low dikes would be required to adequately protect the area from flooding. The dikes constructed for the Phase I small perimeters would be utilized as a portion of the dikes for the larger perimeter. They would probably be made higher and strengthened to provide protection for the more entensive Phase II operation, but would not be rendered useless.

Further discussion concerning the suitability of area this large for irrigation is speculative until three steps are taken :

1) The results of the flood hydrologist findings regarding floods from the marigots to indicate the precise height and extent of the diking effort required to protect the area,

2) If the report of the flood hydrologist is favorable (i.e. indications of only minimal dike requirements) then SAED or an engineering firm will conduct a detailed topographic survey of the entire area proposed for irrigation and include enough of the surrounding zones to be able to plan and design the required dikes,

3) Utilizing the detailed topographic maps, a detailed irrigation land classification survey must be made determine the economic possibilities of those irrigable soils.

When the above steps are completed SAED will be able to determine if it has the capability to plan, design and prepare specifications for the entire job. There are no particularly significant problems envisaged when the above items are determined. The implementation and operational experience now being gained by SAED with its smaller perimeters in the region

will provide invaluable base data for planning, design and cost of the larger perimeter. If AID decides to consider funding Phase II activity documentation for it might begin after the evaluation of Phase I in 1979.

12. Environmental Review of the Project

The Project Paper for this project was submitted and reviewed during the latter part of 1976 when AID was redefining its environmental standards. The original PP had included an environmental section which formed the basis for an Initial Environmental Examination (IEE). The PP team found that no significant adverse environmental impacts would be produced by this small, village level, irrigated perimeter project and a negative determination was recommended. This recommendation was reviewed in AID/W and questions were raised about the potential effects of the irrigation program on the health of villagers involved. AID then arranged a contract for the services of an environmental specialist, Dr. John Nebicker who made a very brief environmental investigation of the area. His report suggested the possibility of a slight increase in the duration of the malaria season as a result of the irrigation project and he recommended a prophylaxis program to decrease the risk to the villagers. This approach was not accepted by an AID/W review. Therefore, the American Public Health Association was engaged to field a team for a full scale Environmental Assessment and to suggest health interventions for the project. Their findings basically confirmed the findings of the original PP team as presented in the IEE. The APHA Team found that there would be no significant adverse health effects attributable to the AID financed village level, small irrigated perimeter project.

Nonetheless, a health surveillance activity is included in the project to continuously monitor the health of villagers. This surveillance program is to be principally carried out by Senegalese services and thus will strengthen the local government's capability to carry on such a surveillance on its own. US technical assistance to backstop this surveillance effort is also included. Also, a village level health component has been added to the project. Annex L contains the IEE.

It might be added that these detailed investigations into the environmental effects of this small, village level irrigated perimeter project are empirically supported by the much vaster experience that SAED has had in large scale irrigated perimeters financed by the IBRD, FED and France. No serious health or environmental problems have been reported in such large perimeters as Dagana, Nianga and Richard Toll, which have been functioning for several years. The size and amount of water irrigated in these larger perimeters truly dwarf the small village level perimeters under consideration in this PP and empirically it seems unlikely that this infinitely smaller project would encounter serious health or environmental problems that have not shown up in the much larger projects.

B. Agronomic Analysis

1. General

The population of the area is almost totally subsistence farmers. They have survived on this marginal existence since time immemorial by planting dry season sorghum and millet and a sorghum crop under recession agriculture following the annual Senegal River overflow in September and recession in November. During this period sedimentation is deposited on land adjacent to the river banks and sufficient moisture is retained by the soil to support an average sorghum yield of 500 kilograms per hectare. Cultivator's inputs are limited to labor and seeds.

Sorghum and millet are planted under rainfed conditions on the sandy soil (dieri), further away from the river banks in June and harvested in October/November with average yields of 350 kilograms obtained under traditional methods of cultivation.

Traditionally, some rice was grown by the women in the swampy areas but suffers a total loss four years in five due to the vagaries of the climate. Some peanuts are also grown by the women of the area on the lightest inland soils. An average rainfall of 625mm (25 inches) may be reduced in certain years to less than 400 mm (16 inches) for long periods of time such as occurred during the drought years of 1965-1972. These often result in hardship to the population and loss in crops and livestock.

The climate is strongly influenced by the desert. Great variations may occur between peak day and night temperatures. An average temperature of 45° C in April, which is the hottest time of the year, will drop to 25° in January.

2. Soils:

The predominant soil types on the perimeters are fondé soils which constitute about 65% of the surface project area. These soils have up to a 44 % clay content. They are well aerated with good capillary action, permeability and drainage. They are irrigable and suitable for wheat, sorghum, peanuts, corn, cowpeas and vegetables. They have about 35% clay content.

The following summary is drawn from an OXFAM report on soils of the region. (Attached as Annex G.)

The soil types of the perimeters are as follows:

1. Heavy alluvial soils (51-60% clay), known as Hollaldés. They are found in perimeters along the river and in low-laying areas. They have fine-textured particles of low permeability and a PH of 6 to 8. About 10% of the perimeters are of this soil type which is irrigable and has slow drainage characteristics which makes it suitable for rice production.
2. Medium heavy soils (45-50% clay) content, known as (Faux Hollaldés). They are found adjacent to Hollaldés soil type. These soils are irrigable and suitable for rice, sorghum and cereal crop cultivation. About 30% of these perimeters are of this soil type.
3. Medium soils with (30-40% clay) content, known as Fondés. These soils are well aerated and have good capillary action, permeability and drainage. They are irrigable and best suited for wheat, sorghum, millet, peanuts, tomatoes and other vegetables but rice production is possible. About 60% of the perimeters are of this soil type.

Random borings of more than one meter depth made at these perimeters by pedologists of the Société d'Aménagement et d'Exploitation des Terres du Delta "S.A.E.D." and technicians of the Compagnie Internationale pour le Développement Rural "C.I.D.R." indicate the absence of hardpan at these depths. Also there are no salinity problems or salt formations at this time.

No detailed soil surveys have been reported made of the perimeters. However, the soils are fine textured with fair tilth, low to fair permeability and capillary action which are suitable for cereal crops production. They are probably deficient in nitrogen, phosphates and other minerals such as potash, magnesium and trace elements. Soil erosion due to lack of cover crops is evident in several places but not serious. Much of this erosion is caused by the heavy harmattan winds in March/April, the uncontrolled grazing by livestock and the Senegal River overflow and inundation.

Predominant use of primitive agricultural tools (daba) have been responsible for the conservation of the soil crust and limited disturbance of the soil surface with subsequent minimum serious erosion.

3. Crop Research Work:

Crop research has been carried out in the Upper Senegal River Valley since 1965. The Institut Sénégalais de Recherches Agricoles (ISRA) has an experiment station at Richard Toll where research work is carried out on rice, wheat, sorghum, millet, sugarcane and vegetables. Also OMVS/FAO/UNDP have three experiment stations at Guede (Senegal), Daedi (Mauritania) and Kayes (Mali). Research work at Guede which has Fondes type soils include wheat, corn, sorghum, millet and cowpeas. The Kaedi station at Vandam has a Faux Hollaldes soil type. Research is performed

there on wheat, rice, sorghum, millet,corn, forage crops and sugarcane. The Kayes station in Mali has a research program that includes wheat, rice, corn, sorghum, millet and vegetable crops.

The Institut de Recherches Agronomique et Tropicale (IRAT) and the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) collaborate with these stations in different phases of their research activities. Also the West Africa Rice Development Association and the West Africa Major Cereals Project work with these stations in developing, breeding and testing rice, wheat and sorghum varieties respectively.

Several semi-dwarf rice varieties including the I.R. line with a short maturity of 90 to 110 days have been identified and tested at these stations. These varieties have shown disease resistance, adaptability to the local climate and soils and high yields in excess of eight metric tons per hectare.

Semi-dwarf wheat varieties with a maturity of 110 to 120 days have been tested and have shown good adaptability, disease resistance, high yields and acceptability by the local population. Further testing for planting density, planting dates, fertilizer application, irrigation frequency, weeding, insecticide, pesticide and herbicide use and harvesting date experimentation are required. The Mexipak variety was reported to have given yields in excess of four tones per hectare at the Kaedi Experiment Station. Also semi-dwarf sorghum varieties tested at the OMVS Experiment Stations have given yields of three tons per hectare and Niebe varieties produced 2.5 tons per hectare while composite corn varieties of IITA (A and B strains) have given yields in excess of five tons per hectare. Crop rotation experiments with double and trible cropping patterns were successfully performed on the principal soil types at these stations as follows:

On Hollalde and Faux Hollalde Soil Types:

Wheat planted under irrigation in November and harvested in March. Upland rice planted under dryfarming conditions in June and harvested in October.

Rice planted under irrigation in November and harvested in March. Rice planted under dryfarming conditions in June and harvested in October.

Rice planted under irrigation in November and harvested in March. Sorghum planted under dryfarming conditions in June and harvested in October.

Rice planted in November under irrigation in November and harvested in March. Corn planted under dryfarming conditions in June and harvested in October.

On Fonde Soil Types:

Wheat planted under irrigation in November and harvested in March. Niebe (cowpeas) planted under irrigation in March and harvested in May. Sorghum planted under dryfarmed conditions in June and harvested in October.

Wheat planted under irrigation in November and harvested in March. Niebe planted under irrigation in March and harvested in May. Corn planted under dryfarmed conditions in June and harvested in October.

Wheat planted under irrigation in November and harvested in March. Sorghum planted under dryfarmed conditions in June and harvested in October.

Wheat planted under irrigation in November and harvested in March. Corn planted in June under dryfarmed condition and harvested in October.

A wide range of vegetable crops including okra, tomatoes, cabbage, Irish potatoes, sweet potatoes, eggplants, onions, carrots, garlic and salads are suitable in rotations between October and March.

4. Crop Varieties Planted at Perimeters:

At present, the following crop varieties and lines are planted at some of the perimeters, under dryfarming conditions:

Rice :	D 5237 (upland)
Millet :	Souna III
	Souna Gam
Sorghum :	CE 90
	CE 67
	Mali
	Soudan
Corn :	BDS
	JDS
	2 M 10

Also the following paddy rice varieties are grown by transplantation:

IKONG PAO

TAICHUNG

Fertilizer application is confined to rice with 150 kilograms of 18-54-0 applied per hectare. None is applied to sorghum and millet. However, animal manure is used when available.

Experience with the 1975 crop in Bakel and the 1974-75 crops in Matam indicated that the best results were obtained from Ikong Pao (4 T/ha average versus 2 - 2.5 T/ha for Taichung Native). Therefore, in the future it is planned to utilize Ikong Pao on a much larger percentage of the area.

To maintain conservatism in yield estimates the team has decided to make the following assumptions regarding yields:

	Beginning	Increasing to in 8 years
Rice	2.5	4.0
Corn (irrigated)	1.5	3.0
Sorghum (irrigated)	1.0	2.5
Niebe (irrigated)	.5	1.5

A changing yield is assumed because as farmers become more experienced with irrigation and irrigated culture and as improved varieties are identified tested and adapted the yields are certain to be increased. Past experience in the Guede and Matam perimeters conforms these assumptions.

Due to the uncertainty of acceptance of improved technologies absolute yield increases are not the goal of this project. Rather the emphasis of this project is to improve traditional culture in order to release additional labor for irrigated culture. The introduction of animal traction on the drylands as well as on the irrigated lands will do much to release labor. A small increase in yields on dryland farms is likely due to the efforts of CIDR and SAED. However, it is assumed that these increases will not result in increased total sorghum and millet production but rather in less hectares planted and more time spent in the more profitable and less risky irrigated farming.

A field trials station is recommended for the Bakel area, at a site tentatively selected by the CIDR personnel, four kilometers west of Bakel. An area of ten hectares earmarked for adaptive research experiments is suggested. This station will perform crop adaptability test, varietal trials, seed density tests, crop management experiments, fertilizer treatments, irrigation method applications, insect and disease identification and control, introduction of new crops such as wheat, lentils, chickpeas and other high protein pulses and cereals and their management. Research

and extension efforts should be coordinated to make maximum utilization of the station for farmer field days and demonstrations for villagers in the region.

5. Dry Land Interventions

The dry land interventions are planned to encourage improvement of traditional cultivation methods. The methodology of approach which has been used in the past and will continue is one of planting community demonstration plots based on the farmers groups in each of the villages. On these plots improved varieties of sorghum and maize will be demonstrated along with use of fertilizers, improved cultural practices and animal traction. This component of the overall project is essentially a technical assistance project with nearly all the costs being for the staff and technical experts. The PP team estimates funding of approximately $220,000 attributable to the dry land component. This cost is broken down as follows:

T.A.	$ 62,000
GOS staff	30,000
Vehicles	17,000
Housing	60,000
Operations	27,000
Equipment	15,000
Ag Inputs	7,000
	$218,000

Dry land demonstration plots will be undertaken in each of the 23 villages utilizing ag inputs provided free of charge by the project. Farmers will be trained in use of the improved technologies and encouraged to utilize these technologies on their own fields. The farmers showed great interest in possible improvement in their traditional farming methods as a complement to the irrigation activity.

6. Pesticides

The small, village level irrigated perimeter project under consideration is not viewed by SAED as a maximum production effort. It is aimed at increasing local food resources but unlike the major, large scale irrigated perimeters like Dagana and Nianga, is not a maximum production project. The systematic use of pesticides is therefore not contemplated in this project. If a serious insect or pest outbreak occurs, SAED will consult with the Crop Protection Service which is being supported through the AID financed Sahel Crop Protection Project (629-0916). Two AID entomologists are based in Dakar for that project and would be available for consultation.

C. Sociological Analysis (detailed report attached as Annex K)

1. Introduction

Social analysis of the project shows that it can integrate into the society of the Sarakolle who inhabit the project area and can respond to essential needs of the population. There is a common will evident among the farmers to organize themselves on the basis of village communities to make their region an example of modern agriculture. Already the local farmers have come to understand the need for joint organized action. The sedentary villagers involved in the project speak a common language and share a common ethnic identity. Thus, the project area constitutes a homogeneous region for development.

The SERDA technicians are well integrated into the local society and into SAED's operations. SAED itself, whose Director General comes from Bakel, is well motivated. The villagers place great hope and trust in the Director General as a "son" from Bakel. There is no question that the project already has had some impact on this traditional society and in the future its impact will become progressively greater. The villagers ability to adapt and to accept the changes progressively appears to be positive. The potential for a positive impact on women is present since for the first time women are working on a project on an equal footing with men within the cooperatives.

2. Operation of Cooperative Groups

A. Membership

All farmers and individuals can join the Cooperative groups which operate the village level perimeters. There is no distinction made with respect to sex, age or caste for admission into the groups. Each member brings his own work-capital (human investment). Every family in the village has at least one representative in the cooperative group. All castes work together and the group itself sets up its management

regulations and divides the group up into teams.

In many of the villages collective gardens have already been established. Members are satisfied with the workings of these collectives. Profits from these collective gardens are used as village funds to set up pharmacies, build dispensaries and schools and other village community projects.

What is remarkable in the village cooperative system as it operates so far is that the leaders are willing to keep village level rules flexible. They demonstrate a strong interest and desire in preventing cooperation itself from becoming an apple of discord. There is a strong feeling among the Sarakolle that investments derived from community undertakings will be used for the community as a whole and not for some privileged groups. Thus, the cooperative concept envisioned by the project fits into the community concept of the Sarakolle.

B. Motivating Future Members

There is motivation at several levels for future members. Dynamic individuals, who are aware of the economic advantages of modern agriculture, have been observed in the village groups. These individuals recognize the need for collective efforts, and understand the economic advantages irrigated agriculture will provide.

A second group of active participants is made up of those who are close relatives of the natural leaders. Other participants join because the cooperative group becomes "a village undertaking". Thus, one would be marginal in relation to the community if one did not participate in the work which elders had come to view as worthwhile. Thus, for most members the determining factors are of a psycho-sociological nature.

What might be termed creative competition between various villages has also taken root. Sarakolle villages tend to watch and rival one another. The construction of sumptuous mosques is an example. Working fields cooperatively benefits from this spirit.

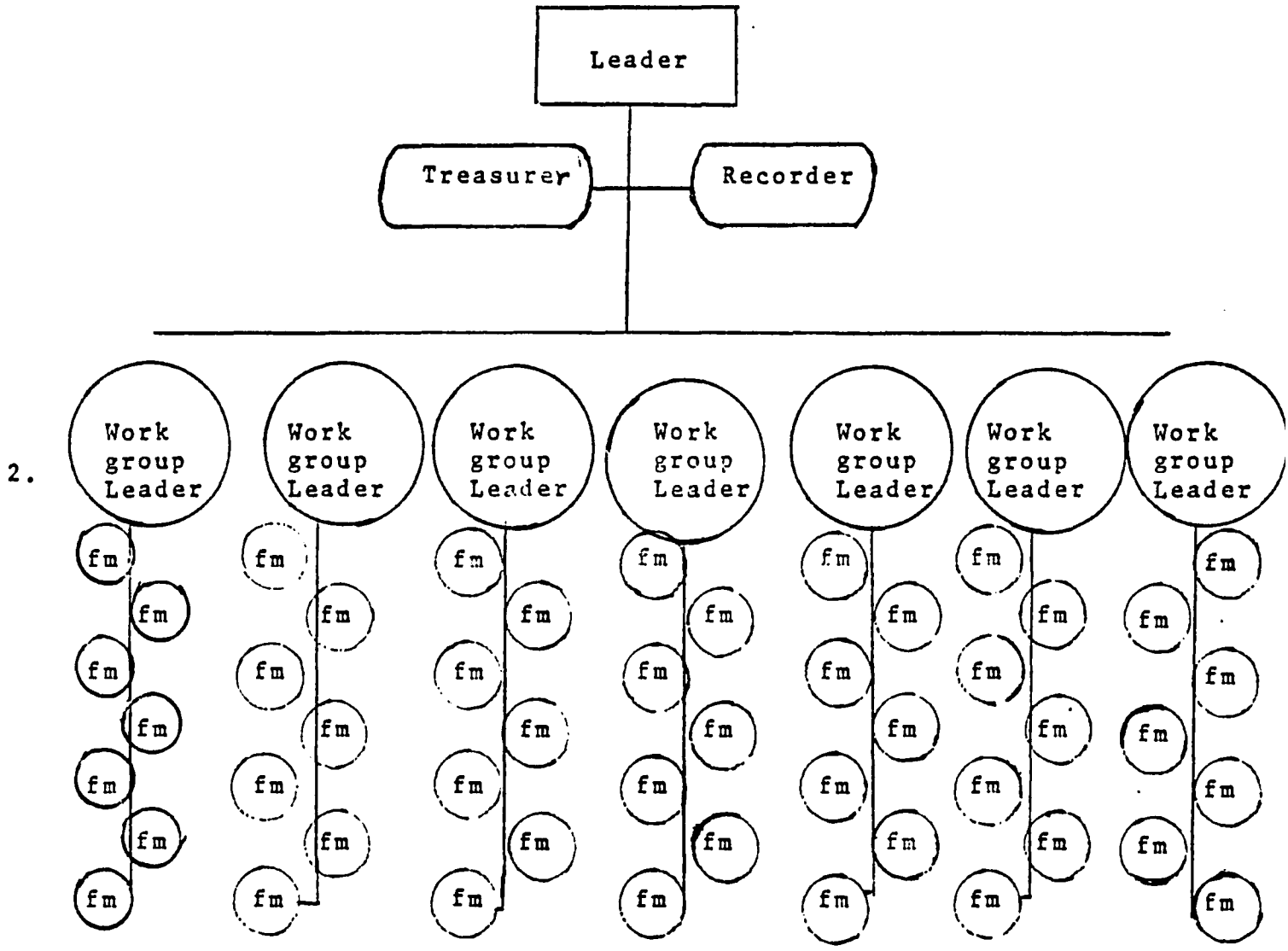
Another motivation observed is the desire of cooperative members to apply new techniques on individually worked fields. In fact cooperative members seem to see their main advantage in applying new technology gained in the cooperative on their individual fields.

C. The Village Group Leaders

In six villages observed at random, four group heads were sons of chiefs. One group is headed by the nephew of a village chief and the sixth group is led by a member of the second most important family. Thus there is a reflection of traditional leadership pattern among the cooperatives. However, there is some innovation at the work team level. Work teams (averaging 5-7 in number) were observed both with an individual of slave ancestry (Thioubalo) and a member of the ruling family as heads. Most team leaders had travelled abroad (mainly Europe) and were chosen based on technical competence and education. This is somewhat of a departure from traditional authority structure among the Sarakolle. There appears to be a strong self-imposed discipline and team leaders are generally obeyed.

3. Project Impact on the Social Structure and Impact on Women

The project is an innovation in the Sarakolle environment. It is the first time that families of all social conditions and castes come together in a project for the whole community. New structures of authority departing from village tradition are appearing. These will be based on technical competency and ability as a team leader



1. Leader - Liaison with Gov't
   Traditional Leader

2. Work group leader - advisory council
   - from all social classes
   - real control

fm = farmer

FARMER GROUP ORGANIZATION

and manager; factors not necessarily linked to the individual's birth status. Thus, working collective fields will become a matrix for experience which will evolve towards transformation of the societal structure.

Also, for the first time in the history of the region a project overlooking the sexual division of work is being undertaken. Women traditionally have been under the absolute authority of the men. However, the presence of women working alongside male heads of households will have long-term remifications on the structure of authority. The women will gradually realize that they play an equal role in the project and will formulate judgments on the overall society. The germ for a positive improvement of the conditions of women is present. This will be a gradual process. The women in the Sakarolle society bear a large labor burden with their days full of heavy labor such as water drawing, grinding millet, etc. The introduction of mechanical pumps under the project will illustrate their efficiency at moving water and the farmer groups will be encouraged to invest some of their returns in pumps for wells. Animal traction will also help to encourage practices which save labor for women.

Emigration from the project area to France, which has been the characteristic and traditional pattern, may not change in the near future because of the project. Almost all young men leave the Bakel area at age 14-16 to replace a brother or cousin in Europe. The relatively large amount of money which can be earned by emigration has been the impetus for this movement. Income from collective fields is too low up to now to rival the enticement of earning money in France or Dakar. After a

period of 4-5 years, however, there may be some slowdown in emigration.

4. Summary

Transformations of a sociological nature are extremely slow; almost unperceptable in the short term. Present day Sakarolle society gives a minimum of security to the individual at the least cost. The project can provide an extra margin of security. Sociologically speaking, deviant individuals are generally looked down upon in rural communities when they experiment with innovations that go wrong. Negative group feedback devices (ostracism, malicious gossip and loss of prestige and influence over other) come into operation. When an innovation is successful the imitative response of others in the community leads to broad-scale acceptance. Thus, positive and negative feedback mechanisms are critical. The present project already has begun this process and has the benefit of a gradual but successful initiation over the past two years. Sociologically, this bodes well for the project.

D. Economic Analysis

The general conclusion that can be drawn from calculation of the internal rates of return for this project, is that it is viable under almost any conditions. Even if costs were to rise or prices to drop significantly, the project would still be viable. The rate of return under expected conditions would be 26%.

The irrigated land after five years into the project would cover almost 2,000 hectares, mostly in units of less than 100 hectares. The principal cash crop will be rice, with the traditional crops of maize and sorghum also being irrigated for commercial sales. New crops such as cowpeas and wheat will also be considered, and if successful, put into the rotations. Vegetables will be produced entirely for local consumption.

The villages appear to have adequate labor in each month of the crop season to continue their traditional crop production, to clear new land and to add the necessary labor for crop production on the newly-irrigated land. Bird-watching which places a heavy requirement on labor in certain months for small grains, has been included in the seasonal labor requirements. Crop yields have been estimated at a moderate level, beginning with what has been obtained

through field performance, and increasing to a level that is still well below what experimental plots will produce.

With an adequate annual allowance for cereal consumption, it appears that traditional production is nearly adequate, although it is known that local consumption usually increases when a program of increased production is initiated. Calories from non-cereal sources have not been calculated, as they do not need to enter into the relationships of prime importance considered here.

Valuation of farm and family labor is always difficult, as it is in this case. The net value of crops produced offers one type of clue if land value can be considered as very low; another is the net savings by rural young men working abroad. An arbitrary value of 75 CFA per workday was used, in order to obtain a figure that is not too high but, on the other hand, does not assume that farm labor is "free".

Surplus crops will probably be sold through parallel marketing channels and this will improve the net position as shown by the present calculation of net benefits.

Population & Crop Production

The amount of crop production is closely related, in the Bakel villages as elsewhere in rural Senegal, to the size of population. This is true both because the people depend primarily on local crop production for their food needs, and because there is not a distinct limitation on land available for crop production - although the "free" land remaining is of poor quality compared with most of the lands now under crops.

Estimated total population now in the villages is shown in Annex J, Table (A-1), and amounts to over 31,000. An additional 8,000 young men over 15 years old are estimated to have migrated, many of them going to France - the majority of them will return to their home area after several years.

The "active" population includes the adults of all ages, and the boys and girls down to pre-teenagers who furnish the work of adults in representing their families in the community. The crop acreage is based on what an adult can normally care for, rather than on a direct census of the fields of crops in the area. The table also contains projections of irrigated cropland for a five-year period, and is based on plans by the CIDR team. Traditional cropland remains at 12,000 hectares, while irrigated land increases to almost

2,000 hectares after five years.

Selection and Areas

Present crops grown in the area, all without the aid of irrigation, include sorghum, millet, maize, rice and groundnuts. On the new irrigated lands, it is planned to begin with rice, sorghum and maize. Small areas of cowpeas and vegetables are also envisioned. About twice as much land has been farmed during the rainy period as during the period of flood recession (see Annex J, Table A-2). Other crops may also be grown as the farmers develop experience for instance, wheat has shown good results in experiments at Matam.

The development of the full 1,900 ha of irrigated land would not reduce the amount of land now used for subsistence crops, although some rotations might be altered and some fields be replaced with others. It is not anticipated that the major part of the crops produced under irrigation will be consumed locally. The exceptions are a part of the rice, and all the cowpeas.

Rice yields are based on experience with actual fields irrigated and under production in Bakel during the past year, as well as the figures used for "semi-intensified"

production by the World Bank in recent studies in Senegal. For other crops, the range between the Bank's "semi-intensified" and "intensified" production contains the boundaries of the figures used by the present report.

It was not felt necessary to include in a budget the typical traditional agriculture now being practiced. This is especially true since the new land is going to be operated for the community, and not for a few individuals. The present rotation is felt by the team to be satisfactory with the limits of present knowledge about the crops and their relationships to the soil. Crops with which the local farmers are familiar are emphasized in production. Vegetables are not considered since they will only be produced for local consumption and thus have a limited demand.

Farm Labor

The traditional season begins with clearing the land, then seeding after the rains begin. Weeding then consumes much time, with bird-watching very time-consuming also as the heads begin to fill on the small grains. Harvest is the final time of much effort. As the floods recede, sorghum and maize are planted and this helps to ameliorate the labor

peaks caused during the hivernage. The estimated person-days required for each crop per hectare is shown in Annex J Table A-3, along with estimates for the new irrigated crops grown under an improved package of practices, and Table A-13 gives time spent on different farm operations.

The person-days have been multiplied by the crop hectares in Table A-4, resulting in estimated total person-days needed for production of traditional crops by the villages in the project. A comparison has been made with the theoretical adult labor available in the same villages. On this basis, there remains adequate village labor for land clearing, irrigation agriculture, and non-crop activities. The typical person-day for crop labor or land clearing and improvement, is not over four hours, and the work-week is six days, except when there is a holiday.

The oxen to be used in the traction program are being trained by the Senegalese Government, as are the drivers. It is assumed that individual villagers will maintain the oxen in the villages, and that a villager will drive each yoke of oxen in the field operations, and be paid the 75 CFA per day for his services that are charged to the project. It is assumed that the production of rice straw, corn stalks, and other crop aftermath will be sufficient to feed the oxen that will be maintained by the villages. It is assumed that oxen for training and

use as draft animals are already owned by villagers and will be available at no additional cost to the project. As noted, in the budget, rental of the oxen is provided for on a daily basis for specific farm operations.

It will be noted in Table (A-4) that there is only one month, September, when there is any evidence that there is a heavy demand on labor. Even then, over half the estimated labor remains free for other tasks. Clearing of new lands for irrigation can be done easily in the months when there is not heavy field labor, especially as there will be assistance from bulldozers and tractor discs for uprooting trees, breaking the surface crust and constructing earthen dikes. Construction of canals and bunds are also a major community project but can be done as labor is available.

When all the 1,896 hectares of irrigated land are developed and in rice, the heaviest labor month will be November, with 159,264 person-days of labor required. September is a relatively light month for labor needs on this irrigation needs, the villages would still have over 250,000 person-days for other work when all field work, irrigated and traditional, is done.

Farmer cooperatives will operate the irrigated lands. A relatively small proportion of the eligible adults have so far joined these cooperatives. It is anticipated that the majority of those eligible will join by the time the land to be irrigated is all cleared. In any case, over 44% of those eligible would have to resist becoming cooperative members before there would be too little labor available in the busiest months of the crop season. Neither is it anticipated that any one village would be overburdened with work in any one year, as it can be seen in Table (A-1) that the land is to be cleared gradually, and in proportion to the village population, wherever sufficient land is available.

Crop Yields and Production

Average yields of crops under traditional production methods are given in Table (A-5), as are suggested yields under improved practices. Demonstration areas of rice production under irrigation have yielded from 1.8 to 3.3 tons per hectare. For project estimation purposes, Table (A-7) shows yields beginning at a modest level and increasing to reach a plateau by the eighth year.

Production and Consumption

Total production of the traditional crops is given in Table (A-6). The figures have been adjusted downward by

20% to allow for periodic flood damage. These adjusted production figures are then compared with the needs of each villager for calories from cereal sources, in Table (A-8). The major cereal and cereal product imports to the area have also been estimated, to complete the nutritional picture. On the average, the table shows that the annual consumption of the villager, from produced and imported cereals, seems to be sufficient for his present needs.

The seasonal pattern of consumption may present a different picture, as it is likely that the several months preceding harvest of the major cereal crop would present a picture of reduced intake and resulting malnutrition on the part of a majority of the population. It is also probable that more than 75% of the daily caloric needs of the average person are provided by cereals, and this would suggest that a higher production of cereals could be consumed in the local region.

The estimated production of cereals under irrigation and double cropping patterns is shown in Table (A-11). The local consumption of newly-produced rice, with the remainder entering the commercial market, is indicated in Table (A-12).

Consumption is shown increasing as population increases over time. By the eighth year of the project, about 9,000 tons of rice, maize and sorghum will be in surplus and available for shipment out of the Bakel area each year. If the cost of handling and transporting grains from Bakel to market were 10 CFA per kg., this would represent 1/3 to 1/4 of the price received by farmers for their grains. However, at present such costs are subsidized. Also, it is possible that the actual costs might be less. Since the villages may sell to consumers living in nearby communities rather than in Dakar, or sell in parallel markets paying more than the official price, these various possibilities have not been addressed directly in the economic analysis of the project.

Project Costs

Major initial project capital costs are summarized in Table (A-16). Contingency allowance is set at 15%, and inflation of costs at 12% per year. Details of these summary cost figures are found in Section 3.F of the P.P.

Farm Budgets

Two farm budgets, calculated on a per-hectare basis, are shown in Tables (A-9) and (A-10). Here, annual operating costs are detailed. The fifth year of the project is specified, to standardize yields and inputs of fertilizer,

The instance of double cropping would require the most labor and water input.

Birdwatching

All labor inputs calculated have made allowances for birdwatching during the period of the season when sorghum and rice are subject to damage. This is a heavy toll on the labor supply for a few months, but the use of children and older persons can relieve somewhat the need for allocation of the adult labor force. Because of the use of non- adult laborers wherever possible, the charge per man-day has been set at only 1/3 of the charge for adult field labor.

In spite of birdwatching, it is estimated that rodents and birds now cause crop losses in the field of 15% before harvest, and this adjustment has been made in the yield figures shown in Table (A-5).

It is assumed that fertilizer application during the first year of the project is the same as on the demonstration fields during the past year. Application per hectare is as follows, and is shown for the rice crop only, as an example of the changes planned.

Year	Application
1	250 kg of NP 100 kg of K (Senegalese rock phosphate)
2	300 kg of NP 100 kg of K
3	350 kg of NP 100 kg of K
4	400 kg of NP 100 kg of K

After the fourth year, 400 kg of NP would be applied annually, but no more K would be needed. At the full cost price of 70 CFA per kg, the fertilizer cost in the fifth year would be 54,270 CFA per hectare for two crops.

Seeding rates are at the following level and price:

Seed	Kg/Ha *	Price (CFA)
Rice (paddy)	100	46.5
Peanuts	100	45.5
Cowpeas	20	60.0
Maize	16	53.0
Sorghum	10	34.0

* Estimates by the PP team

Storage units in the village are built of local materials and located near family dwellings. A small storage unit holds 250 - 300 kg, and takes 15 people one week to build. A larger unit holds 500 kg and takes 20 people one

week to build. A larger unit holds 500 kg and takes 20 people one week to build. Every two years the thatch roof is renewed, and the unit should last seven years.

In relation to Table (A-9), Table (A-10) with single cropping shows less labor, less pumping and less seed cost. The net value of production after allowing for all costs of production is over 200,000 CFA per hectare under double cropping and over 150,000 under single cropping.

Operating, Maintenance, Replacement

Table (A-17) gives details on important continuing or intermittent costs -- building maintenance, vehicle replacement, and replacement of certain pumps (those operating before the project officially begins).

Pump operating costs are outlined in Table (A-15), both for single cropping (during hivernage), and for double cropping (rice followed by maize and sorghum). For single cropping, the fuel costs for 2,500 M^3 are added to the standard costs for repairs and maintenance, total CFA 17,260.

Charges for Labor

It is difficult to estimate a reasonable charge for farm labor, in a basically self-sufficient agricultural region. In any case, such a charge would depend on the

surrounding conditions and must ultimately be somewhat arbitrary. The minimum agricultural wages set by the government in 1974 are 92.77 CFA per hour, but seem to have no pertinence to the problem under consideration here.

Young men from the Bakel area working at unskilled jobs in France remit a part of their savings to relatives living near Bakel. The remittances amount to an estimated 20,500 per year for each man working, or 68 CFA per day of work for him. If he remits only half of his total savings, then he would earn (above his subsistence costs) about100 CFA per workday. This figure is higher than any farm laborer could earn in Bakel, obviously.

Another measure of the value of farm labor would be the implied income from production of crops, if it can be assumed that the farmer pays no land rental, (70% of the villagers cannot now go abroad to work, and 70% of these local villagers are in the "active" group shown in Table A-1). For 175 days of field work, he harvests crops valued at CFA 19,000, or 108 CFA per workday. If he consumes half this crop as his subsistence, then sells the remainder, his net income is only 55 CFA per workday. It must be remembered that he is actually working less than half the workdays available in the year.

Taking the above factors into account, and being careful to fully account for the costs of community labor which might otherwise be considered as "free" or of little value, the decision was made to value village labor on the land, whether in land clearing, ditching, diking, irrigation or crop production, at 75 CFA per adult person per day. The exception is birdwatching, valued at 25 CFA per day.

In addition to the destruction of crops that serious floods can cause, they can also damage the earthen dikes. It might not be surprising that up to 1/4 of the dikes constructed could be destroyed to the extent that they would have to be rebuilt by the villagers, and this event might take place as often as once every ten years. This possibility has not been integrated directly either into the costs of dike construction or the costs of farm budgets. The possibility has been anticipated indirectly in the sensitivity analysis, where total cost increases have been assumed.

Shadow Prices

When administered or official market prices differ to a very marked degree from the unofficial or "black-market" prices, it may be useful to calculate shadow prices that more nearly reflect actual conditions in the country than do the official prices -- prices

that would clear the market, leaving neither a surplus nor shortage of capital or labor. Prices for foreign exchange, for cereals and for fertilizer come to mind. It is probable that, if such shadow prices were calculated, they would be lower foreign exchange, and higher for cereals and fertilizer, than official prices now prevailing.

In the IRR sensitivity analysis, shadow pricing has been used for rice, the most important irrigated crop, and for fertilizer, the most important commercial farm input (Table A-12). The full price of fertilizer to the project (75 CFA/kg) has been used. Rice production has been separated into two parts. That locally consumed has been valued at 75 CFA, the paddy equivalent of the retail price. That sold out of the area has been valued at 65 CFA, 75 minus 10 CFA for marketing and transport to market.

Marketing

S.A.E.D. is the official marketing agent for the crops of this project. When the surplus becomes enough to consider commercial shipments out of the region, S.A.E.D. will need to come to an agents agreement with ONCAD, the general quasi-governmental organization that handles and processes cereals nationwide.

It is probable that the least costly way to market will be from Bakel to Kidira by truck, and from Kidira to Dakar by railroad. Although village storage can be handled in the traditional way, even with the larger amounts of cereals to be produced, the organizations authorized to deal with these crops should be planning for their eventual commercialization. Rice mills will be needed in Bakel to process locally-produced rice for the local population. These mills can be developed as a commercial enterprise and therefore are not included in the project. Commercial storage may be needed in Bakel and Kidira, so the cooperatives can concentrate their cereals for shipment. One of the potential constraints to efficient marketing is the lack of transport infrastructure. Bakel is an isolated town, lacking all weather road connections to other areas of Senegal. Its link to the remainder of the country is an allweather road to the railhead 40 km away at Kidira. During the dry season bush tracks to MATAM, meeting the paved road to S. Louis and Dakar, and to Tambacounda, meeting the all weather road to Dakar, are open to trucks of 10 tons and above. Others donors (FED) are interested in improving the road from MATAM to Bakel and upgrading it to all weather standards. This project

is under study at the present time and could be undertaken in 1979-80, thus alleviating the transport problem. Until such time as the road is improved, ag inputs must be prepositioned in Bakel prior to the beginning of the rainy season and marketed produce stored until the dry season allows export from the area. Past experience indicates that SAED is capable of managing this prepositioning.

Rural access roads are nearly nonexistant in the project area. Roads tend to be tracks across the brushland which are easily passable with a 5 ton truck in the dry season. Larger trucks are not practical since corssings of gullies are very rough and steep. Since each of the villages in the project is along the river, they are readily accessable by boat in the wet season. However, due to the problems of transporting large amounts of supplies in small boats, it is planned that ag inputs will be prepositioned in villages during the dry season and that produce will be stored in the village until the roads are passable.

Transport is not viewed as a real constraint to development of the small irrigated perimeters because ag inputs can be prepositioned and harvest comes at the beginning of the dry season so that transport of materials can be accomplished by road during the dry season. Technical staff have

year round access to the villages utilizing roads in the dry season and boats in the rainy season.

Although wheat flour continues to be received in the Bakel area, it is not anticipated that wheat would become a major export crop in the next few years, nor that any wheat will be commercially processed locally. Irrigated vegetables will continue to be grown for local demand but not for shipment.

The above problems are noted so that preliminary planning may be initiated toward their solution and the costs involved can be calculated. If the authorized organizations are ready to market any Bakel surpluses as they become available, then no problem should arise. Since the country is on a substantial net import basis for cereals, it is assumed that the surplus from this project will not depress average prices nationwide.

Rate cf return

For projects involving individual participants (such as the SAED and the small Bakel Farmers), it is critical to assess whether they will have sufficient financial incentives

and suitably timed cash flows so that they will be able and willing to participate enthusiastically in the project. A summary of the projected effects on the farmers is included in Section 3.F. of this paper. For the government and concerned donor organizations, it is important to calculate the net economic benefits of the project for each year of the project. This calculation is done in Table (A-18) under various assumptions, which result in the IRR's shown in Table (A-19).

The internal rate of return (IRR) is the preferred method of calculating financial or economic viability of a revenue-producing project such as this. Under this method, the discounted present value of the net benefits is calculated and cumulated for the years of the project. The IRR is defined as that discount rate which results in the total net present value of the project being equal to zero. There are seven alternative cases calculated in Table (A-18), and an additional case presented (through its IRR) in Table (A-19). The"net income" column in Table (A-18) is derived from crop incomes and farm costs. The "cost" column in Table (A-18) is derived primarily from Tables (A-16) and (A-17), with logical extensions to the end of the project.

Sensitivity Analysis

This analysis is summarized in Table A-19. Case No. 1, the "base" case, has rice shadow-priced but sells the other crops at official prices and pays full price for fertilizer. Although complete destruction of all crops one year in five is assumed -- not a very likely circumstance with the protective diking now planned -- the IRR is still a respectable 26%.

If all field labor is priced at a low 25 CFA per man-day, and a second crop is assumed harvested in flood years as in Case No. 2, IRR only rises by 1%. If the approximately $500,000 of capital costs already invested in the project are included in costs, then IRR in Case No. 3 drops to 22%. Office and training facilities for cooperatives are already costed in the Base Case. If cooperative farm credit and marketing operations at a level of $100,000 per year are included, the IRR (Case No. 4) is 21%.

If the villagers decide to produce only the rice crop each year, and do not produce a second crop, the IRR will be 20%. If capital costs are increased by as much as 25% over the Base Case, the IRR will also be 20%. If crop prices should drop by as much as 25%, then the IRR would drop to 14%. And if crop prices should drop by as much as 20%, while at the same time capital costs were to rise by as much as 20%, then the IRR would be only 13%.

The general conclusion from this sensitivity analysis is that the project would be economically justified under such changes or additional burdens as may be reasonably expected.

Distribution of Project Benefits

The impacts of the Bakel project benefits are shown in Table (A-14). On traditional cropland, the adult worker has an estimated net return above his own subsistence of 3,690 CFA worth of surplus crops. He can utilize this surplus through family consumption or sale on the market. It is anticipated that the worker would consume about 250 kg. of cereals from his own crop production during the year.

While the amount of irrigated cropland per adult worker is small, amounting to a 10% increase over his total traditional cropland in area, the net benefits in monetary terms from this small increase are substantial. The benefits amount to over 16,000 CFA per cooperative member, 12,000 CFA per adult worker, or 8,000 per person when the total population in the villages is considered. The benefits per person-day of adult labor are only 30 CFA on traditional cropland, but rise to 58 CFA on the irrigated cropland.

Village Cooperatives

Several thousand adults now belong to the village cooperatives which are being organized to deal with various problems

that will result from production on the newly-irrigated land. It is expected that many more villagers will join as new land is cleared for irrigation. It is possible that some educated villagers can be found to begin the operation of these cooperatives. Budgeted in the costs of the first years is the training of future cooperative officials and the construction of modest offices.

The cooperatives may well be assigned local functions associated with provision of agricultural credit to the farmers, and the assembly and shipment of crop surpluses, as well as the provision of farm family needs (farm inputs, for example). In one case identified in Tables (A-18) and (A-19), annual costs against the project of $100,000 are assigned for the various cooperative operations. To the extent that SAED and other government organizations can include the Bakel activities under their overall nationwide activities, and to the extent that villagers can perform these functions during what would otherwise be idle time, there will be little cost to the project. Furthermore, at the present time, with development plans so vague, it is difficult to plan the necessary activities clearly or to put a price on them. Consequently, these costs have not been included in the "base case", which in any case has the "contingency funds" costed

into the budget to absorb a reasonable amount of costs. There is assumed to be sufficient money in the villages to supply the farm credit that will be needed.

3. Financial Analysis

1. Project Budget Analysis

As can be seen from the notes on Table 3F (1) the PP team has made its best efforts to make the most accurate estimations of the costs of the project. SAED assisted by providing the benefit of its long experience in conduction this type of project in the Senegal River Basin. The PP team checked and verified many of the costs and found them to be accurate. The budget items were put at the higher level if any doubt existed about a given item's cost. The most difficult item to obtain accurate costs for was the construction of the dikes needed for flood control. SAED had undertaken a design study of the dikes in about half of the planned perimeters and had demonstrated their capabilities to design the earthworks very well. The perimeters surveyed by SAED are those which are closest to Bakel, thus the first to be developed. Since these perimeters were selected fortheir proximity to Bakel, not for ease of development it is assumed that diking for the remaining unsurveyed sectors will be of the same magnitude. Spot checks by the SERDA team confirms the homogeneity of the area.

Due to the lack of data concerning the flood height in the fields SAED was unsure about the height to construct the dikes. Therefore AID brought in a flood hydrologist to assist SAED in evaluating the dike design. The results of his study are attached as Annex I. He found that due to uncertainty surrounding the flood heights it would be better to err on the conservative side and have dikes that were too high rather than dikes that were too short. Since this recommendation, which was agreed to by SAED was made only very shortly before the project was to be submitted to AID/W there was not sufficient time to redo the entire design of the dikes for all perimeters. Therefore accurate estimates were made for four separate perimeters which gave a representative sample of the perimeters and this information was used to derive a cost per hectare which could be put against all the perimeters that need diking. Again the team, recognizing that projects are almost never over-funded but rather are usually sadly short of needed funds, made this estimate generous. SAED has reviewed the budgets and find that they represent an accurate estimate of costs in Bakel, the most remore area in Senegal.

It will be noted in Table 3 F(2) that the majority of the expenses are to occur in the first year of the project. All of the construction activities will be undertaken in the first year and this puts most of the expenses in the first year. The pumps will be purchased on an as-needed basis according to the plan given by SAED and attached in Annex H. The vehicles will be spread out through the four years of the project so

that some of the vehicles will always be in rather good shape. Spare parts budgets have been included with each of the vehicles because of the chronic shortage of spares in the Bakel region. The SAED mechanics in Bakel are capable of repairing vehicles if they are assured of having the basic parts.

BUDGET

Total Project Costs Table 3.F.1.
1977-1980
$000

		Total	Dollars Costs	Local	USAID Dollars Costs	USAID Local	USAID Total	GOS Dollars Costs	GOS Local	GOS Total
1.a.Central Infrastructure Construction										
Houses	4 @ 60.000	240		240		240	240			
Office	1 @ 60.000	60		60		60	60			
Shop	1 @100.000	100		100		100	100			
Warehouse	1 @100.000	100		100		100	100			
a.Total Construction		600		600		600	600			
b.Equipment										
3 Landrover	@ 12.000	36		36		36	36			
3 Peugeot 404	@ 5.000	15		15		15	15			
1 Peugeot 504	@ 10.000	10		10		10	10			
3 Trailers	@ 2,000	6		6		6	6			
1 5-T truck		17		17		17	17			
1 10-T truck		25		25		25	25			
2 small boats		5		5		5	5			
2 large boats		12	12		12		12			
10 Mobylettes		8		8		8	8			
Office equip		5		5		5	5			
Shop Tools		20		20		20	20			
Spare Parts (25%)		33		33		33	33			
1. Total		792	12	780	12	780	792	-0-	-0-	-0-
2. Farm Infrastructure										
a.Pumps 75	@ 5,500	412	309	103	309	103	412			
Pumps Equip	@ 2,500	213	107	106	107	106	213			
Parts (25%)		167	-0-	167	-0-	167	167			
a.Total Pump. Equip.		792	416	376	416	376	792			
b.Construction										
Dikes		950		950		950	950			
Mech.Clearing (D-6 bulldozer)		120	120		120		120			
Spare Parts		30	30		30		30			
Discing 1781	@ $35	63		63					63	63
Hand Clearing		62		62					62	62

	Total	Dollars Costs	Local	USAID Dollars Costs	USAID Local	USAID Total	GOS Dollars Costs	GOS Local	GOS Total
Hand Construction	100		100					100	100
Cement Structures	64		64		64	64			
Culverts	50		50		50	50			
b. Total Construction	1439	150	1289	150	1064	1214		225	225
c. Tools & Equipment									
Hand Tools	4		4		4	4			
46 Animal Traction @ $500	23		23		23	23			
50 ox carts @ 100	5		5		5	5			
50 Threshers @ 100	5		5		5	5			
c. Total	37		37		37	37			
Rotating Fund									
d. Farm Annual Supplies									
Fertilizer	75		75					75	75
Other	89		89					89	89
Water Cost (Annual)	190		190					190	190
d. Total	354		354					354	354
e. Village warehouses 24 @ 6,250	150		150		150	150			
2. Total	2772	566	2206	566	1627	2193	-0-	579	579
3. Technical inputs									
a. Staff									
T.A. 7 yrs @ 35,710/gr	250		250		250	250			
Senegalese	172		172					172	172
a. Total	334		334		162	162		172	172
b. Studies									
Topographic @ $90/ha	160		160		160	160			
Evaluation	50	25	25	25	25	50			
b. Total	210	25	185	25	185	210			
c. Training									
Materials	10		10		10	10			
Visitations (Senegal)	15		15		15	15			
c. Total	25		25		25	25			
3. Total	657		632		460	485			

	Total	Dollars Costs	Local	USAID Dollars Costs	USAID Local	USAID Total	GOS Dollars Costs	GOS Local	GOS Total
4. Administrative Operations									
Gas, oil, utilities	200		200					200	200
Parts and Maint.	70		70					70	70
4. Total	270		270	-0-	-0-	-0-	-0-	270	270
5. Misc.									
a. Field Trial Station									
Construction	20		20		20	20			
Storehouse	12		12		12	12			
Fence	4		4		4	4			
Cement, culverts, etc.	5		5		5	5			
Pump	10	10		10		10			
Small tools	3		3		3	3			
Personnel									
Technician	13		13					13	13
6 Workers	45		45					45	45
1 Guard	9		9					9	9
Ag Inputs	15		15					15	15
a. Total	136	10	126	10	44	54		82	82
b. Capital charge for rotating Fund for 2d above	73		73					73	73
5. Total	209	10	199	10	44	54	-0-	155	155
6. Health									
Surveillance									
1. Local data collection	125		125		125	125			
2. Consultants	150	150		150		150			
3. Misc. équip. (vehicle)	20		20		20	20			
Health Services									
1. Nurses retrain (12)	6		6		6	6			
2. Equip. for disp. (12)	24	24		24	24				
3. Train. Sanit. (24)	6		6		6	6			
4. Local Training	5		5		5	5			
5. Train. Cost for disp. stock	6		6		6	6			

	Total	Dollars Costs	Local	USAID Dollars Costs	USAID Local	USAID Total	GOS Dollars Costs	GOS Local	GOS Total
6. Drugs & Med.	48		48		48	48			
7. Mobylettes (12)	12		12		12	12			
8. Salaries	60		60					60	60
Operation	40		40					40	40
6. Total	502	174	328	174	228	402		100	100
Total Cost	5202	787	4415	787	3139	3926		1276	1276
Contingency (15 %)	780	118	662	118	470	588		192	192
Total Incl. Cont.	5982	905	5077	905	3609	4514		1468	1468
Inflation 12 % annual	2009	560	1449	560	785	1345		664	664
Grand Total Cost	7991	1465	6526	1465	4394	5859		2132	2132
Prior year Costs 1974 - 1977	565		565		290	290		275	275
Total Cost	8556	1465	7091	1465	4684	6149		2407	2407
% of Total	100	17	83			72			28
% of AID Contrib.				24	76	100			

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Expenditures TABLE 3.F.2.
by year

	Total	Yr.1	Yr. 2	Yr. 3	Yr. 4
A.I.D.					
1. Central Inf.	792	700	65	27	-0-
2. Farm Inf.	2193	1399	400	394	
3. Technical	485	210	150	100	25
4. Admin.	-0-	-0-	-0-	-0-	-0-
5. Misc.	54	54	-0-	-0-	-0-
6. Health	402	100	182	60	60
7. Total	3926	2463	797	581	85
8. Cont.	588	369	119	88	12
9. Total	4514	2832	916	669	97
10. Infl.	1345	626	322	333	64
11. Grand Total	5859	3458	1238	1002	161
G.O.S.					
1. Central Inf.	-0-	-0-	-0-	-0-	-0-
2. Farm Inf.	579	116	126	166	171
3. Technical	172	43	43	43	43
4. Admin.	270	60	66	72	72
5. Misc.	155	17	46	46	46
6. Health	100	25	25	25	25
7. Total	1276	261	306	352	357
8. Cont.	192	39	46	53	54
9. Total	1468	300	352	405	411
10. Infl.	664	66	124	202	272
11. Grand Total	2132	366	476	607	683
GRAND TOTAL GOS & AID	7991	3824	1714	1609	844

NOTES ON THE BUDGET TABLE

1.a. Houses were calculated at 100,000 CFA per sq meter according to SAED estimates. This amount correlates well with costs for similar houses in Chad and other countries.

The shop cost was also based on SAED and MATFORCE estimates for shop cost and includes major equipment (hoists, etc.).

The warehouse is to be a 300 sq meter warehouse at 70,000 CFA per sq meter including access and drainage, etc.

b. All equipment costs are based on present Dakar prices as estimated by SAED/CIDR and verified by review of AID R&R program costs and local price quotes.

2.a. The pumps and pumping equipment prices were quoted by MATFORCE, the supplier and verified by comparison with R&R program costs.

b. Construction costs were derived as follows:

1) Dikes - A review of SAED's current bid responses was made showing costs to vary between 400 and 550 CFA per cubic meter for earth moving. Due to the remoteness of the area, a cost of 600 CFA was selected. The total cubic meters for the dikes had been calculated by SAED

for 986 hectares and after revision per the AID hydrologist's findings a cost of $750 per hectare was determined for the 1,100 ha needing dikes. An additional $100,000 was added for construction of diversion ditches to stop runoff on three perimeters.

2) Clearing - A D-6 bulldozer will be purchased for clearing and also maintenance of dikes.

3) Discing was calculated at 8,000 CFA per hectare which is SAED's standard price for this operation.

4) Light clearing labor was calculated at 100 man days per ha (including minor leveling) and 75 CFA per day as explained in the economic section of the paper.

5) The cement structures were calculated according to the following formulas:

a - Settling basin	1 per 15 ha.	at 30,000 CFA
b - Field structures	1 per 5 ha.	at 20,000 CFA
c - Road Crossings	1 per 100 ha.	at 200,000 CFA

6) Field culverts were calculated at 4-5 per hectare at 14,000 CFA each..

c. All tools were based on past SAED/CIDR experience confirmed by R&R reports. Equipment was based on official quoted price from government entity supplying.

d. Rotating fund for the farm input supplies was costed according to estimates developed in economics section. The fund is costed at the amount needed to provide sufficient inputs in the final (largest) year as this is the amount of capital needed.

e. Village warehouses were calculated at 30,000 CFA per square meter.

3.a. Technical inputs were derived from existing requests for financing and official salary scales.

b. the evaluation study was calculated based on average U. S. consultant costs and the topographic study cost was based on SAED cost per hectare as confirmed by R&R data.

c. Training - Training costs are a lump sum since detailed plan is not yet made.

4. Administrative costs were developed by CIDR/SAED based on present cost per vehicle and houses expanded for future plans. Operation costs for the bulldozer was included in this data.

5.a. Costs for the field trial section were developed based on previously calculated construction costs, personnel based on official scales and Ag. inputs and operation based on agronomic section of paper.

b. The charge for capital on the rotating fund was placed at 12% per year calculated on a 9 month period between purchase and repayment by farmers.

It as calculated on the basis of anticipated annual needs for each of the four years of the project since SAED does not plan to charge interest on their supplies.

6. A 15% contingency was included to allow for minor changes in specifications or possible underestimating of requirements.

7. Inflation was included at 12% compounded annually on the planned noncommitted amount. Since costs are based on 1976 prices and project was delayed one year in review inflation is calculated using the first year of the project as 2 years inflation, 2nd year as 3 years inflation, etc.

8. Prior year costs 1974-77 were included in order to show the total investment in the project from beginning to total development. The costs were calculated based on annual budget data as explained in Section 2 of the Paper.

Recurrent Cost Analysis

The detailed farm budgets presented in Tables A-9 and A-10 of Annex J provide details of what the farmers income statement on each hectare of land will be after year 8 of the project. Year 8 was selected because that is the point at which the income stream reaches its maximum. Tables A-10 (a) (b) (c) and (d) indicate what the cash flow on each hectare under various

assumptions will be during each of the first eight years of the project. The variables used were double cropping as a base case, single cropping, slower adaptation of double cropping and an increase in fuel costs of 100%.

Analysis of the farm budgets and cash flow tables indicate that the farmers' net returns are sufficient to serve as an adequate incentive for continuation of the project activities. Table A-10 (b) shows cash flows over the first 8 years (at which point the income stream levels off) for each of the four assumptions. Table A-10 (c) indicates how the net income from Table A-10 (b) theoretically could be allocated tofunds for replacement of pumps and for amortization of the $1,500 per hectare land development costs. Table A-10 (d) shows the farmers cash flow if funds were set aside for pump replacement and the land development costs were treated as a loan at 8% interest to be totally repaid in 7 years. This analysis should not be viewed as a recommendation that the farmers be required to repay farm development costs but rather as an illustration of the overall profitability of the project and an indication of the feasibility of replication of the project.

The most critical major item to be financed by the farmers is replacement of the pumps after their useful life of seven years. The PP team has calculated the amount to insure sufficient funds exist at the end of seven years to be able to replace the entire pump. Their findings are as follows:

$8,000 present cost at 12% inflation for seven years equals $17,685.45 future cost of pump,
$17,685,45 equals 4,067,653 CFA or 581,093 CFA per year,
581,093 CFA for 15 ha. equals 38,793 CFA per hectare per year charge for amortization of the pump.

The PP team deliberately made this cost a maximum cost by assuming no salvage value for the old pump, no interest earned on funds put aside and a relatively small plot size for the pump. If the farmers contribute the amount suggested then they will probably have enough at the end of seven years to purchase other needed capital inputs as well as the pumps. This can be addressed in two ways:

1. A replacement fund could be established with annual contributions on a per hectare basis; and 2. An outright lump sum cost could be incurred following the seventh year of the project.

The first option has the advantage of spreading the cost over several years as well as introducing a formalized savings system. However, at the present time no institution exists in the area to serve as the repository for these savings. Lacking a local institution to hold savings, it would be possible to establish special accounts for the farmer groups in banks in Dakar. This constitutes the most sure method of accumulating an amortization fund.

The farmers'groups would be capable of converting their entire

7th year net profits into replacement pumps. If the pump costs 4,000,000 CFA in 7 years farmer groups with a net income of 200,000 CFA per hectare on the 20 hectares or more served by one pump would be able to purchase the pump outright. Table A-10 (d) shows that even with slower adoption of double cropping, the per hectare income should exceed 200,000 CFA per hectare and thus be sufficient to replace the pumps. If only single cropping is utilized, the wear on the pump should be less and the funds available in the eighthand later years will be sufficient to replace the pumps.

Thus, it appears that either of the options for pump replacement is feasible. The PP team would prefer to see option number one explored due to its beneficial introduction of a savings mechanism but if it proved unfeasible the second option of replacement from the current years earnings would be acceptable. SAED is fully aware of the need for replacement of the pumps by the farmer groups and plans to emphasize the need for village kept replacement funds in their extension efforts. The sociological report (page 46 and 47 Annex K) points out that the income from the irrigated plots has, in the past, been used for reinvestment in community projects including the communal farm. Therefore, the PP team feels that the farmer groups will utilize a portion of their income to replace the pumps, either on an annual basis or as a one year expenditure.

As far as SAED is concerned the picture is much less clear. It is the opinion of the PP team that they will be providing their technical help as a development contribution funded from the National budget. Total costs of over $200,000 per year will be borne by SAED including personnel costs at $43,000, Operation costs of $60,000 and building maintenance and vehicle replacement at $60,000 per year.

The marketing and input supply functions should be self supporting. The input supply as presently envisaged by SAED will be a money losing proposition since the goods are to be provided at cost with fees neither for administration nor for short-term credit provided. Therefore SAED will be foregoing interest that they could have earned if the money had been placed either in a commercial bank or in a profit making activity. The interest cost calculated at 12% for 9 months of each year on a revolving fund of $354,000 is $31,360 per year We suggest that this be looked at very carefully in the context of overall SAED management and their financial position. It is suggested that a covenant be placed in the project agreement requiring SAED to review their position on this matter and be prepared to make firm justification for continuing this practice during the 1980 evaluation.

In summary, it is obvious to the PP team that the farmers are fully capable of covering their recurrent expenses even if charges were placed on the inputs to cover the costs of administering the program. However, we are less sanguine about SAED. It appears to us that many of SAED's present problems

stem from a lack of financial autonomy and that they should take a very careful look at how to address this very serious constraint in a way that is equitable to the farmers involved as well as to SAED itself.

Part 4 - Implementation Planning

A. Analysis of Recipient Management Capabilities

The project will be implemented by the Societe d'Amenagement et d'Exploitation des Terres du Delta (SAED), Ministry of Rural Development and Hydraulics. The Director General of SAED will be responsible for the overall direction of the project and will certify all requests for disbursement and procurement before they are transmitted to the Director of Investments, Ministry of Finance and Economic Affairs for payment certification and the Senegalese National Development Bank for payment. Field direction and supervision will be the responsibility of the SAED agent accredited to Bakel. This agent, working in close consultation with the representatives of SERDA, will be responsible for all field activities and insuring proper use of AID provided materials.

Originally, SAED was charged with development only in the Delta area of the basin. However, beginning with the IBRD Dagana project in 1973, the GOS extended SAED's area of responsibility and action to include the whole river basin. SAED recognizes that a wholly different strategy and structure is required in extending its operations from developping large unpopulated areas in the river delta to small perimeters in the populated areas of the upper basin.

SAED is competent technically but it does have administrative problems. In its early years, SAED was not always able to guarantee adequate water supplies and therefore lost the confidence of many participating farmers who experienced crop failures. In recent years the water supply situation has improved, but SAED is still heavily dependent on government support for operating expenses. This has made timely provision of necessary inputs difficult to achieve.

The fundamental current problem is that SAED relies on GOS provison of working capital rather than generating its own. This, in turn, has led to extremely tight government controls over SAED expenditures which cause long delays in making funds available for the purchase of critical inputs. The solution to this problem is to provide greater flexibility to SAED and permit SAED to develop internally viable schemes which can allow reasonable charges for its services, thereby giving it a greater degree of financial autonomy. Attempts to date at using intensive management techniques with strict controls over the production process has led to an overly paternalistic and non-commercial attitude toward peasant farmers in irrigated perimeters developed thus far, and has not alleviated the financial problems of SAED. A new strategy based upon greater individual farmer autonomy and internal financial self-sufficiency is being explored by SAED with the help of SATEC.

AID is assisting in this effort through its SAED training project scheduled for 1978.

In view of the above, this project is designed to put minimal additional burden on the SAED organization. SAED will be responsible for provision of farm inputs, technical design of the irrigation works and supervision of the works, dispensing technical knowledge and marketing but, in line with SAED's new policies, major management responsibility will rest with the village cooperatives and the SAED/SERDA team in Bakel.

A REVIEW OF SAED's capabilities in these areas is as follows:

1) Technical design and supervision

SAED has demonstrated that it is capable of preparing detailed topographic maps and irrigation plans. The topographic team under the leadership of a French Agricultural Engineer who is the head of the Engineering Section of the Studies Division began the field work in the Bakel area in January 1976. The PP team has reviewed their maps and plans for the 227 ha. and 12 km of dikes surveyed and finds them satisfactory. The office has a staff of 26 topographers and designers who appear to be well qualified to undertake the work. AID also reviewed bid documents drafted by the SAED engineers for the Ronkh project and found these documents complete and well done.

SAED designed and constructed a flood protection dike nine kilometers long for the Bakel perimeter. A contract was executed for the construction with a local contractor and

the work was supervised by the SAED topographer assigned to the Bakel office. The work was completed and met suitable standards. The topographer in Bakel is also staking out work to be done by the farmers in the fields and providing overall supervision of these works. The PP team finds that SAED's engineering department is capable of conducting the engineering needed for the project.

2) Dispensing Technical Information

SAED will be assisted in this effort by the SERDA group. SAED will provide its Bakel manager and 10-12 village level extension people. The project manager also serves as liaison between the farmers in Bakel and SAED in St Louis. He was trained in Taiwan in rice culture and appears technically competent to advise farmers. He has known in villages and made constructive comments to the villagers regarding their construction work.

The SERDA group which will be the most important implementing body in the initial stages of the project, has had considerable experience in the Bakel area. CIDR's (predecessor of SERDA in Bakel) first technician agriculturist, arrived in Kounghani in March 1974 as a result of a request from the President of Farmers Group in Kounghani and spent eight months living and working in the villages and organizing the farmer groups and developing demonstration communal plots in other villages. In April 1975, two other French agriculturists from

CIDR arrived to assist in developing thedry land farms and the irrigated perimeters.

It was obvious to the PP and PRP teams during their visits that the SERDA (formerly CIDR) team enjoys an outstanding rapport with the farmers in the area. They were met in each village with great enthusiasm and farmers were asking many questions regarding proper techniques to be used on their crops.

The village level extension agents were newly arrived on the job so their performance is difficult to evaluate. They are graduates of Agricultural technical schools in St. Louis, Zinguinchor, or Kaolack and at least some of them have experience with rice culture in the Casamance. They are not from the Bakel area and therefore do not speak the local language. However, it appears thatenough of the farmers in the area have spent time in France and speak French well enough to be able to communicate well with the extension agents.

3) Provision of Farm Inputs

SAED will be charged with provision of ag inputs and has been performing this function for other development schemes along the river. Capitalization for the rotating fund for ag inputs will come from SAED as part of the GOS contribution.

The SAED representatives in Bakel in coordination with the CIDR group is responsible for detailing items required from SAED (ag. inputs, fuel, etc.) and insures that they arrive

He also coordinates requests for technical assistance from SAED and overseas operations. The PP team observed that ag. inputs, fuel, etc. were arriving as planned prior to the rainy season and were placed in villages while the roads were passable. It was the SAED representatives who coordinated the bulldozers and tractors provided by SAED and who assisted the topographic team.

During the project the SAED/SERDA team at Bakel will have their own trucks for transport of goods and so will be capable of transporting their own needs from St Louis. In the past they had been forced to rely on commercial truck contracts but it is felt that commercial trucking is not adequate for the 1,900 ha development and that since trucks will be needed to haul marketed grains out, a good utilization woud be to use their own trucks to bring in the inputs.

4) Marketing

In the past SAED has not needed to be involved in marketing in Bakel as all the production was for auto-consumption. With the present project SAED will provide the marketing structure for the major market crop, rice. SAED buys rice from the village groups at the official price and will transport it to St. Louis using SAED's trucks or direct to Dakar via the railroad. Since rice is not very perishable or fragile commmodity, no serious problems are foreseen in the marketing cycle.

It is expected that by the third year of the project the farmers groups themselves will have sufficient experience to be able to begin to manage their own affairs to a large extent using the Bakel SAED office only as a procurement and marketing service. The project will further develop the basic communications and procurement liaison between Bakel and the SAED offices in St. Louis which will be necessary for any future larger scale investments in the area.

B. Farmers Groups

The farmers groups themselves perform an important function in the implementation of the project. These groups will provide the day to day management of individual perimeters, controlling all the hand labor, planting, water supply, etc. They serve as the mechanism through which the farmers can manage their own enterprise.

The groups are actually loose associtations of people gathered together working toward a common cause. As pointed out in the Sociological analysis, this type of loose association is not uncommon in the Sarakolle culture. Traditionally they have formed these types of groups when immigrating to France and when undertaking other community action activities. However, the present project moves slightly beyond the traditional associations by cutting across both social class lines and age group lines. In the early groups formed during the past two years this diversification appears to be working out well.

The membership in the farmers groups is essentially open to all with some villages requiring membership payments and others not requiring any membership payments. All group members , men and women, work on the irrigated plot with men of all ages working on one day and women the next. In some cases fees are assessed for being absent from work.

The groups are organized with a leader (usually from the traditional leading family) and a recorder and treasurer. The farmers group is further broken down into work groups of 5-7 persons, each work group having its own leader. It appears as if the work groups are based on age groups as they often contain persons from several social classes. The leaders of the working groups are chosen for their honesty, worldliness and technical abilities without regard to their social class.

It is feeling of the PP team that decisions are made by the leaders of the working group acting as an advisory council to the leader of the farmer groups. Since the adhesive that holds the farmer groups together is working together, basic agreement on the work to be done must be universal or the group will disband. It seems that this is well understood by leaders and members and they have developed a methodology for getting the work done in a harmonious manner.

A major question for which it is impossible to give a definite answer at the present time is how the returns from the irrigated lands will be distributed by the farmer groups. With past actions as a guide, the PP team feels that in most cases community action activities such as wells, pharmacies, schools, mosques, etc. will be undertaken with the returns from this project. The Sarakolles have a long history of community action to provide the investments needed to improve this quality of life. The community action activity spreads the benefits over the whole population of the village and thus is a very equitable use.

The PP team feels that decisions regarding the use of returns from the irrigated plots will also be made by the leaders of the groups as advised by the leaders of the work groups.

Based on the results of the first three farmer groups, it is the opinion of the PP team that these loose associations of farmers, working together toward a common goal, will be sufficient to manage the operations of the irrigated plots. The approach taken by SAED is one of advising the farmers but letting them learn by trial and error. The farmers are informed of the proper technical practices and strongly encouraged to follow recommendations but it is the farmers who make the final decisions concerning what to do, how to do it and when to do it. Therefore, the farmers will become accustomed to making their own decisions about their own work and will not be relying totally on SAED. As the Sociological analysis points out, the farmers will not accept decisions made without their participation and they have the desire and the will to manage their own work if SAED will provide the technical expertise.

C. AID Administrativ_ Arrangements

Initial start-up of the AID funded activities will require a project manager full time for the period of September 15, 1977 to June 1978. Numerous actions must be undertaken by AID if the necessary inputs are to be in place prior to the beginning of the 1978 crop cycle. The sub-network shown in Section 4C below illustrates the actions which the PP team considers to be most crucial. A full time person will be required to push these actions along.

ADO/Dakar in an airgram (TO-AID 152) has requested the establishment of a project manager position to be responsible for the Matam and Bakel perimeters. The PP team fells that this is an excellent approach as the most crucial AID action time lies between September 1977 and January 1978.

After the first few months the project manager will be responsible for basic areas:

1. Procurement of AID financed commodities such as pumps, etc. through PIOs,
2. Monitoring progress by the PPT network and assuring schedules are met,
3. Reviewing SAED quarterly and annual reports,
4. Coordinating AID approvals as required, i.e. plans and specifications, contracts, procurement actions with AID funds.

The project manager will be assisted in his work by expertise from REDSO/WA as needed. Technical reviews such as engineering and contracts will require REDSO assistance.

It is suggested that the controller in Dakar maintain all financial records and perform all financial activities per implementation letter number 1. Since the majority of the project costs are local costs, it is only reasonable that the Dakar controller be given financial responsibility.

D. Implementation Plan

Annex D gives a complete Project Performance tracking network for this project with an accompanying narrative description of quantified Critical Performance Indicators (CPI). This network illustrates what the PP team feels are the most critical activities necessary to accomplish the complete project in the time allowed. It is suggested that due to the critical importance of planning around the rainy season in terms of delivery of items, crop cycles, etc., the reporting on achievement of all CPI's except for harvests be done on a positive basis. That is that reports be submitted when the event is achieved not only if an event is missed. Harvest reports would be made only if the goals for that harvest were not achieved.

As a supplement to Annex D, the PP team has prepared a subnetwork for the delivery of pumps for the 1978 season. The provision of pumps is crucial to the project therefore the activities outlined should be very closely monitored by ADO/Dakar to insure that they are moving well. Activities for which AID has direct responsibility such as Authorization and Agreement, and AID approval of specifications must be given priority to be

accomplished before the dates indicated on the subnetwork. There is little slack time available so actions must be begun early and accomplished promptly. Any slippage in the documentation stages of the procurement process will probably mean that the pumps will have to be air freighted from the states in order to arrive in Dakar by 1 March 1978 which is the critical date to allow assembly and placing on the farm for the 1978 season.

The project agreement will establish a requirement for SAED to submit an annual work plan which should be keyed to the accomplishing of events identified in the PPT. It is suggested that the ADO/Dakar project manager draft simple subnetworks for each event based on the SAED annual plan to assist him in monitoring the project.

Other activities not shown in the PPT are also important to progress of the project but are not as crucial to success. Building construction could stop for a year and not have any serious effect on the project. The staff is already on board and working and has some vehicle support available. Thus the crucial input is the farm level infrastructure as shown in the PPT.

E. Monitoring and Evaluation

1. Monitoring:

It is planned that the project will be monitored by ADO/Dakar assisted as needed by engineering services provided by REDSO/WA. Field inspections will be done at all key points

identified in PPT (Annex D). Due to the critical constraint imposed by the rainy season, it is important that construction works and input positioning be completed according to plan. Therefore we recommend positive reporting on construction and input positioning.

In addition a quarterly and annual reporting requirement will be established in the project agreement and defined in Implementation Letter number one for reports from SAED/SERDA. Quarterly reports should include at a minimum:

1. Progress of construction works,
2. Update of annual work plan,
3. Financial statement showing planned disbursements vs. actual disbursements for the quarter and cumulative for the project,
4. Narrative report of project progress and problems.

The annual report submitted by SAED should include at a minimum:

1. Comparison of works accomplished vs. annual work plan,
2. Annual disbursement summary planned vs. actual,
3. Narrative of project progress and problems,
4. Work plan in graphic form for next year,
5. Agronomic and economic data on past campaign,
6. Technical plans for upcoming campaign.

It is suggested that annual report and work plan be submitted in December of each year. This would allow inclusion of results for rainy season crops, data for off-season crops

and a plan for all works to be done for following season's campaign.

Quarterly and annual reports will be reviewed and commented on by ADO/Dakar.

2. Evaluation

A full scale evaluation of the project is planned for January-February of 1979. The purpose of this evaluation is to review and verify technical, sociological and economic data as presented in the PP to define the validity of the PP team assumptions. It is foreseen that this team will require the following skills:

1. Financial Analyst,
2. Agricultural Economist,
3. Irrigation Engineer,
4. Agronomist,
5. Sociologist.

The general scopes of work for these team members is as follows:

1. Team Leader/Financial Analyst

   A. Coordinate Evaluation Team and Final Report,

   B. Review budgets, disbursements, costs, etc. to verify accurate cost per hectare,

   C. Review contracts, etc., and their costs,

   D. Refine actual costs of each output as defined in project description.

2. Agricultural Economist

   A. Review labor calendar, requirements and availability and compare with data assembled in PP,

   B. Review farm budgets, update data based on current yields and costs and calculate actual returns per hectare and per farm family,

   C. Update cost benefit analysis and calculate actual rate of return,

   D. Review actual marketing practices and analyze market structure as it is actually functioning,

   E. Review procedures established by farmer groups to set aside amortization funds to allow purchase of replacement pumps.

3. Irrigation Engineer

   A. Review construction works vs. design of works,

   B. Prepare summary of costs of major construction (dikes, clearing, housing, etc.),

   C. Prepare summary of farmer construction labor provided,

   D. Prepare analysis of timetable planned vs. accomplishments and project's future timetable,

   E. Review flood data and field flooding results vs. SAED 1976 report and flood hydrologists projections.

   F. Prepare summary of actual water usage per hectare for various soil types.

4. Agronomist

   A. Evaluate results of technical package,

   B. Prepare summary of yields,

   C. Prepare projections of future yields,

   D. Review actions at Field Trial Facility and actions needed to improve,

   E. Review effectiveness of extension agents.

5. Sociologist

   A. Prepare analysis effects of irrigation activities on the traditional culture of the area and farm projections of the effects of future expansions,

   B. Evaluate functioning of farmer groups and interaction within various groups,

   C. Determine the extent to which women are involved in the project in terms of decision making, sharing of work and profit sharing. Describe effects on projects on role of women in the society,

   D. Determine the effectiveness of the extension agents fom the point of view of the people as far as competence, interest, etc.

The evaluation report would be most useful if it were done as a non-AID document but rather as a "lessons learned and where do we go from here" type of approach. The final report should include a description of the situation, analysis of how actual situation varies from PP plans and a series of recommendations

both for this project and for future projects of the same type.

It is suggested that an outside team be recruited to do the evaluation. A budget of $50,000 has been included to cover a 7-man-month study. Depending upon program decisions, this same team might be utilized to design a project to include Phase II, medium sized perimeters. This would allow them to build their experiences into the Phase II operations.

A separate evaluation of the health component is to be done under the surveillance program.

F. Conditions Covenants and Negotiation Status

1. Conditions and Covenants

a. The main condition in this project deals with AID approval of plans, specifications prior to beginning construction activities. It is suggested that a condition be put in the project agreement that requires the submission of all plans and specifications to AID for their approval prior to inviting bids for the items. Further all awards and contracts will be approved by AID prior to their execution. This will include all procurement actions as well as contracts for the construction of the dikes. This item could be included as a condition precedent to disbursements for construction or procurement or could be handled under the standard clause requiring AID approval of contracts, etc.

b. A covenant suggested by the project design team deals with the question of amortization of the capital requirements at farm level. We suggest that a covenant be placed in the project agreement which requires SAED to show progress toward encouraging the farmers to establish their own accounts to serve as a capital source to replace expendable capital such as pumps and irrigation equipment. The farmers and SAED in Bakel both agree that it is necessary to do this and that they are planning to do it in the future but the design team feels that this is of sufficient importance to the long term success of the project that it should be included as a covenant in the agreement.

c. A covenant should deal with SAED financial management It is widely recognized that SAED has financial management problems. In the Bakel project they are providing farm inputs at cost, seasonal credit at no cost to the farmers, and other services at no cost to the farmers. We feel that it is essential that SAED consider these activities very carefully and move toward having the farmers pay their fair share of the costs incurred by SAED in providing services. Our analysis of the benefits accruing to the farmers indicates that they would be in position to pay for these services and still show a suitable profit and return for their labor and management. As a minimum, we would like to see a detailed analysis done by SAED of what their returns and costs are for their marketing and input supply services. Based on this analysis a method of charging the farmers for the costs could be negotiated with the farmers.

2. Negotiation Status

The project has been developed in very close collaboration with SAED which is in complete agreement with the goals, purpose and outputs of the project. A meeting with the planning group of SAED and representatives from Bakel, chaired by the Director General of SAED was held on 22 July 1976 at which time the complete plan for the project was discussed in detail. The result of this meeting was some minor changes in the inputs which were agreed upon by both SAED and AID. The present PP reflects the agreements between SAED and AID

and has been negotiated from a technical standpoint. The Ministry of Rural Development has been given a written description of the project and is in agreement with it. This will allow signature of the agreement prior to the end FY 1977 provided ADO/Dakar is allowed sufficient time to prepare and obtain host country signature on the grant agreement.

This is the end of the body of the Project Paper. Annexes follow.

BAKEL CROP PRODUCTION

SENEGAL

PROJECT PAPER

685-208

VOLUME TWO

<u>ANNEXES</u>

122

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PROJECT DESCRIPTION FOR PROJECT AGREEMENT

The project consists of a program to introduce small-scale, village level irrigated agriculture into 23 villages in the Bakel area of the Senegal River Basin. The use of improved technologies in dry-land agriculture will be encouraged as a complement to the introduction of irrigated culture. The project will develop irrigation in small village level perimeters over about 1800 hectares and will involve about 7,000 persons working on the irrigated lands. AID will provide financing for construction of a workshop warehouses, housing and offices in Bakel; vehicles, equipment and tools, irrigation equipment, the construction of dikes, construction of village warehouses, clearing of land, farm tools, equipment, technical assistance and training; also a health services activity and a health surveillance program. The detailed contributions of SAED and AID are defined below:

AID

Central infrastructure.....$ 792,000

4 houses, 1 office, 1 warehouse, 1 shop
3 Landrovers,
3 Peugeot 404,
2 5-Ton trucks,
2 Small boats,
2 Large boats,
10 Mobylettes, and
Mis. tools and office equipment.

Farm infrastructure.....$2,193,000

75 pumps with equipment and spare parts, Dike construction, mechanical clearing of 1781 hectares, 46 Animal Traction Units, 50 Ox carts, 50 threshers, 24 village warehouses.

Technical Inputs	$ 485,000
Technical assistance (10 man/year) Topographic and evaluation studies and training	
Field station construction and equipment	$ 54,000
Inflation	$ 782,000
Contingency	$ 520,000
Total AID contribution	$ 4.834,000

GOS

Farm infrastructure	$ 479,000
Disk 1781 ha and annual farm supplies and credit	
Technical inputs	$ 172,000
Staff, I perimeter chief 3 mechanics, I topographer, 10 technical assistants	
Administrative operations	$ 270,000
Field trails station	
Staff and ag.inputs	$ 82,000
Interest charge on rotating input fund	$ 73,000
Inflation	$ 485,000
Contingencies	$ 176,000
Total GOS contribution	$ 1,837,000

Health Component

AID

Contract for Surveillance	$ 125,000
Consultants for Surveillance	150,000
Equipment for Surveillance	20,000
Training village health	23,000
Equipment & supplies village health	84,000
Total	$ 402,000

125

GOS

Salaries	$ 60,000
Operations.....	40,000
Total.....	$.100.000

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Chron. file : With/WO Attachments

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E.O. 11652: N/A

TAGS:

SUBJECT: BAKEL CROP PRODUCTION, REVIEW AND AUTHORIZATION STATUS
REF: DAKAR 0463

1. WHILE ATTEMPTING TO CLEAR ACTION MEMO TO MOVE FORWARD WITH INITIAL PHASE OF PROJECT AS DISCUSSED LATE DECEMBER WITH RDO, IT WAS FOUND IMPOSSIBLE TO PERSUADE KEY OFFICES CONCERNING TIME TABLE FOR PROCUREMENT, HEALTH COMPONENT DESIGN/ENVIRONMENTAL ASSESSMENT (EA), PHASE II AUTHORIZATION FOR BASIC ENGINEERING AND CONSTRUCTION WORK (1977 PERIMETERS) ETC. ALL RELATED TO CRITICAL JUNE 1977 PLANTING DEADLINE. PPC, FOR EXAMPLE, FOUND IT "IMPRUDENT" TO TAKE THE RISKS INVOLVED IN PROCUREMENT AT THIS TIME.

2. WITH ABOVE IN MIND, AID/W RECOMMENDS PROCEEDING WITH HEALTH STUDY/EA AT EARLIEST POSSIBLE DATE AND CONTINUATION OF TECHNICAL ASSISTANCE FROM CIDR. WILL ADVISE OF FUNDING SITUATION FOR CIDR BY SEPTEL. HOPEFULLY ENTIRE REVISED PROJECT PACKAGE, INCLUDING HEALTH COMPONENT, COULD BE APPROVED FOR LOP FUNDING IN THIRD QUARTER OF FY 1977.

3. AID/W AWARE OF AND APPRECIATES DIFFICULTY AND COMPLEXITY OF DEALING NOW WITH COUNTERPARTS WITH WHOM EXPECTATIONS HAVE BEEN RAISED CONCERNING TIMELY IMPLEMENTATION OF THE PROJECT. THE LOSS OF MOMENTUM AT THIS POINT IS SINCERELY REGRETTED. IN THE CASE OF BAKEL, HOWEVER, IT IS BELIEVED ESSENTIAL TO TAKE A DELIBERATE AND CAREFULLY MEASURED COURSE OF ACTION DUE TO THE PROTOTYPE NATURE OF THE PROJECT IN RELATION TO OVERALL SAHEL DEVELOPMENT STRATEGY AND ITS RELATIVELY HIGH PROFILE CURRENTLY IN THE AGENCY.

4. BEYOND THE HEALTH ISSUE, THE PROJECT HAS RECEIVED FAVORABLE REVIEW IN GENERAL.

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5. WILL ADVISE ASAP ON TA FUNDING. HEARD WILL HANDCARRY TOR FOR DESIGN OF HEALTH COMPONENT/EA FOR DISCUSSIONS WITH REDSO AND DAKAR TO FINALIZE AS RAPIDLY AS POSSIBLE.

VANCE

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TAGS:

SUBJECT:BAKEL IRRIGATED PERIMETERS, ECPR REVIEW

REF: (A) STATE 257903, (B) DAKAR 7139, (C) DAKAR 7200

1. ECPR REVIEW HELD NOV 9 ACCEPTED PROJECT COMMITTEE RECOMMENDATIONS ON ALL ISSUES EXCEPT FOLLOWING:

A. ENVIRONMENTAL HEALTH: ECPR WAS SATISFIED WITH NEBIKER'S FINDINGS IN TERMS OF PROBLEM DEFINITION. NOT PERSUSDED, HOWEVER, THAT PROPHYLAXIS DISTRIBUTION AND EDUCATION PROGRAM PROPOSAL ARE ONLY POSSIBLE RESPONSE TO POTENTIAL INCREASED HEALTH HAZARD, ESPECIALLY MALARIA. ADDITIONAL STUDY PROPOSAL NOW BEING PREPARED BY AFR/DR/H WHICH WILL FURTHER ANALYZE PROBLEM AND PROTECTIVE MEASURE RECOMMENDATIONS RE PROJECT PER SE AND REPLICABILITY. STUDY PROPOSAL MUST AT A MINIMUM BE CLEARED BY AA AS ADEQUATE PRIOR TO PROJECT AUTHORIZATION.

B. PROCUREMENT: SER/COM OPPOSED PROPRIETARY PROCUREMENT OF PIPE THROUGH NASOCO MATFORCE AND ZS DRAFTING MEMO TO THIS EFFECT. HOWEVER, BUREAU CONCURS ADO/DAKAR POSITION PARA 2B REF C RE NEED FOR WAIVER. WILL ADVISE OUTCOME THIS ITEM.

C. CIDR TECHNICIANS: ECPR VERY CONCERNED BUT PERSUADED AFTER STRONG CASE PRESENTATION SUPPORTED BY REF C TO ACCEPT PROPRIETARY PROCUREMENT. (WILL ADVISE CONCERNING RETRO ACTIVE COVERAGE REQUESTED). ECPR RECOMMENDED, HOWEVER, THAT ADO DAKAR/GOS BE APPROACHED RE POSSIBLE ACCEPTANCE OF ONE ADDITIONAL U.S. TECHNICIAN IN ORDER TO INSURE THAT VALUABLE IRRIGATED PERIMETER EXPERIENCE REPRESENTED BY THIS PROJECT BE CAPTURED BY U.S. INSTITUTION. TECHNICAL CAPABILITY DEVELOPED WILL BE INVALUABLE FOR FUTURE

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PROJECTS OF THIS NATURE.

2. OTHER ISSUES SUCCESSFULLY RESOLVED THANKS TO ADDITIONAL INFO PROVIDED BY MISSION. WILL ADVISE APPROVAL STATUS TOGETHER WITH ACCEPTED RECOMMENDATIONS AS SOON AS HEALTH STUDY PROPOSAL DEVELOPED, HOPEFULLY BY END OF THIS WEEK.
KISSINGER

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DEPARTMENT OF STATE TELEGRAM

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INFO RUTAIJ/AMEMBASSY ABIDJAN PRIORITY 5253
BT
UNCLAS STATE 065989

AIDAC

E.O. 11652: N/A

TAGS:

SUBJECT: BAKEL IRRIGATED PERIMETERS

REFS: DAKAR 1,64

1. ON MARCH 22 AA/AFR SIGNED ACTION MEMO RECOMMENDATIONS ON SUBJECT PROJECT AS FOLLOWS:

A. PROJECT FUNDING IS AUTHORIZED (UP TO DOLS. 120,000) TO COVER NINE MONTHS OF TECHNICAL SERVICES TO THE PROJECT (UP TO DOLS. 100,000) PLUS THE PURCHASE OF TWO LANDROVERS (UP TO DOLS. 64,000).

B. HOST COUNTRY PROPRIETARY PROCUREMENT OF THIRD COUNTRY NATIONAL TECHNICAL ASSISTANCE IS AUTHORIZED IN AN AMOUNT NOT TO EXCEED DOLS. 100,000 FROM A SENEGALESE CONSULTING FIRM WHICH WILL COVER THE PERIOD OF PROJECT RELATED SERVICES FROM OCTOBER 1, 1976 THROUGH JUNE 30, 1977. IT IS CERTIFIED THAT EXCLUSION OF PROCUREMENT FROM THE SOURCE REQUESTED WOULD IMPEDE ATTAINMENT OF U.S. FOREIGN ASSISTANCE OBJECTIVES AND WOULD BE INCONSISTENT WITH THE FULFILLMENT OF THE FOREIGN ASSISTANCE PROGRAM.

C. IT IS DETERMINED THAT SPECIAL CIRCUMSTANCES EXIST AT THIS TIME THAT WARRANT THE PROCUREMENT OF NON-U.S. MANUFACTURED VEHICLES, AND CERTIFIED THAT EXCLUSION OF PROCUREMENT FROM THE SOURCES HEREIN REQUESTED WOULD SERIOUSLY IMPEDE ATTAINMENT OF U.S. FOREIGN POLICY OBJECTIVES AND OBJECTIVES OF THE FOREIGN ASSISTANCE PROGRAM. CODE 935 PROCUREMENT OF TWO LANDROVERS AT A COST NOT TO EXCEED DOLS. 64,000 IS AUTHORIZED

2. COPIES ACTION MEMO POUCHED 3/23.

UNCLASSIFIED

Classification

FORM FS-412
REV 6/73

ACTION: PEM
INFO: RSO
ADDCOM
CHRON

DEPARTMENT OF STATE

TELEGRAM

209

-2- STATE 065989 UNCLASSIFIED

Classification

3. SEPTELS ON ALLOTMENT AND EA TEAM FOLLOW.

VANCE

LAF 0930 UNCLASSIFIED

Classification

FORM FS-112
REV. 6/72

137

ANNEX C

Est. Project Completion
Date FY 81

LOGICAL FRAMEWORK
FOR SUMMARIZING PROJECT DESIGN

Project Title: Integrated Crop Production Bakel

Narrative Summary	Objectively Verifiable Indicators	Important Assumptions
Program Goal: The broader objective to which this project contributes: Increased cereal production in the Senegal River Basin region of Senegal in order to provide a more attractive alternative to overseas work for the Sonike in the area.	Measures of Goal Achievement: 1) Cereal production in the River Basin increased by 251 MT by 1990. 2) Immigration from basin area to France decreased by 50% by 1990.	Concerning long term value of program/project: 1) Those persons now immigrating to France can provide a greater economic benefit to Senegal by staying in Senegal than is provided by cash inflow from their salaries in France
Project Purpose: Introduce farmer managed irrigated crop production in the Bakel area to acquaint the farmers with the improved technologies and demonstrate the economic and technical feasibility of irrigated culture and introduce improved health and sanitation.	Conditions that will indicate purpose have been achieved: End of project Status. 1) Total of 7,000 persons working on irrigated perimeters by 1980. 2) 900 ha. of land being double cropped in 1980. 3) Average rice yield exceeding 3 T/ha. 4) Health indicators will be either constant or improved after introduction of irrigation into project villages.	Affecting purpose-to-goal link: 1) Larger scale irrigation utilizing flood control dikes in the Bakel Department will be feasible thus allowing expansion of area under irrigated cultivation 2) Future projects in the Bakel area in other sectors are undertaken. 3) SAED is capable of providing services for expanded area. 4) Other irrigation projects in the basin are undertaken as planned.

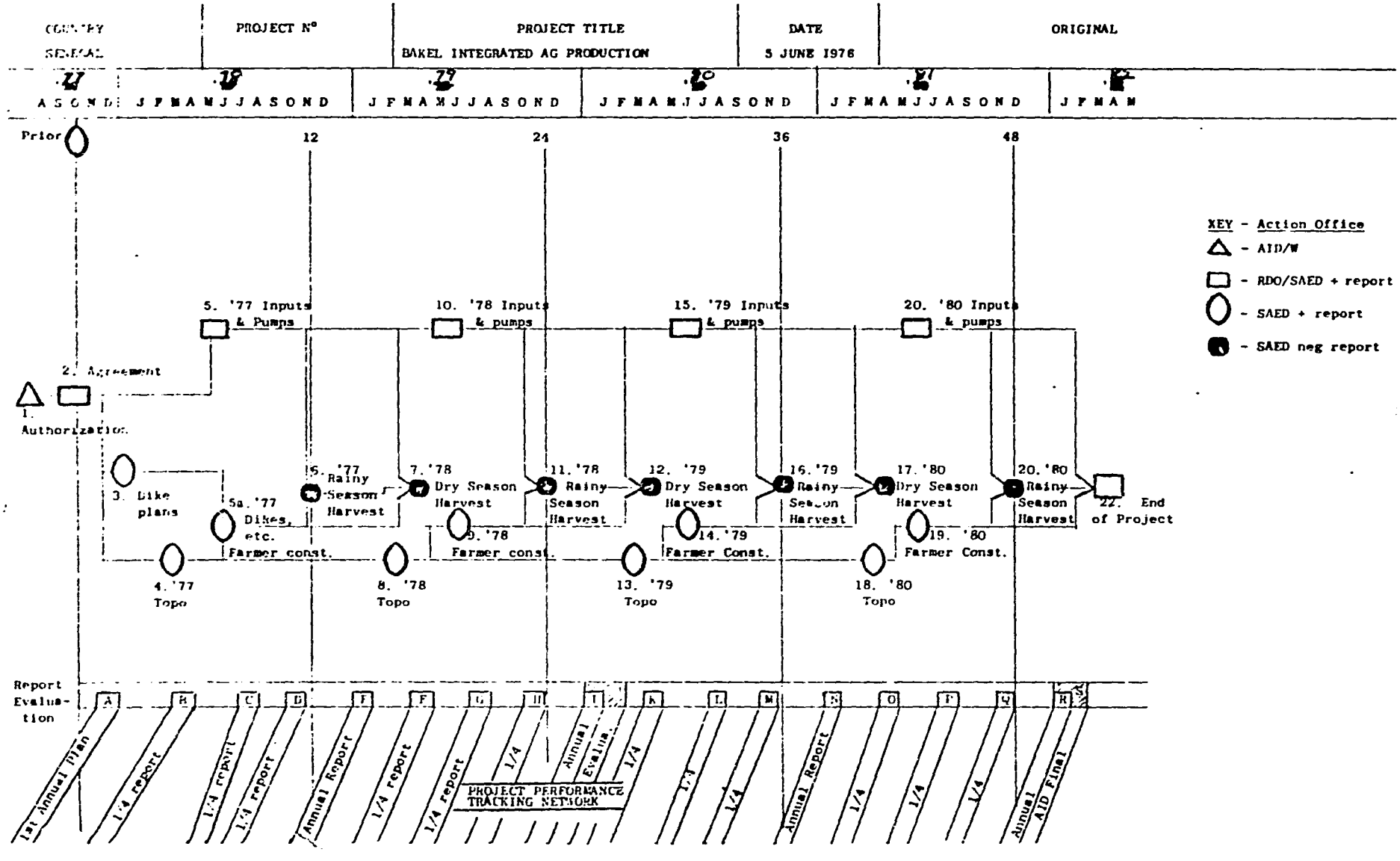
Narrative Summary	Objectively Verifiable Indicators	Important Assumptions
Outputs: 1) Creation of at least one small irrigated perimeter in each of 23 riverside villages. 2) Introduction of improved technologies including animal traction for dryland culture in each participating village. 3) Expansion of existing health delivery system into project villages.	Magnitude of Outputs necessary and sufficient to achieve purpose. 1) 24 farmer groups organized by 1977. 2) 24 small perimeters with a total area of over 1800 ha. developed by 1980. 3) 24 farmer group demonstration plots underway. 4) 23 villages covered by health program.	Affecting output-to-purpose link: 1) Coops organized will continue to grow in size and capabilities. 2) Animal traction proves to be sufficient in decreasing labor requirements on traditional fields so that labor can be utilized on rice fields. 3) Farmers continue to make own management decisions based on CIDR/SASO suggestions.
Inputs: Activities and Types of Resources. 1) Technical Assistance 2) Administrative Infrastructure 3) Administrative operating costs 4) Pumps and hand tools 5) Village labor 6) Animal traction equipment 7) Dikes 8) Training and materials for health program 9) Health/Environmental Surveillance Program.	Level of Effort/Expenditure for each activity. See Budget.	Affecting input-to-output link: 1) Sufficient land meeting "threshold feasibility" requirements with either no dikes or less than 2 m.dikes, can be found to allow development of a minimum of 15 ha. in each participating village. 2) Small pilot hectarage is supplementary to traditional culture and is not restricted by labor availability. 3) CIDR people can be funded under project.

PROJECT PERFORMANCE TRACKING

CPI #	Crit. Date	Type Report	Narrative	Action Office	Quantification
1.	8/77	N.A.	Authorization	AID/W	N.A
2.	10/77	+	Agreement	RDO GOS	N.A
3.	1/78	+	Dike Plans Complete Health surveillance survey begins	SAED RDO	1. 1896 ha flood free 2. REDSO/Eng approved plans
4.	3/78	+	'78 topo studies	SAED	1. 250 additional ha having detailed plans 2. REDSO/Eng approved
5.	6/78	+	'78 pumps and inputs in place	RDO SAED	1. 19 additional pumps on site at villages 2. Adequate ag supplies for '78 season in place at villages.
5a.	6/78	+	Dikes, stumping completed and discing and farmer construction for '78 complete	SAED	1. Dikes and stumping for 1800 ha complete 2. Discing and farmer construction for 250 ha complete
6.	11/78	-	'78 rainy season harvest complete	SAED	1. 399 irrigated ha harvested with ave. yield of T/ha
7.	4/79	-	'79 dry season harvest complete	SAED	1. ha irri. sorghum yield _____T/ha 2. 6 ha vegetables 3. ha yield _____T/ha
8.	3/79	+	'79 topo studies	SAED	1. 460 additional ha having detailed plans 2. REDSO/Eng approved
9.	6/79	+	'78 discing and farmer const. complete	SAED	1. 460 additional ha disced and hand const. complete 2. 856 ha total irrigated land ready to plant

CPI #	Crit. Date	Type Report	Narrative	Action Office	Quantification
10.	6/79	+	'78 pumps and inputs on site in villages	RDO SAED	1. 14 additional pumps 2. Ag inputs for 856 ha irrigated and 200 ha dryland
11.	11/79	-	'78 rainy season harvest	SAED	1. 850 ha of irrigated land harvested with yield of T/ha
J.	2/80	+	Evaluation	SAED AID RDO	1. Total evaluation of 1st two years and replanning of 79 and 80.
12.	4/80	-	Dry season harvest	SAED	1. ha sorghum T/ha 2. 6 ha garden 3. ha T/ha
13.	3/80	+	'80 topo complete	SAED	1. 535 additional ha having detailed plans 2. REDSO/Eng approved
14.	6/80	+	'80 discing and farmer const. complete	SAED	1. 535 additional ha disced and hand const. complete 2. 1396 ha. irrigated land ready to plant
15.	6/80	+	'80 pumps and inputs in place	RDO SAED	1. 26 additional pumps on site in villages 2. Ag inputs for 1396 ha irrigated and 200 ha dry land in place in villages.
16.	11/80	-	'80 rainy season harvest	SAED	1. 1390 ha irrigated crop harvested T/ha
17.	4/81	-	'80 dry season harvest	SAED	1. ha sorghum T/ha 2. 10 ha garden 3. ha T/ha
18.	3/81	+	'80 topo study complete	SAED	1. 505 additional ha detailed plan prepared 2. REDSO/Eng approved

CPI #	Crit. Date	Type Report	Narrative	Action Office	Quantification
19.	6/81	+	'81 discing and farmer construction	SAED	1. 505 additional ha completed 2. 1896 ha prepared for irrigated culture
20.	6/81	+	'80 pumps and farm inputs in place	RDO SAED	1. 16 additional pumps received making total of 95 pumps in Bakel area - 90 on farms, 5 in reserve 2. Farm inputs for 1896 ha in place in villages
21.	11/81	-	'81 rainy season harvest	SAED	1. ha rice T/ha
22.	3/81	-	Project completed	AID	1. Completion report submitted


COUNTRY
SENEGAL
PROJECT N°
PROJECT TITLE
BAKEL INTEGRATED AG PRODUCTION
DATE
5 JUNE 1976
ORIGINAL
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1. Authorization
2. Agreement
3. Dike plans
4. '77 Topo
5. '77 Inputs & Pumps
5a. '77 Dikes, etc. Farmer const.
6. '77 Rainy Season Harvest
7. '78 Dry Season Harvest
8. '78 Topo
9. '78 Farmer const.
10. '78 Inputs & pumps
11. '78 Rainy Season Harvest
12. '79 Dry Season Harvest
13. '79 Topo
14. '79 Farmer Const.
15. '79 Inputs & pumps
16. '79 Rainy Season Harvest
17. '80 Dry Season Harvest
18. '80 Topo
19. '80 Farmer Const.
20. '80 Inputs & pumps
20. '80 Rainy Season Harvest
22. End of Project
XEY - Action Office
- AID/W
- RDO/SAED + report
- SAED + report
- SAED neg report
Report Evaluation
A B C D E F G H I J K L M N O P Q R S
1st Annual Plan
1/4 report
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Annual Report
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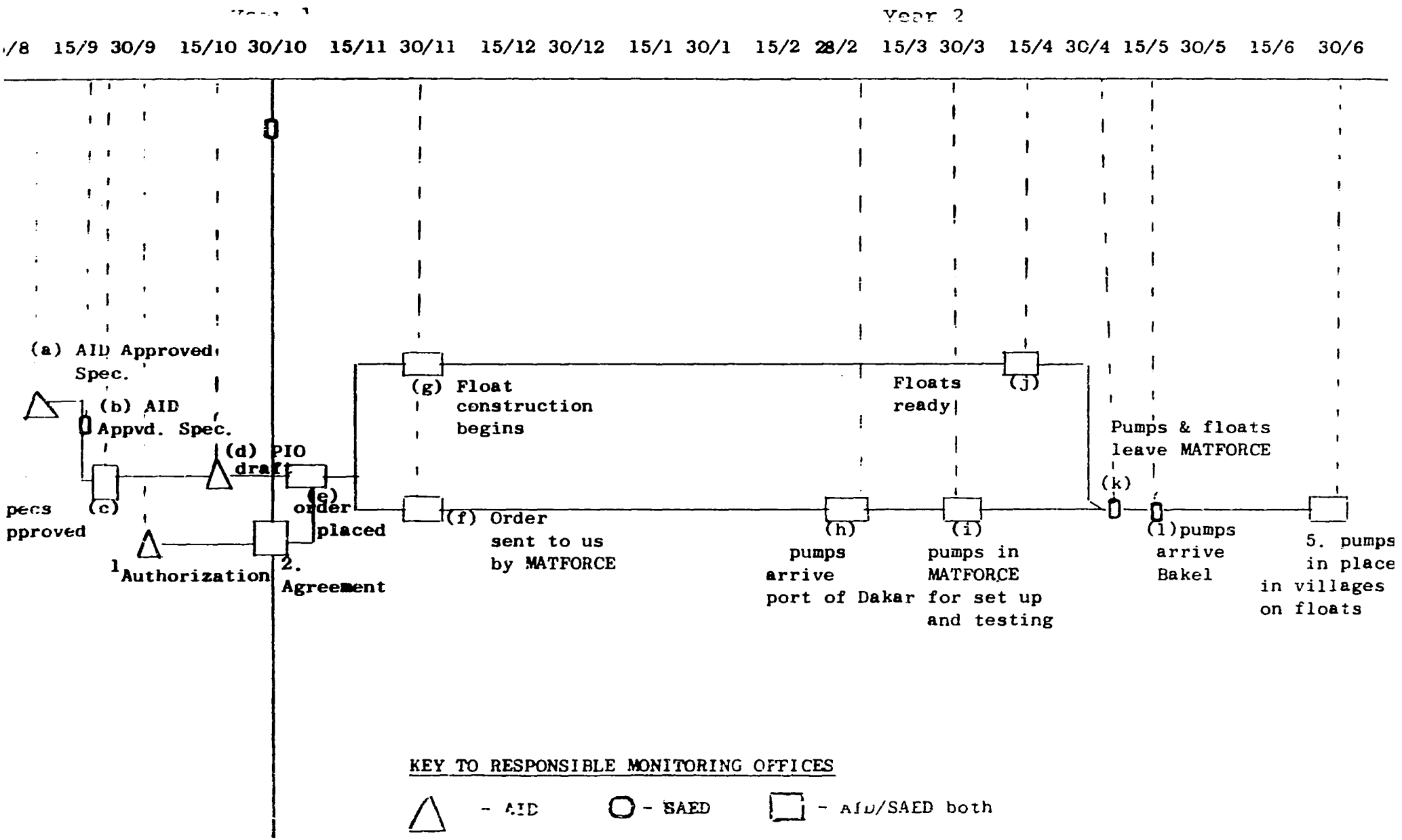
Annual AID Final
PROJECT PERFORMANCE TRACKING NETWORK

IMPLEMENTATION PLAN

PPT ITEM 5 SUBNETWORK FOR AID AND SAED ACTIONS

ON PUMP PROCUREMENTS



DRAFT GRANT AUTHORIZATION

AID Grant Number: _____

Provided from : Food and Nutrition Funds

Senegal: Bakel Crop Production Project

Pursuant to the authority vested in the Administrator of the Agency for International Development by the Foreign Assistance Act of 1961, as amended, (the "Act"), and the delegations of authority thereunder, I hereby authorize a grant to the Government of Senegal in the amount of FIVE MILLION EIGHT HUNDRED AND FIFTY NINE THOUSAND dollars ($5,859,000). The Grant shall be used to assist in financing the foreign exchange and local currency costs involved in developing 18,000 hectares of small village level irrigated perimeters in the Bakel area. It will be used to finance construction of warehouses, offices, housing and procurement of vehicles, office equipment, tools, irrigation equipment, technical assistance, training, and provision of a health services activity and a health surveillance program.

The Grant is subject to the following conditions:

1. Source and Origin

   a. Except as hereinafter provided, goods and services financed under the grant shall have their source and origin in countries included in Code 941 of the AID Geographic Code Book or in Senegal.

   b. Technical assistance shall have its source and origin in countries included in Code 935 of the AID Geographic Code Book. Based on justification given in the project paper, vehicles, except for boats, shall have their source and origin in countries included in Code 935 of the AID Geographic Code Book.

2. Competitive Procurement

a. All procurement of goods and services except as hereinafter provided shall be competitively procured according to normal AID regulations.

b. Based on the justification given in the project paper, I hereby determine that in the interest of standardization and insuring proper maintenance and spare parts availability, pumps, motors and ancillary irrigation equipment, having their source and origin in Code 941 countries or Senegal, may be procured under this grant, without competitive bidding, from NOSOCO-MATFORCE Dakar.

c. Based on the justification given in the project paper, I hereby determine that in the interest of providing continuity in the technical services at a reasonable cost, technical assistance under this grant can be procured, without competitive bidding from SERDA in Dakar.

3. The Grant shall be subject to such other terms and conditions as AID may deem advisable.

_____
Administrator

_____
Date

Annex F

Certification Pursuant to Section 611 of the
Foreign Assistance Act of 1961, as amended.

_____ May 13, 1977

I. Arthur Fell, Acting Regional Development Officer/Dakar, having taken into account among other things:

A. The importance attached to developments in the Senegal River basin in the Senegal national plan;

B. That the Société d'Aménagement et d'Exploitation du Delta (SAED) has been charged by the Government of Senegal with the responsibility for implementin all agricultural projects in the Senegal River basin in Senegal;

C. The demonstrated capability of SAED to implement irrigation projects in the Senegal River basin;

D. The demonstrated willingness of SAED to provide adequate staff in the Bakel area;

E. The demonstrated capability of SAED to design irrigation schemes, to arrange contracts for construction and to serve as supervisory engineer on irrigation projects; and

F. The reasonableness of the costing of the construction activities; do hereby certify that, in my judgement, the Government of Senegal will have adequate financial capability and the human resources capability to implement, and operate effectively, the subject small irrigated perimeters.

This judgement is based on the facts that:

1. SAED has already gained two years experience in installing small perimeters in the Bakel area.

2. SAED has several years experience in designing and constructing large scale irrigation schemes, both on a contracted and force account basis, in the lower basin area using donor funds;

3. Technical assistance provided under the grant will assist SAED to implement the program;

4. That the perimeters as designed will be managed by the local farmer groups and that they are small enough to allow local management;

ANNEX G

SOILS CONDITIONS

This environment appraisal refers to the region on the Senegalese side of the Senegal river between the villages of Balou and Gandé and inland away from the river to the edge of the flooded area. Three basic terrain types, with subdivisions, are recognized :

(a) Falo - essentially the river bank

(b) Fondé - a levee dating from an earlier period c.5500 B.P. during which sea level was higher and conditions of deposition were different. This levee now stands above the highest flood levels and forms the site of all river-side villages.

(c) Oualo - the land area away from the river behind the Fondé, formed into a series of depressions receiving flood water and sediment. Within these major terrain forms, particularly the last two, sub-types can be identified and it is these sub-types that are of immediate relevance to the CIDR programme.

The geomorphological relationships between these terrain types is reflected in soil properties, soil-moisture states and vegetation. All three are depositional features formed as a result of changing sea levels during the Holocene period, and seasonal and long term changes in the Senegal river regime; secondly the sediments are generally well-sorted and homogenous and characterised according to the elevation and form of the depositional features themselves. Since the maximum transgression of the Nouakshottian sea (5500 B.P.) the subsequent lowering of the base level has produced the major land forms noted above. Detailed knowledge of the Fondé and Oualo areas is a requirement for an environmental appraisal of the CIDR programme.

5. REDSO engineers have reviewed the plans for the first years construction and find them adequate. Plans for future year construction will be approved by AID prior to initiation of construction activities; and

6. Implementation of the project will be closely monitored by a project manager attached to the Regional Development Office in Dakar.

Arthur Fell
Regional Development Officer (Acting)

FONDE

The Fondé is restricted in area by comparison to the Oualo. Although a depositional feature of the Post-Nouakchottian the present-day regime of the river never produces a flood to cover this land form. All major villages are situated on the Fondé as is the major road access to Bakel. The Fondé is periodically broken by deeply-incised streams (marigots) which drain the Oualo land further away from the river.

The soil of the Fondé is generally a clayey sand to a sand type, young, and poorly developed. Where less well-drained, hydromorphic soils show evidenc of white-grey and ochre-red mottling, and dark ferro-magnesium concretions.

The feature of these soils with immediate relevance to agriculture is the contant of silt. Figures are not yet available from the War on Want Survey but Audry's (1961) work indicates silt contents are high as 30% and coarse san less than 10%. General chemical properties are indicated in table 1.

Table 1 (after Audry, 1961)

	Clayey-sand	sand
CEC°	10-25	5-8
saturation	50-90	35-100
Ca°	5-10	2.5-5.0
Mg°	2.5-6	1.5-2.5
K°	0.1-1.0	0.1-0.6
Na°	$<$ 0.25	$<$ 0.15
pH, 1:5H_2O	6.0	6.5
available phosphate, % of total P	0.4-0.08	
organic matter %	1.0-1.2	0.5-1.0
C/N	6-12	

°meq/100 gs a.d.s.

Because of their sandy nature these soils tend to be porous although clay content may increase with depth. The level of the water table may be close enough to the surface to support deep-rooted plants while flood levels in the nearby Oualo are high, but in general, agricultural crops exist on rain fall alone, and whithout irrigation, dry-season cultivation is not possible. The high silt content tends to make these soils hard and difficult to cultivate.

The vegetation supported by the Fondé is composed of varying proportions of the following principal species:
Balanites aegyptiaca, Zizyphus, Acacia seyal, A albida, A sieberiana, Guiera senegalensis, Piliostigma reticulata, and Bauhinia rufescens.
Exact relationships of these species have not yet been determined. The density and overall size of these plants would seem to reflect intensity of human pressure rather than local variations in physiographic phenomena, although concentrations of Guiera senegalensis may reflect sandier soil conditions. As a general rule, the Fondé vegetation is more or less degraded, particularly close to villages. The intensity of farming activity is constrained by distance and no obvious fallow regime is observable, though this must exist in some form. The net outcome is a pattern of well developed bush around the mid-point between villages as between Mouderi and Diawara, and north of Mouderi. South of Bakel, the Fondé is more heavily utilised, particularly as it merges with the Falo. This is most evident between Koungani and Golmi and between Golmi and Yafera. Air photo evidence from 1960 clearly indicates greater utilisation of the Fondé since that time, particularly north of Bakel.

OUALO

Because of their topography and subsequent sediment enrichment through annual flooding, the Oualo lands offer the best soils for agriculture. Both their chemical and water-retentive properties make these lands the most productive and valuable in the Soninke agricultural system. These depressions, which vary both in areal extent and depth, receive annual flood water containing large quantities of suspended solids. The flood arrives in July and retreats at the end of September. The duration of inundation depends on topography; the lands merging with the higher Fondé on the river side and the Dieri on the interior side being reached only by the higher floods and then only for a short period. By contrast deeper depressions may retain water as permanent lakes long after the main flood has retreated. The short time in which the marigots have had to develop (5000 years or less) has resulted in an as yet inefficient drainage system which ensures the existence of the permanent lakes.

Soils conditions vary according to topographic position. A gradient exists between the silty Fondé soils and the strongly gleyed clay-rich soils of the lowest Oualo lands around the margins of the lakes, e.g. in the centre of the large basin west of Mouderi. A sequence of soils is found from strongly gleyed to vertisolic to the hydromorphic Fondé soils. Within the gradient variations exist. Thus on the lower, more recent levees which are found within the Oualo, pseudogleyed soils exist. In general the sequence from Fondé to Oualo is one of increasing clay content, decreasing silt, decreasing pH, increasing organic matter, and increasing K&Na. Within this gradient vertisols occur in higher level depressions with high proportions of double-lattice clays and marked changes in soil moisture between the wet and dry seasons. Table 2 shows some soil properties of this sequence.

Table 2

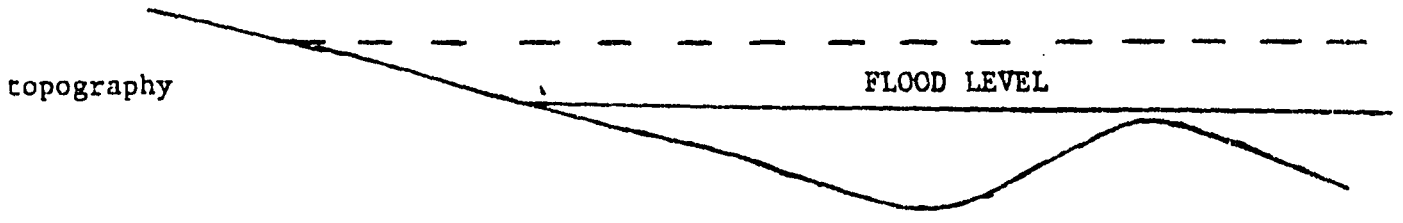
Basic soil types of Senegal alluvial deposits (after Audry, 1961)

	Poorly Evolved Transported Hydromorphic	Vertisols	Gley	Pseudogley
	Low Fondé (Ouallere)	High Oualo (Hollalde)	Low Oualo	Petit Levees
clay		35-40	40-55	40-60
silt	20-25%	10-15	10-20	15-25
c. sand	< 10%	very low	< 2	
OM°°	1.0-1.2	c. 1.0	0.5-2.5	1.0-1.6
pH	6.0-6.5	7.0 +	5.0	5.5-6.0
Na°	< 0.25	< 0.20	< 0.50	< 0.30
Ca°	5-10	15-20	6-8	6-9
Mg°	2.5-6.0	6-20	1-10	> Ca
P_2O_5	0.04-0.08	c.0.05	0.075-0.100	c. 0.100
K°	0.1-1.0	0.3-0.5	< 1.5	0.25-0.5
CEC°	10-25	20-30	20-25	20-25+
Sat'n %	50-90%	100%	70-90	60-90

meg/100 gms

phosphate as % of total P

°° % by weight



The vegetation of the Oualo is more distinctive. Around the margins of the permanent lakes with strongly reduced gley soils Mimosa asperata is found in dense thickets. Further away from the lake, or in Oualo lands which are completely drained after the flood retreat, the natural vegetation is of Acacia nilotica forest, backed by a zone of Mitragyna inermis. Little of this remains intact as most of the Oualo lands, particularly to the north of Bakel, have been cleared for flood-retreat agriculture. The smaller levees support vegetation similar to the Fondé. On the Dieri side of the Oualo, still in clay-rich soils (pseudogley) large stands of Acacia seyal dominate. Most of these are still intact, especially to the south of Bakel behind Golmi, Yafera and Balou. The road from Bakel to Koungani passed through such an Acacia seyal woodland, merging into the Mitragyna inermis-Acacia nilotica-Mimosa asperata zonation close to Koungani.

CIDR irrigation project

Of particular importance to the CIDR programme are the intermediate lands between the high Fondé and the lower Oualo. These areas include the low Fondé or Fondé Oualere and in certain circumstances the higher Oualo Hollalde (see table 2). Whilst the initial programme is one of irrigated vegetable gardens on the high Fondé, later extension will move to sites suitable for larger scale motor-pump irrigation on the low Fondé for rice. Low Fondé sites are favoured for two reasons :

(1) They are generally close to the villages which stand on the high Fondé

(2) Large areas are as yet uncultivated, especially south of Bakel. The reason for this would seem to be because of their topographic position. Whilst the soil type is closer to the silty soils of the higher Fondé which are cultivated as soon as the rainy season begins, they are also subject to short

term inundation if the annual flood is high. Because the flood comes a month after the first rains, there exists a risk of inundation of crops planted at the start of the rains should the flood be high. This would effectively eliminate the type of wet season agriculture practised on the high Fondé. For the same reason (lack of flood reliability) these low Fondé sites are not suitable for the flood retreat agriculture of the Oualo.

In recent years, because of the drought, and subsequent poor floods, some low Fondé areas have been cultivated in the same way as the high Fondé. This is particularly evident around Mouderi and Tuabo.

Two points are of relevance to the CIDR programme; the suitability of the soils for irrigation, and their chemical properties.

(1) Irrigation potential

An ideal site for irrigated rice production would be nearly flat, with a clay-rich soils, and predictable flood levels. The sites under consideration, particularly north of Bakel, fail to meet these exacting criteria. Firstly the nature of the topography - soils - water gradient is such that a combination of these three factors is unlikely to coexist. Flat sites are almost invariably at the bottom of the Oualo lands and are either flooded for too long or already cultivated. Clay-rich soils are unlikely to be found on the low Fondé slopes because they are above the level of long-period inundation and therefore do not receive large quantities of fine depositional material. Finally it has already been noted that these areas are the least predictable with respect to flood levels.

Despite these reservations rice cultivation may still be possible. Within the low Fondé areas, flatter sites do exist. For example between Yafera and Golmi, north of Balou, west of Tuabo, north west of Bakel and along the

marigot north of Manael. A detailed survey of all possible sites has not been possible during this initial visit, but the indication is of a sufficiency providing social and economic criteria can be met (i.e. distance from villages, labour requirements etc.). Even if flat sites cannot be found, the possibility of low embankment construction to impound water may effectively bypass this apparent limitation.

However it does seem that high level clay-rich sites which are not already cultivated are unlikely to be freely available. If irrigation by motor-pump is viable, the higher porosity of the silt/sand-rich soils can be offset. Detailed sediment analysis of soils from low Fondé sites is as yet incomplete, but field observations suggest that although not dominant, the clay-fraction in these soils may be sufficient to optimise the efficacy of irrigation.

The third criterion, of predictable flood levels, is impossible to meet. The danger here is less from inadequate flooding (as this can be offset by irrigation) but from irregular high flooding which may over-inundate rice seedlings at critical times. By siting the fields towards the drier extreme of the Fondé soils this danger can be minimised, though this will, of necessity, mean a shift towards the more porous silty soils of the high Fondé.

By careful site selection with the assistance of local knowledge, it is believed that a compromise can be found between these conflicting requirements.

Chemical properties

Table 3 shows the major features of a series of soils taken from sites ranging from dry Fondé to much lower and wetter Oualo edge. The Oualo edge soils show low pH, reasonable cation exchange capacity, variable organic carbon

content (though generally fair by savanna-zone standards), medium to poor available phosphate levels (except for Soil 8) and low potassium. By contrast with other soils of the Sahel/Sudan zone they may be thought of as relatively productive. The drier soils of the low Fondé are less acidic with higher pH, similar though slightly lower cation exchange capacity and organic carbon, generally higher, though very variable available phosphate, and slightly better potassium.

Table 3

Means and standard deviations for chemical characteristics of Oualo Hollalde and Fondé Oualere soils.

Soils	8, B2, K2, Y3, Y4 low soils : Oualo margin	15, 20, 4, 3, 35, K1, Y1 higher level soils : low Fondé
pH, 1:5H_2O	4.7 ±0.07	5.8±0.41
CEC+	16.44± 1.78	13.57±4.13
C,%	1.79± 1.03°	1.31±0.53
P, p.p.m	24.10± 30.73	46.43±63.17°°
K+	0.28± 0.08	0.36±0.14

° two samples from currently cultivated land are below 1.00

°°P levels show great variation

+meq./100 g. a.d.s.

Further constraints

(1) Sites so far examined have been close to the Fondé for reasons already specified. In addition it should be mentioned that the most readily available water supply for rice irrigation is from the river and this adds to the reasons for selecting a low Fonde site. Although irrigation from wells may prove adequate for collective gardens (as is envisaged at Gabou and Gounia) this would probably prove insufficient for the larger fields planned for rice cultivation. Alternative sources may be dammed marigots (though this would have much wider implications with respect to lake levels, fishing activity and flood retreat farming) or the lakes themselves.

(2) Land at the rear of the Oualo areas, now supporting Acacia seyal woodland on gleyed or pseudogleyed soils may provide suitable areas for rice after clearance (see table 4 for soil properties). However, these are generally some distance from the Fondé villages and may therefore be too far to be adequately tilled. Water supply may also be difficult, although nearby lakes may contain a sufficient quantity, especially in view of the higher clay content of these soils.

(3) Profile pits were dug for sites B1, B2, K1, K2, Y1, Y2, Y3, and Y4. In most cases (B-Balou, K-Koungani and Y-Yafera), as the lower area close to the Oualo is reached, clay content increases, as do mottles and concretions. Water retention increases, especially below 50 cms. (examination in early April in the latter half of the dry season). A schematic view of these soils is shown in Fig. 1.

Table 4a **Soil characteristics of rear Oualo sites**

	pH 1:5H_2O	CEC°	Sat'n %	C %	N %	P p.p.m.	K°	Ca°	Mg°	Na°
(10) W. of Koun.	5.5	9.2	72	2.12	0.15	13.6	0.3	5.0	1.2	0.1
(11) ditto drier	5.0	10.8	61	1.86	0.13	15.8	0.3	4.0	2.3	0.0
(17) W. of Golmi	6.3	28.0	100	1.16	0.11	12.2	0.8	16.8	10.8	0.2
(18) drier										
(19) drier	6.7	24.5	95	2.29	0.16	10.9	1.0	15.8	6.3	0.1

Table 4b **Soils characteristics of Marigot bank sites**

(25)	6.6	15.00	100	1.23	0.08	8.1	0.4	9.6	5.3	0.0
(26) S. of										
(27)°° Gounia	6.4	13.9	97	0.85	0.06	5.9	0.2	8.1	5.2	0.0
(28)										

°meq./100 gs. a.d.s.

°°30 cm. rather than surface sample; hence low C and N values.

The increasing proximity of mottling to the soil surface as the lower sites are approached is to be expected and indicates reduction under water-logged conditions and locates these soils within the category 'SOLS PEU EVOLUES D'APPORT, HYDROMORPHES' (I.R.A.T. 1969). The Balou soils show some vertisolic development.

Clay content does not increase progressively with depth, there being a concentration zone, below which clay content decreases. At Koungani the clay zone is near the surface (K1) or at 40 cms (K2); at Balou no apparent concentration (B1) or at 50 cms (B2). Further details of soil texture await completion of the analyses. Chemically, lower sites show high Na values at depth and these may present problems requiring consultation with a soil chemist-agronomist. Table 5

Table 5 Sodium and conductivity levels of samples from 8 soils pits

			B1	B2	K1	K2	Y1	Y2	Y3	Y4
Na	1		1.4	0.4	0.0	0.2	0.4	0.3	0.2	0.2
meq/	2	depth	4.6	1.3	0.0	1.3	1.6	1.5	1.6	1.2
100 g. a.d.s.	3				0.0	1.5	2.1	1.1	1.4	1.1
Conductivity	1		0.13	0.14	0.06	0.06	0.03	0.06	0.05	0.07
mmhos	2	depth	0.78	0.05	0.03	0.06	0.09	0.12	0.09	0.07
$1:5H_2O$ 25 C	3				0.02	0.08	0.11	0.08	0.15	0.11

CONCLUSION

Physical constraints on the CIDR programme require careful selection of sites to optimise soil conditions whilst minimising flood difficulties. With irrigation, selection of less clay-rich soils is possible and flood problems can thus be minimised. The areas at present consideration by the CIDR team encompass a range of soils from the low Fondé to the Oualo margins, and with local knowledge of flooding, optimisation is possible. It may well be that non-physical constraints such as tenure, labour requirement, cultivation techniques and irrigation conditions will be more influential in determining exact locations for the programme.

Appendix C

Population of the Department of Bakel (1975-76)

Arrondissements	Active Workers	Children	Handicapped and elderly	Total Population
OLOLDOU	15,652	7,853	1,461	24,946
BELE	3,579	2,991	645	7,215
GOUDIRY	9,373	7,675	1,162	18,210
BALA	10,025	6,198	968	17,191
TOTAL	38,629	24,697	4,236	67,562

Source: Préfet de Bakel (Monsieur M'Baye Niang)

Adjoint du Préfet de Bakel (Monsieur Sekou Sonko)

Date: January 2, 1974

ANNEX H.

Table 1: Status of Plans Per Perimeter

Village	CIDR/BAED BAKEL 76 plan	BAED ST-LOUIS DETAIL PLAN		BAKEL 4 yr Plan		ST-LOUIS DIKE PLANS		PLANNED HA HAVING Dike plans	DIKE PLANS remaining	DETAILED PLANS remaining
Ballou	28	13,8	1)	150		150	1)	150	- 0 -	136,2
Aroundou	4	8	2)	60		70	2)	60	- 0 -	52
Yafera	6	4,2	1)	100		150	1)	100	- 0 -	94
Golmi	- 0 -	- 0 -	1)	30		100	1)	30	- 0 -	30
Kounghani	12	24	1)	120		150	1)	120	- 0 -	96
Bakel I	15	28	1)	16		30	1)	16	- 0 -	- 0 -
Bakel II	- 0 -	- 0 -	3)	300		- 0 -	3)	- 0 -	300	300
Tuabou	6	33	2)	50		60	2)	50	- 0 -	17
Manael	10	53	2)	70		45	2)	45	25	77
Yelingara	5		2)	60		25	2)	25	35	
Diawara	15	30	1)	150	250	1000	1)	250	- 0 -	207,5
Moudery	8			100					- 0 -	
Galade	- 0 -	8,3	2)	60		60	2)	60	- 0 -	51,7
Gande	6	12	2)	80		30	2)	30	50	68
Sobou	- 0 -	- 0 -	3)	40		- 0 -	3)	- 0 -	40	40
Diimbe	- 0 -	- 0 -	3)	40		- 0 -	3)	- 0 -	40	40
Dialiguel	- 0 -	- 0 -	1)	50		150	1)	50	- 0 -	50
Ouro Amadou	- 0 -	- 0 -	3)	40		- 0 -	3)	- 0 -	40	40
Selliny	- 0 -	- 0 -	3)	40		- 0 -	3)	- 0 -	40	40
Dembakane	- 0 -	- 0 -	3)	100		- 0 -	3)	- 0 -	100	100
Bokeladji	- 0 -	- 0 -	3)	40		- 0 -	3)	- 0 -	40	40
Lobali	- 0.-	- 0 -	3)	40		- 0 -	3)	- 0 -	40	40
Gourel Dara	- 0 -	- 0 -	3)	40		- 0 -	3)	- 0 -	40	40
Wacunde	- 0 -	- 0 -	3)	120		- 0 -	3)	- 0 -	120	120
Total	115	226,8		1896		2020		986	910	1679,4

1) Surveyed for Dikes, needing dikes, dike plans done 700 ha
2) Surveyed for dikes, no dikes needed 290 ha
3) Not yet surveyed for dikes 910 ha

Table 2: Labor in Man/ Days and Hours to Construct Ditches and Bunds

	Meters per hour/man
Bakel	
Double bund ditch 9M/man/day/4 hr. day	2.25
Tuabou	
Double bund ditch 1M/man/day/3 hr. day	0.33
Khoungani	
Large dike equivalent 0.21 M/man/day/3 hr. day to main ditch	0.07
Gande	
Main ditch 3.03 M/man/1 hour	3.03
Diawara	
Main ditch 2.22 M/man/day/3 hr. day	0.74
Manual	
Main ditch 1.00 M/man/day/3 hr. day	0.33
CIDR Estimates	
Main ditch 3.33 M/man/day/3 hr. day	1.11
Av.	1.12

Secondary ditch 5.00 M/man/day/3 hr. day

$$\left(\frac{3.33}{5.0} \times Av\right. = \quad 0.746$$

Bund 10.00 M/man/day/3 hr. day $\left(\frac{3.33}{10} \times Av\right. = \quad 0.373$

Table 3 — Lengths of Main Canals, Laterals, Drains and Field Bunds (Small Dikes) of selected Perimeters

	Meters	Meters Per hectare
BAKEL (28 ha)		
Main Canal	1,420	50.71
Laterals	2,340	83.57
Drains	3,120	111.43
Field Bunds (Small Dikes)	20,800	742.86
KOUGHANI (24 Ha)		
Main Canal	800	33.33
Laterals	2,350	97.92
Drains	2,450	102.08
Field Bunds (Small Dikes)	17,390	724.58
DIAWARA (30 Ha)		
Main Canal	1,140	38.00
Laterals	1,900	63.33
Drains	1,900	63.33
Field Bunds (Small Dikes)	15,548	518.27
YELLINGARA (20 Ha)		
Main Canal	480	24
Laterals	1,500	75
Drains	1,500	75
Field Bunds (Small Dikes)	11,706	585.3
MANAEL (33 Ha)		
Main Canal	1,080	32.73
Laterals	2,690	81.52
Drains	3,310	100.30
Field Bunds (Small Dikes)	19,040	576.97

Table Summary of Meters per Hectare of Main Canals, Laterals, Drains and Field Bunds (Small Dikes) of Selected Perimeters

METERS/HECTARE

	BAKEL 28 Ha	KOUGHANI 24 Ha	DIAWARA 30 ha	YELLINGARA 20 Ha	MANAEL 33 ha	Average	Est.	WEIGHTED Average
Main Canal	50.71	33.33	38.00	24.00	32.73	35.75	82.5	59.13
Laterals	83.57	97.92	63.33	75.00	81.52	80.27	198	139.14
Drains (bunds)	111.43	102.08	63.33	75.00	100.30	90.43		
Field Dikes(bund)	742.86	724.58	518.27	585.30	576.97	629.60		
	854.29	826.66	581.60	660.30	677.27	720.03	1,023	871.52

TABLE 4

ANNUAL CONSTRUCTION LABOR REQUIREMENTS

NAME	MAX. DEVELOPMENT HA./YR.	HOURS/DAYS (3H) PRIMARY	HOURS/DAYS (3H) SECONDARY	BUNDS	TOTAL REQUIREMENT 3Ha/PERSON HRS.	TOTAL REQUIREMENT 3Ha/PERSON DAYS	# PERSONS NEEDED TO ACCOMPLISH WORK IN 2 MONTHS	WORKING POPULATION
BALLOU	40	2625/875	4152/1384	13003/4334	19780	6593	126	1001
AROUNDOU	15	984/328	1557/519	4876/1625	7417	2472	48	505
YAFERA	30	1968/656	3114/1038	9752/3250	14834	4944	95	563
GOLMY	20	1312/437	2076/692	6501/2167	9889	3296	64	1116
KOUNGHANI	35	2297/765	3633/1211	11377/3792	17307	5768	111	873
BAKEL	90	5906/1968	9342/3114	29257/9752	44505	14834	286	4485
TUABOU	20	1312/437	2076/692	6501/2167	9889	3296	64	722
MANAEL	20	1312/437	2076/692	6501/2167	9889	3296	64	642
VELINGARA	20	1312/437	2076/692	6501/2167	9889	3296	64	385
DIAWARA	50	3281/1093	5190/1730	16254/5418	24725	8241	159	1958
MOUDERY	30	1968/656	3114/1038	9752/3250	14834	4944	95	1731
GALADE	20	1312/437	2076/692	6501/2167	9889	3296	64	387
GANDE	20	1312/437	2076/692	6501/2167	9889	3296	64	301
SEBOU	15	984/328	1557/519	4876/1625	7417	2472	48	197
DJIMBE	15	984/328	1557/519	4876/1625	7417	2472	48	250
DIALIGUEL	20	1312/437	2076/692	6501/2167	9889	3296	64	190
DURO AMADOU	15	984/328	1557/519	4876/1625	7417	2472	48	194
SELLINY	15	984/328	1557/519	4876/1625	7417	2472	48	178
DEMBAKANE	40	2625/875	4152/1384	13003/4334	19780	6593	126	2070
BOKELADJI	15	984/328	1557/519	4876/1625	7417	2472	48	1380
LORALI	15	984/328	1557/519	4876/1625	7417	2472	48	660
GOUREL DARA	15	984/328	1557/519	4876/1625	7417	2472	48	410
WAOUNDE	40	2625/875	4152/1384	13003/4334	19780	6593	126	2277

Table **Summary of Meters per Hectare of Main Canals, Laterals, Drains and Field Bunds (Small Dikes) of Selected Perimeters**

	METERS/HECTARE							
	BAKEL 28 Ha	KOUGHANI 24 Ha	DIAWARA 30 ha	YELLINGARA 20 Ha	MANAEL 33 ha	Average	Est.	WEIGHTED Average
Main Canal	50.71	33.33	38.00	24.00	32.73	35.75	82.5	59.13
Laterals	83.57	97.92	63.33	75.00	81.52	80.27	198	139.14
Drains (bunds)	111.43	102.08	63.33	75.00	100.30	90.43		
Field Dikes(bund)	742.86	724.58	518.27	585.30	576.97	629.60		
	854.29	826.66	581.60	660.30	677.27	720.03	1,023	871.52

M.D.R.H.

S.A.E.D.

Project Bakel

CHARACTERISTICS OF PUMPING REQUIREMENTS

IF DIKES ARE BUILT IN 1977

Villages	Hectares Rainy Season				Number of Pumps HR3 300m3/h 32;25hp				Number of Pumps HR2 170 m3/h 17hp			
	77	78	79	80	77	78	79	80	77	78	79	80
Ballou	50	80	110	150	2	3	5	6	0	0	0	0
Aroundou	15	30	45	60	0	1	1	2	1	1	1	1
Yafera	16	40	70	100	0	1	2	3	1	1	1	1
Golmy	10	30	30	30	0	1	1	1	1	1	1	1
Kounghani	30	55	90	120	1	2	4	5	0	0	0	0
Bakel I	16	16	16	16	0	0	0	0	1	1	1	1
Bakel II	60	50	220	300	2	6	9	12	1	1	1	1
Tuabou	20	30	50	50	1	1	2	2	1	1	1	1
Manael	15	30	50	70	0	1	2	2	1	1	1	1
Yelingara	15	30	50	60	0	1	2	2	1	1	1	1
Diawara	30	60	100	150	2	2	4	6	0	0	0	0
Moudery	20	40	70	100	1	1	2	4	1	1	1	1
Galade	15	30	50	60	0	1	2	2	1	1	1	1
Gande	20	40	60	80	1	1	2	3	1	1	1	1
Sebou	5	15	30	40	0	0	1	1	1	1	1	1
Djimbe	8	15	30	40	0	0	1	1	1	1	1	1
Dialiguel	8	20	30	50	0	0	1	1	1	1	1	1
Ouro Amadou	5	15	30	40	0	0	1	1	1	1	1	1
Selliny	5	15	30	40	0	0	1	1	1	1	1	1
Dembakane	10	30	60	100	0	0	1	1	1	1	1	1
Bokeladji	5	15	30	40	0	0	1	1	1	1	1	1
Bobali	5	15	30	40	0	0	1	1	1	1	1	1
Gourel Dara	5	15	30	40	0	0	1	1	1	1	1	1
Waounde	10	40	80	120	0	1	3	4	1	1	1	1
	399	856	1396	1896 Total Ha	10	24	50	66 Total HR3	21	21	21	21 Total HR2

ALL TOTALS CUMULATIVE

M.D.R.H.
- M.E.D
Projet Bakel

C A R A C T E R I S T I Q U E D U P O M P A G E

Villages	Lift Height from Float: Ht Géométrique de refoulement de plan d'eau au bac	Suction Height: Ht Géométrique d'aspiration	Length of Piping or Canal: Longueur refoulem.	Loss in Power: Pertes de charge	Total Lift Re: HMT (I)
Ballou	14	0,60 m	45	+ 1,20	15,20
Aroundou	14		90	+ 1,50	15,50
Yaféra	13		80	+ 1,50	14,50
Golmy	13		80	+ 1,50	14,50
Kounghani	13		40	+ 1,10	14,20
Bakel I	2,20	1,20 m	20		
Bakel II	14	0,60 m			
Tuabou	2,50	1,30 m	145	+ 1,80	15,80
Manael	14	0,60 m	120	[illegible]	[illegible]
Yélingara	13		70	+ 1,30	14,30
Diawara	14		40	+ 1,20	15,20
Moudéry	14		40	+ 1,20	
Galadé	14		40	+ 1,20	
Gandé	14		45	+ 1,20	
Sébou	14	0,60	40	+,1,20	
Djimbé	14	0,60	40	+ 1,20	
Dialiguel	14	0,60	40	+ 1,20	
Curo Amadou	14	0,60	40	+ 1,20	
Selliny	14	0,60	40	+ 1,20	
Dokeladji	14	0,60	40	+ 1,20	
Dembakané	14	0,60	40	+ 1,20	
Kobali	14	0,60	40	+ 1,20	
Gourel Dara	14	0,60	40	+ 1,20	
Waoundé	14	0,60	40	+ 1,20	

(I): HMT: pour débit 180 m3 en canalisation Ø 200 mm
for output 180 m3 per 200 mm canals

Table Summary of Meters per Hectare of Main Canals, Laterals, Drains and Field Bunds (Small Dikes) of Selected Perimeters

	METERS/HECTARE							
	BAKEL 28 Ha	KOUGHANI 24 Ha	DIAWARA 30 ha	YELLINGARA 20 Ha	MANAEL 33 ha	Average	Est.	WEIGHTED Average
Main Canal	50.71	33.33	38.00	24.00	32.73	35.75	82.5	59.13
Laterals	83.57	97.92	63.33	75.00	81.52	80.27	198	139.14
Drains (bunds)	111.43	102.08	63.33	75.00	100.30	90.43		
Field Dikes(bund)	742.86	724.58	518.27	585.30	576.97	629.60		
	854.29	826.66	581.60	660.30	677.27	720.03	1,023	871.52

M.D.R.H.
M.E.D
Projet Bakel

CARACTERISTIQUE DU POMPAGE

Villages	Pump Pompe 1976	Power (HP) Puissance 1976	Output Débit 1976	Ha rainy season Ha hivernage 1976
Ballou	1	52 ch.	40 m3/h	25 ha
Aroundou	1	21,5 ch.	170	6
Yaféra	1	21,5 ch.	170	10
Golmy	*1 démarera	en 77	si digues réalisées	
Kounghani	1	52	400	14
Bakel	1		180	14
Tuabou	1	21,50	170	6
Manael	1	21,50	170	4
Yélingara	1	21,50	170	5
Diawara	1	32,25	300	15
Moudéry	1	21,5	170	6
Galadé	1	21,5	170	4
Gandé	1	21,5	170	5
Sébou	*2 démarera en 77			
Djimbé	4	4	4	
Dialiguel	4	4	4	
Ouro Amadou	4	4	4	Gardening Pumps
Sélliny	4	4	4	
Bokeladji	4	4	4	
Dembakané	4	4	4	
Lobali	4	4	4	
Gourel Dara	4	4	4	
Waoundé	4	4	4	

*1 planned in 77 if dikes are constructed
*2 planned in 77

ANNEX I

BAKEL SMALL PERIMETERS

HYDROLOGIC STUDY

Draft
7-28-76

I

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STUDY OBJECTIVES

Several of the perimeters proposed for irrigation development will require diking for flood protection. Data as to the height of flood waters in the perimeter areas are limited to the remembrances of the local villagers. The SAED engineers [1/] have related the flood height information for the Bakel area, as obtained from the villagers, to the recorded gage heights at the Bakel station. As adequate protection from flooding is crucial to the success of the irrigation perimeters, the primary objective of the hydrological study was to check the methodology for selecting the top of dike elevations.

The above objective plus other objectives outlined by A.I.D. in their request for the study are listed below:

"Verify data used by SAED to determine flood frequencies on the Senegal and Falémé rivers from Kidira on the Falémé to Waoundé about 50 km down river from Bakel on the Senegal River. Task includes:

A. Review rationale and methodology of SAED conclusions and recommendations.

B. Review ORSTOM data on Senegal River at Bakel and make judgement regarding its accuracy as far as flood heights and duration is concerned.

C. In Bakel discuss floods and flooding with farmers and inhabitants of area and correlate this data with ORSTOM data.

1/ Périmètre de Bakel - Aménagement Hydro-Agricole Petits Périmètres - Projet d'Exécution, SAED, Saint Louis, Sénégal - July 1976.

D. Develop recommendations for heights of dikes needed to give flood protection for 4 years in 5 and 9 years in 10. Give particular attention to the SAED thesis that floods from marigots are lower than floods on river itself, and give rationale for recommendations.

E. Consider the effects on flood regime of river due to construction of protection dikes.

F. Make analysis of effects of pumping water out of river for irrigation at three development levels: 1000 ha., 2000 ha., and 3000."

An additional objective was added later. A study was needed to determine if there will be a surface drainage problem on some of the diked perimeters. In order to avoid flooding the crops, any accumulation of drainage water would have to be pumped out over the dikes when the river is in flood.

DIKE DESIGN INFORMATION

Perimeter Diking Requirements

The proposed irrigation perimeters generally extend from the banks of the Senegal River across a system of marigots (or over-flow channels) which parallel the main river channel. The river has built up natural levees along its main channel so that the land slopes away from the river to the chain of lakes and low swampy areas. Tributaries or other connecting channels punctuate the main river bank at intervals providing access for floods from the river to flow into the system of marigots. Some reaches of the river valley have 2 or 3 parallel chains of marigots each separated in places by low narrow mounds. Most of the villages are located at the higher places on the river bank where the flooding is less frequent.

Two of the proposed first phase perimeters, Balou and Yafera would have two main dikes extending from the river bank across a marigot to the edge of the river flood plain. (See figures 1A and 1B for a location map of the proposed perimeters). The two dikes, one upstream and one downstream of the perimeters would cut off the marigots' access to the main river channel. Additional short dikes would be required at low spots along the river bank of the main channel to prevent direct over-bank flood flows into the perimeters.

The perimeter at Mouderi-Diarowa, which is proposed for Phase II and is not a part of this initial study, would be similar in plan to Balou and Yafera. The dike profiles for this perimeter have not yet been completed. A field inspection of the perimeter indicated that to

protect the entire proposed area of over 1000 ha. would required dikes 4 to 5 meters high in places.

The perimeter Tuabo II lies at the end of a chain of marigots and would require only one main dike to cut off the area from the river flooding.

The perimeters Koungani and Golmi would each have a pair of dikes extending from the main river bank across a single marigot to a low mound, beyond which lies a second larger marigot. For Koungani, a dike would be required on the mound which separates the two marigots to prevent flood flows, passing through the second marigot from the river, from backing into the perimeter. For the Golmi perimeter, the mound between the marigots is reportedly high enough to protect the perimeter.

Flood Frequencies

The frequency of maximum annual flood elevations (IGN) for the Falémé River at Kidira and the Senegal River at Bakel have been determined in a study by Mr. C. Rochette (ORSTOM)[1/]. The results of the study are given in the following tabulation. The period of record used in the analysis was from 1930 to 1964 for the Kidira station and from 1903 to 1964 for the Bakel station.

1/ Monographies Hydrologiques - Le Bassin du Fleuve Sénégal - ORSTOM, C. Rochette, 174.

Frequency	Senegal at Bakel		Falémé at Kidira
	El. in m. maximum	El. in m. 15 day	El. in m. maximum
1	24.61	23.90	31.85
5	24.11	23.36	31.10
10	23.78	22.91	30.70
20	23.31	22.46	30.10
50	22.11	21.11	29.00
80	20.76	19.61	27.60
90	19.91	18.76	26.75
95	19.06	17.91	25.85
99	17.26	16.51	23.85

Additional years of gage height records (up to 1974) were available for the two stations. A new flood crest (water surface elevation) frequency analysis was made for both stations to determine if the addition of the recent drought years would have changed the frequency values computed by Rochette. Figure 2 presents a plot of the updated flood frequency for both the maximum and the 15 day (water surface higher than indicated for 15 days) elevations for Bakel. Similar data for the flood crests for Kidira are shown on figure 3. The results are summarized in the following tabulation for comparison with Rochette's values.

Frequency %	Maximum Flood Crest Elevations m.			
	Rochette's		Revised	
	Bakel	Kidira	Bakel	Kidira
10	23.78	30.70	23.6	30.5
20	23.31	30.10	23.2	30.0

The additional years of record lowered the elevation of the maximum flood elevations at Bakel by about 0.2 meters for the 1 in 10 year frequency, and 0.1 meters for the 1 in 5 year frequency. The results did not change for the 15 day flood elevations.

It should be noted that the difference in providing protection for the 1 in 10 year flood rather than the 1 in 5 year flood amounts to about .4 meters additional height of the dikes.

Flood Crest Elevations

River - Main Channel -- Records of flood water surface elevations in the vicinity of Bakel exist at several gaging stations along the main channel of the Senegal River and its tributary, the Falémé. The following tabulation lists the stations and their channel distance from the river mouth.

Station	River	River Distance km	ORSTOM 10% Frequency Flood Crest Elevation
Matam	Senegal	623	16.17
Ouaunde	Senegal	715	19.68
Bakel	Senegal	794	23.78
Kidira	Falémé	873 1/	30.70
Kayes	Senegal	923	31.76

The station distances are plotted on figure 4 and show the flood elevations (IGN) for 1 in 10 year (10% frequency) flood as computed by Mr. C. Rochette (ORSTOM). It should be noted that the 1 in 10 year flood is not representative of a single flood. A flood can have a different frequency of occurrence as it passes different stations. The volume of

1/ 50 $\pm$ km from Jct. of Falémé with Senegal River.

a flood and its rate of increase can effect its maximum crest height at different station depending on the antecedent conditions of flooding in the marigots.

The proposed irrigation perimeters are located within about 30 to 35 km upstream and downstream of the Bakel gaging station.

The flood crest profile for the 1 in 10 frequency has been repeated on figure 5 to a larger scale to show river flood elevations adjacent to the various perimeters. The flood profile has been interpolated as a smooth curve between the different gaging stations. Undoubtedly, constrictions and riffles in the river channel do cause some variations from the assumed smooth profile. However, the Bakel station is situated in the center of the group of perimeters and the assumed elevations should be adequate for determining river flood crests at the perimeters.

As discussed under the preceeding paragraph on flood frequencies, the addition of the last 10 years of hydrologic record reduced the flood crest heights for the 1 in 10 year flood as computed by Mr. C. Rochette, by about 0.2 meters for both the Bakel and Kidira stations. Therefore, the 1 in 10 frequency flood crest elevations, as plotted on figure 5, are shown as 0.2 meters lower than those plotted on figure 4.

Marigots - Data as to the heights of the flood crests in the marigot areas are limited to the remembrances of the local inhabitants. The elevations of the flood crests would determine the required heights of the perimeter dikes where they cross the marigots.

The SAED engineers[1/] interviewed the villagers near each proposed perimeter to determine the maximum point reached by recent large floods in the marigot areas.

Villager's Observations -- Information was requested concerning the 1974 flood, which had a frequency of occurence at Bakel of about 1 in 4 years (25%) and the 1950 flood with a frequency of about 1 in 14 years (7%). The villagers stated that concerning the flooding of the marigots, the 1950 flood was the highest in their memory. The SAED engineers ran levels from the indicated points to known bench marks to determine the flood crest elevations. Where local opinions differed or where nearby indicated points gave different flood crest elevations, an average of the elevations was assumed.

The resulting flood profiles in the marigot areas as determined by SAED through the above procedures are plotted on figure 6 taken from the SAED report [1/].

In general, SAED found that the flood crests in the marigots were about 1 meter lower than the flood crests in the adjancent reach of the main channel. The reason for the difference in flood crests is because of the time required to fill the marigots. As a flood crest moves down the river its spills over through restricted channels to fill the marigots. Several days are required to fill the marigots depending on the height of the river flood crest and the amount of water already in the marigots. In any event, the highest part of the river flood crest is past by the time marigot flood levels reach an equilibrium with the river water levels.

1/ Périmètre de Bakel - Aménagement Hydro-Agricole Petits Périmètres - Projet d'Exécution, SAED, Saint Louis, Sénégal - July 1976.

As protection from flooding is crucial to the success of the irrigation perimeters it is necessary that a sound method be used to determine an adequate height for the dikes. At the same time it is desirable to keep the dikes as low as possible to achieve a lower construction cost.

Several different methods as well as an available mathematical model could be used to estimate the marigot flood crests. However, the best and most practical method is obviously the historical observations, if they are reliable.

Therefore, a field check was made on the perimeters, accompanied by SAED personnel, in an attempt to evaluate the reliability of the villagers observations. The subject was also discussed with the SAED surveyor who made the survey. The reliability was very difficult to evaluate. Undoubtedly, some of the observed flood crest points are correct. However, there was sufficient diverse opinion or incongruency with local topography to warrant a further evaluation of the problem. Also, as would be expected most all of the observed flood heights were in or next to the villages rather than in the marigot areas or at the locations of the proposed dikes.

Two other methods of determining the marigot flood crest elevations were considered in order to verify the villagers observations. One method was a mathematical model of the Senegal River system developed by SOGREAH.[1/] The other method was an analysis of the river flow regime between Bakel and Matam.

/ Société Grenobloise d'Etudes et d'Applications Hydrauliques - Modèle Mathématique de la Vallée du Sénégal - Grenoble, France - November 1970.

Mathematical Model - The mathematical model has been used to reproduce historical floods on the river as well as to predict typical floods for annual frequencies of 1 in 10, 1 in 100 and 1 in 1000. The model channel network includes the marigot systems as well as the main river channels. A portion of the limited time available for this study was spent in attempting to trace down promising leads as to the location of pertinent data derived by the model studies, but to no avail. Many of the reports contained flood crest elevations along the river and related data in the marigots, but not the marigot elevations for the Bakel vicinity. The desired data undoubtedly exists in the SOGREAH office in Grenoble France, but the time available did not permit attempting to obtain it. It is recommended that before construction of the dikes, the model data, if available, be obtain in order to check the conclusions of this study.

River Flow Regime - Because of the complex network of the river and marigot channels, a detailed mathematical model (such as developed by SOGREAH), is really needed to adequately compute channel flows and water surface elevations. However, an approximate solution can be obtained through an analysis of the river flow regime between Bakel and Matam. (Although Ouaunde is the next gaging station below Bakel, its records were too incomplete to use).

The important question is how long, for a particular flood crest, does it take to fill up the marigots and over flow channels. If only a day or so is required, then the maximum flood crest elevations in the marigots could approach those in the main channel. If several days are

required, then the main channel flood crest could have dropped well below its maximum elevation by the time the marigot water levels reach a quasi-steady relationship with the river stage.

Several of the larger floods were analyzed to determine the time required to fill the marigots. The required filling time was about 20 to 25 days for the floods studied. The filling time was estimated by determining the differences in flow between Bakel and Matam.

For example, daily plots of the 1950 flood flows for Bakel and Matam are presented on figure 7. The lag in flood peak between the two stations is about 4 or 5 days which is assumed to be the approximate travel time for the flood flows. If the flows did not leave the main channel to fill the marigots, then the flow at Matam should be at least as great as the flow at Bakel 4 days previously. As indicated on figure 7, a considerable loss in flow occurred between the two stations for about 19 days from August 21 to about September 9. On September 9 the flow at Bakel again approximately equaled the flow at Matam 4 days later. From that date on, as the flood crest receded, the flow at Matam was greater than the previous 4 day flow at Bakel, indicating that some of the flow lost to the marigots was draining back to the main channel. On September 9 to September 13 the water surface elevations in the marigots would have been approximately in equilibrium with the main channel for the reach from Bakel to Matam.

As shown on figure 8, the rate of loss (inflow to the marigots) between Bakel and Matam varies consistently with the flood stage elevation at Bakel and with the net amount of water already stored in the marigots.

The net amount of water stored in the marigots was computed by accumulating the daily net loss between Bakel and Matam (considering the 4 day lag in flow time).

The above analysis disregards the unknown intervening tributary inflow, which is small compared to the river flood, and the unmeasured flow in the marigots which bypasses the Matam gage. However, the two unknowns tend to compensate each other. Also the actual flow through the marigots is probably about an order of magnitude smaller than the rate of flow to fill the marigots.

On September 9 the water surface in the marigots near Bakel would have approached the elevation in the main channel as evidenced by lack of a net loss of flow between Bakel and Matam. The water surface elevation at Bakel of about 23.5 meters on September 9 was about 0.4 m, less than at the maximum flood crest of 23.87 on September 6. Therefore, it is believed that for the 1950 flood, the maximum water surface in the marigots probably was within 0.4 meters of the maximum flood crest on the river.

The network of marigots varies in depth and complexity along the river. Undoubtedly some areas fill up and reach an equilibrium with the river faster than others. However, in general, the complexity of the marigot system increases downstream to Matam and the average filling time for the reach should be conservative for the Bakel area.

The relationship between the maximum flood crest in the river and the elevation where the marigots and river reach equilibrium is not only a

function of the maximum flood crest but also the duration of the higher flows. The flood of 1950 had a large volume discharge as well as a high maximum rate of flow. For the flood of 1961 which had a low volume compared to its maximum flow, the difference between the flood crest and the elevation where equilibrium was reached with the marigots was much greater (about 1.0 meter). Therefore, an adjustment was made in estimating the difference in maximum flood crest elevations between the river and marigots based on the duration of the flood crest.

Figure 9 shows for selected historical floods, the relationship at Bakel between the maximum crest and the duration of lower water surface elevations (for 15 days) and the elevations where it is estimated that the marigots were in equilibrium with the river. Assuming a similar relationship for the point of equilibrium for the 1 in 10 frequency flood the estimated maximum flood crest in the marigots would be about 0.5 meters below the river flood crest.

Effect of Dikes on Flood Crests

Enclosing some of the perimeters with dikes will reduce the overflow storage capacity in the river flood plain. In the case of Balou and Yafera, dikes would completely cut off any flow through the marigot (on the left bank). These restrictions would increase the water depth in the main channel and thereby require additional dike heights for the perimeters. An estimate was therefore made of the impact, of the perimeter dikes on the flood crests.

Near Yafera about 5 percent of the flood (1 in 10 frequency) was computed as being transported through the left flood plain. Assuming a similar river stage-flow relationship at Yafera as for the Bakel station, dikes blocking off the marigot would increase the flood crest by about 0.2 meters.

Near Balou on the Falémé River, it was estimated that about 12 percent of the flood on the Falémé with a 1 in 10 year frequency would be carried by the marigot which is to be diked off. The river stage-flow relationship is not known for this location which is about 3 km. above the Falémé junction with the Senegal River. Undoubtedly the flood crest elevation is influenced by back-water from the Senegal River. If the stage-flow relationship for Balou were the same as at Kidira, the dikes would raise the flood crest by about 0.6 meters. However, because the main channel cross-section is probably much greater than at Kidira, the dike effect was assumed at about 0.3 meters or 1/2 that of Kidira.

For the other diked perimeters which would not block off the marigots, but would only reduce the marigot storage capacity, the impact of the dikes would be insignificant compared to other unknowns in computing dike heights.

A previous study on the effect of dikes on flood crests of the Senegal River for the proposed Matam perimeter was made by SOGREAH [1/] using the mathematical model. The perimeter dikes evaluated in the SOGREAH study

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1/ Etude Hydro-Agricole du Bassin du Fleuve Sénégal - Schéma de Principe détaillé - Casier Pilote de Matam - SOGREAH, Grenoble, France - December 1972.

were all downstream of Bakel. The study did include the Diawara-Mouderi perimeter which is to be included in Phase II of the Bakel small perimeters. The results of the SOGREAH analysis indicated that the dikes assumed in their study would increase the 1 in 100 flood crest at Matam by 0.7 meters and at Ouaounde by 0.2 meters. No increase was noted at the Bakel station.

Freeboard

The SAED report 1/ assumed a freeboard of 0.5 meters in the design of the dikes. The SAED engineers related that in their 20 years of experience of building dikes along the Senegal River, a 0.5 meters freeboard has proven adequate.

Based on the wind records at Matam and Kayes and a minimum assumed fetch, the minimum freeboard, using the procedures recommended by the publication "Design of Small Dams" 2/, is about 3 feet or 0.9 meters.

It is recommended that the 0.9 meter freeboard be used along the main river channel where river currents against the dikes could be a problem. In light of SAED local experience and recommendations, together with the low height of the dikes (average of about 2 meters), a freeboard of 0.7 meters is recommended for the dikes across the marigots. With the freeboard reduction from 0.9 to 0.7 meters it is recommended that trees or bushes be planted in front of the dikes crossing the flood plain to reduce wave action. The 0.7 meters in place of the 0.5 meters for the marigots is still recommended for the following reasons:

1/ Périmètre de Bakel - Aménagement Hydro-Agricole Petits Périmètres - Projet d'Exécution, SAED, Saint Louis, Sénégal - July 1976.

2/ Design of Small Dams - U.S. Bureau of Reclamation.

(1) The uncertainty in the estimates of the flood crest elevations for the assumed 1 in 10 frequency.

(2) The lack of precision in estimating the effect of the dikes on the flood crest elevation.

(3) Allowances for settling of the dikes.

(4) Erosion due to rain, wind and use as a path by animals.

(5) Unfavorable orientations resulting in an increased fetch.

Recommended Dike Elevations

Table 1 lists the estimated river and marigot flood crest elevations for the various perimeters, both Phase I and Phase II. The elevations have been adjusted for the revised 10% (1 in 10) flood frequency. The adjustment for the impact of the dikes on the flood crest has not been added to the table values.

Table 2 lists the estimated river and marigot flood crests for the Phase I perimeters for which dikes are planned. The elevations are again for the revised 10% frequency flood and include an adjustment for the impact of dikes on the flood crest. Where the dikes for a perimeter are sufficiently far apart, specific elevations are noted for each dike location.

Also listed on Table 2 are the recommended top of dike elevations which include allowances for freeboard. Where appropriate, different elevations are specified for the dikes of a perimeter; whether on the river side, marigot side, the upstream (east) end or the downstream (west) end. Also listed in Table 2 for comparison are the original dike elevations used by SAED. The differences between the elevations recommended in this report and the SAED estimates vary from about the same for the

Golmi perimeter to an increase of 1.5 meters for the Balou perimeter.

In setting the top of the upstream dike elevations for Balou and Yafera, where the dikes would completely block-off the marigots, the river flood crest elevation was used as a base instead of the marigot flood crest. With the marigots blocked-off, the reduced flood plain in front of the upstream dike should fill relatively fast. The marigot dike freeboard of 0.7. was still used however.

There would be a transition zone where the higher elevation dike along the river would grade to the lower elevation across the marigot.

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WATER REQUIREMENTS AND AVAILABILITY

Double cropping is planned for the Bakel perimeters with the second irrigated crop to be grown during the dry season. In drought years, the Senegal River goes dry toward the end of the dry season. The following analysis was made to determine the frequency that a water supply would be available from the Senegal River for a second irrigated crop. The study assumed different development level's of 1000, 2000, or 3000 ha.

Cropping Pattern

The feasibility of the project has been tested assuming the following cropping pattern for the perimeters 1/:

Season	Crop	% in Crop
June-September	rice (paddy)	100
December & January	cowpeas (niebe)	10
January-April	maize	50
January-April	sorghum	50

Although, about 60% of the soils on the perimeters are of the lighter "fonde" type soils, the villagers are mainly interested in growing rice. Therefore the economic analysis and the water requirements were computed assuming that all the perimeters would be planted to rice during the rainy season, June through September. Considering the additional water required to grow rice on the lighter soils, future economic conditions might cause a change in the cropping pattern on these soils.

1/ Economic Evaluation of Bakel Irrigation Project, Senegal - C.J.Miller, July 1976.

The perimeter soils consist of the following types 1/:

Soil Type	% of the Area	% Clay Content
Fonde	60	30-44
Faux Hollaldes	30	45-50
Hollaldes	10	51-60

Water Requirements

The basic water requirement estimates for the crops to be grown on the perimeters were taken from an earlier study by SOGREAH 2/ for the Matam perimeter. The following tabulation lists the monthly farm requirement values in m^3/ha for the different crops without consideration of effective rainfall. The values were computed using the base monthly evapo-transpiration values and crop coefficients listed in the SOGREAH report. The growing season however was adjusted to fit that assumed for the Bakel perimeters.

Crop	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rice						2310	4750	3515	1510				12085
Cowpeas	1402											542	1944
Maize	797	1809	3496	3462									9564
Sorghum	809	2095	3004	2280									8188

The values include allowances for pre-irrigation, deep percolation, and drainage (for rice). The irrigation efficiency is approximately 65%, except for rice on the "faux hollaldes" and "fonde" soils.

The requirement for rice grown on the "faux hollaldes" soils was estimated at about 10 greater than for the "hollaldes" soils because of

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1/ Data from USAID Project Planning Team Report

2/ Etude Hydro-Agricole du Bassin du Fleuve Sénégal - Schéma de Principe détaillé - Casier Pilote de Matam, SOGREAH - Grenoble, France. December 1972

of greater loss to percolation. The rice water requirement for the "fonde" soils was assumed as 20% greater than for the "hollaldes" soils.

As was assumed in the SOGREAH report, 50 percent of the average monthly rainfall was assumed effective in meeting the farm requirement for rice.

The following tabulation lists the farm delivery demand in m^3/ha for an average hectare on the perimeter (after consideration of effective rainfall).

Crop	%	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rice Hollaldes	10						192	396	234	75				897
F. Holl.	30						645	1331	806	270				3,052
Fonde	60						1429	2946	1823	631				6,829
Cowpeas	10	140											54	194
Maize	50	398	905	1748	1731									4,782
Sorghum	50	405	1047	1502	1140									4,094
Total		943	1952	3250	2871		2266	4673	2863	976			54	19,848

The total annual farm delivery demand is about 2.0 m with 1.1 m required for the rice crop during the rainy season.

The following tabulation lists the required water to be pumped from the river in m^3/s during the dry season for assumed developments of 1000, 2000 and 3000 ha.

m^3/s

Perimeter Size - ha	Month				
	D	J	F	M	A
1,000	.02	.35	.81	1.21	1.11
2,000	.04	.70	1.62	2.42	2.22
3,000	.06	1.05	2.43	3.63	4.44

River Flow Availability

The following tabulation lists the frequency of the low flows in m^3/s for the Senegal River at Bakel. The flows are monthy averages for March and April, as computed for the period of record of 1903 to 1974.

Frequency %	March	April
1	11	3
10	26	9
20	32	12
50	43	17

Shortage Frequency

The last irrigation on the perimeters would usually be completed before the middle of April. For a 3000 ha. development the average rate of water to be pumped from the river is 3.63 m^3/s in March and 4.44 m^3/s in April. Comparing the water requirement with the available river flow, indicates that the only probable shortage would occur in April. The shortage would occur about 3 years out of 100 years. This analysis assumes that there would be no new depletions upstream of the project and that the Bakel projects would have a "senior" right over downstream users.

SURFACE DRAINAGE

The diked perimeters will be entirely enclosed. When the river is in flood, there will not be any outlet for surface drainage water unless it is pumped over the dikes. The following analysis was made to determine the amount and frequency of drainage water which would have to be pumped.

Rainfall Frequencies

The requirement for drainage is determined by the amount of rainfall which is in excess of the rate lost to evapo-transpiration and deep percolation.

The following tabulation lists the amount of rainfall which occurs at Bakel in 1, 2, 3 and 10 day periods at different frequencies.

Frequency %	1 day	2 days	3 days	10 days
1	170	173	175	
10	108	113	120	216
20	83	94	100	
50	60	65	73	

The frequencies for the 1 to 3 day periods were based on the daily rainfall records at Bakel for the period 1918 through 1972. The frequency for the 10 day period was extrapolated in proportion to similar, 1, 3 and 10 days values for Matam.

The runoff coefficient of 0.6 was assumed for the perimeters, based on a similar study made for the Matam Perimeter by SOGREAH 1/ The coefficient

1/ Etude Hydro-Agricole du Bassin du Fleuve Sénégal - Schéma de Principe détaillé - Casier Pilote de Matam, SOGREAH - Grenoble, France, December 1972.

allows for evaporation from the soil, rainfall intercepted by the plants and deep percolation through the soil.

Drainage Within Perimeters

The criteria for the rate for draining the perimeters was again taken from the SOGREAH [1/] study for the Matam perimeter, with some modifications, and consisted of the following:

(1) all the excess rainfall occuring within 10 days would have to be evacuated in 10 days,

(2) the rice crop could tolerate an additional 15 cm of flooding for the lo days,

(3) additional flooding of the rice, above 15 cm, can only be allowed for three days,

(4) it was assumed that maximum 3 day rainfall occured at the start of the 10 day period (Designed for 10% frequency).

The "hollaldes" soils are the heavier low lying lands which make up about 10 percent of the perimeters. The probable worst assumption would be that all the excess rainfall would accumulate to this 10 percent of the area. A 120 mm rainfall for the 3 day maximum period, with a runoff coefficient of 60 percent, would concentrate the water to a depth of 0.72 meters on 10 percent of the area. The water would have to be pumped out at a rate of .022 m^3/s per ha. in order to evacuate all but .15 meters of the standing water within 3 days. If the percent of the area in which the drainage water is concentrated were larger, smaller capacity pumps would suffice. A detailed topography map of each diked perimeter would be

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1/ Etude Hydro-Agricole du Bassin du Fleuve Sénégal - Schéma de Principe détaillé - Casier Pilote de Matam, SOGREAH - Grenoble, France,

necessary to determine the actual area of concentration.

To evacuate all the excess rainfall in the 10 day period (216 mm @ .60 coefficient) would require a drainage capability of 0.015 m^3/s per ha. Therefore, the drainage capability should be between 0.015 - 0.022 m^3/s depending on the perimeter topography.

Tributary Drainage (Interceptor Drains)

The perimeters of Balou and Yafera will have dikes extending from the river bank across the marigots to the edge of the river flood plain. Local drainage from small areas tributary to the river flood plain would flow into the perimeters if not diverted. The tributary drainage area to Balou is about 6 km^2 and to Yafera about 8.4 km^2.

It is proposed to construct an intercepting dike and drain channel between the tributary drainage area and the perimeter to divert the runoff around the perimeter. To reduce (by one-half) the size of the diverting dike and channel, each perimeter would have 2 channels starting from the same point, one diverting upstream around the perimeter and the other downstream.

The capacity of the diverting channels was estimated for a daily rainfall of 10% frequency. The 108 mm of rain was assumed to occur in 6 hours. A runoff coefficient of .6 was used. The general slope of the tributary basins is about 10 m in 2 km. Assuming a triangular runoff curve of 12 hours duration, the peak flow rates for Balou and Yafera would be about 4.5 m^3/s and 6.3 m^3/s respectively. The above estimates are for one-half of each of the tributary drainage areas.

The Mouderi-Diarawa perimeter, which is planned for Phase II and is not a part of this study, would have a tributary drainage of about 55 km^2. This perimeter will require a detailed study for an economical solution to its tributary drainage problem.

TABLE 1

FLOOD CREST ELEVATIONS
(10% Frequency)

Station or Perimeter	River Distance Km	Maximum Crest Elevations		
		River[1/] Revised	Marigot	
			Recomm.	SAED
Ouaounde (station)	715	19.5	-	-
Mouderi-Diawara				
West	763	22.1	21.8	22.00
East	773	22.4	22.1	22.10
Tuabo II - East	783	22.9	22.6	-
Bakel (Station)	794	23.6	-	-
Koungani				
West	800	23.9	23.5	23.23
East	802	24.0	23.6	23.23
Golmi				
West	807	24.3	23.9	24.56
East	808	24.4	24.0	24.56
Yafera				
West	813	24.6	24.2	24.45
East	817	24.9	24.5	24.45
Balou (Faleme)				
West	1.5	25.4	25.0	24.76
East	3.5	25.6	25.1	24.76
Kidira (Faleme)	50	30.5	-	-
Kayes	923	31.5	-	-

Note: 1/ Does not include impact of proposed dikes on maximum flood crest.

TABLE 2

RECOMMENDED DIKE ELEVATIONS
(Phase I Perimeters)

Perimeter	River Distance Km	Max. Flood Elev.		Dike Elevations	
		River 1/	Marigot 1/	SAED	Recomm.
Tuabo II					
Marigot			22.8	-	23.5
River		23.1		-	24.0
East	783		22.8	-	23.5
Koungani					
West	800		23.7	23.73	24.4
Marigot			23.7	23.73	24.4
River		24.2		23.73	25.1
East	802		23.8	23.73	24.5
Golmi					
West	807		24.1	25.06	25.1
Marigot			24.1	25.06	25.1
River		24.6		25.06	25.5
East	808		24.2	25.06	25.1
Yafara					
West	813		24.4	24.95	25.1
River		24.8-25.1		24.95	25.7-26.0
East	817		25.0	24.95	25.7
Balou (Faleme)					
West	1.5		25.3	25.26	26.0
River		25.9		25.26	26.8
East	3.5		25.9	25.26	26.6

Note: 1/ Flood elevations include adjustments for effect of dikes on flood crest.

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Figure 1.A

PERIMETRE DE BAKEL

Echelle : 1 / 200.000

B.E.P 44813 _ FEUILLE B

Petit périmètre

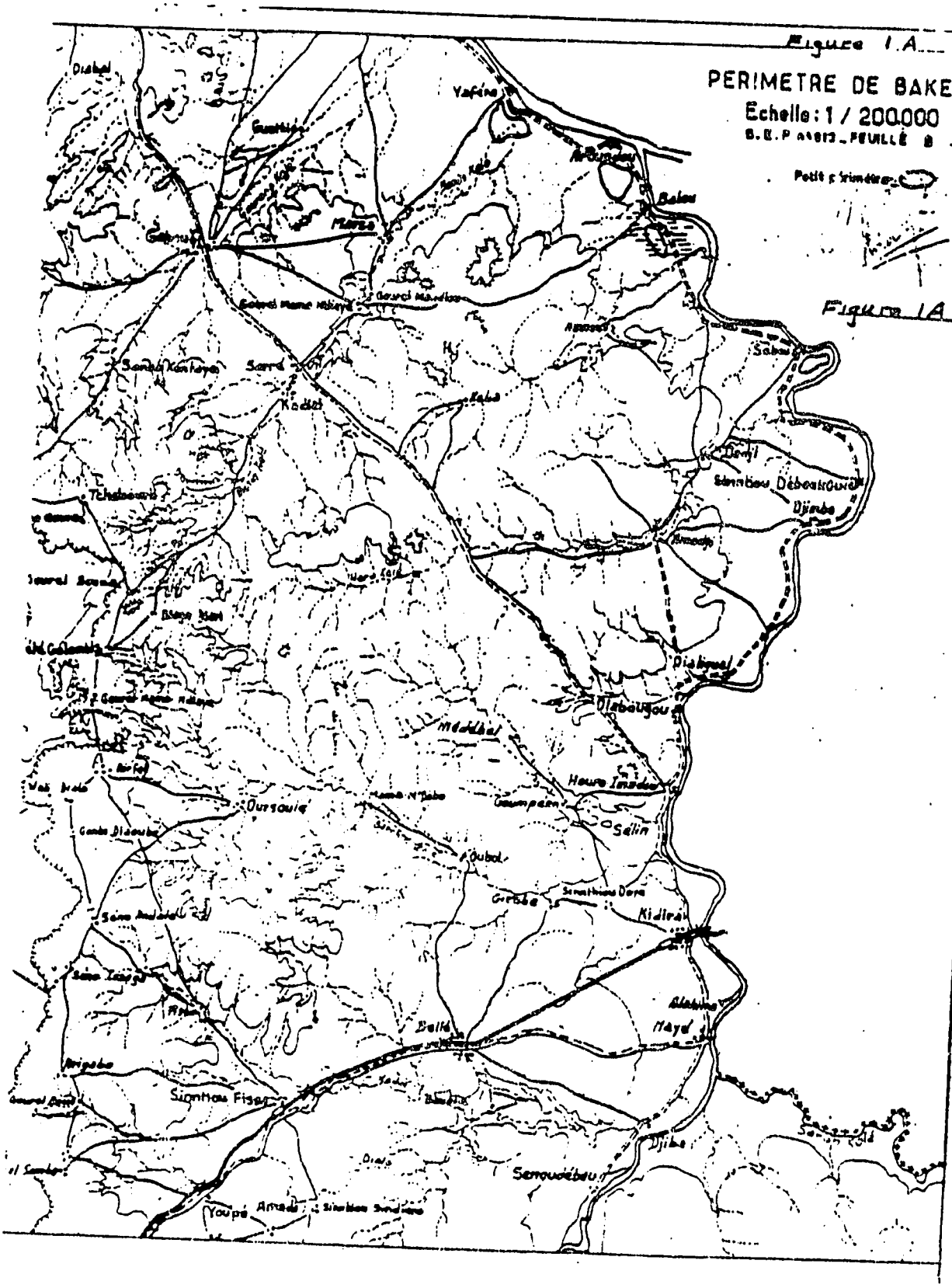
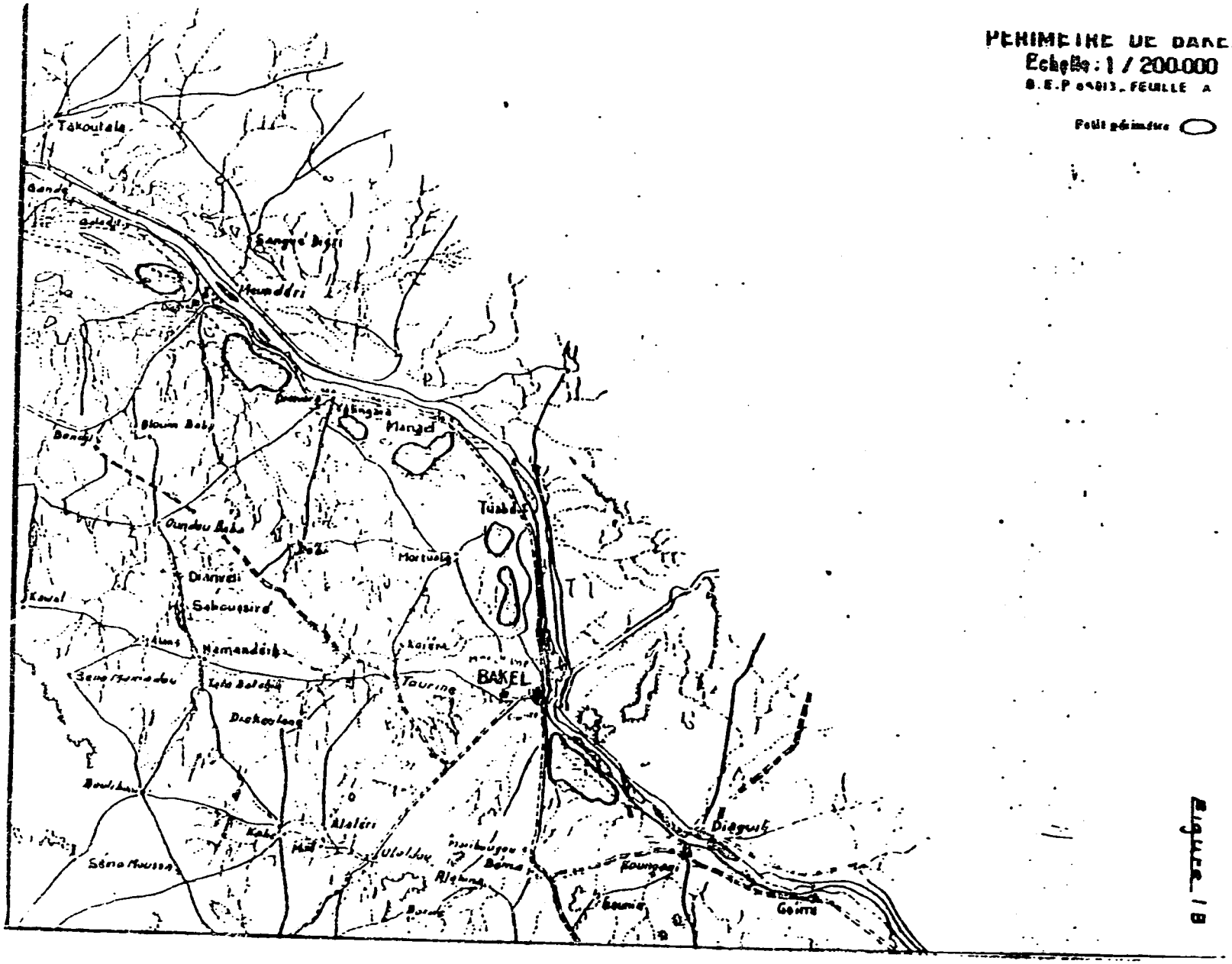


Figure 1A



PERIMETRE DE BAKEL
Echelle : 1 / 200.000
B.E.P 64013 - FEUILLE A

Feuil périmètre

Figure 18

NO. 3127 ARITHMETIC PROBABILITY. DESIGNED BY HAZEN, WHIPPLE & FULLER. CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

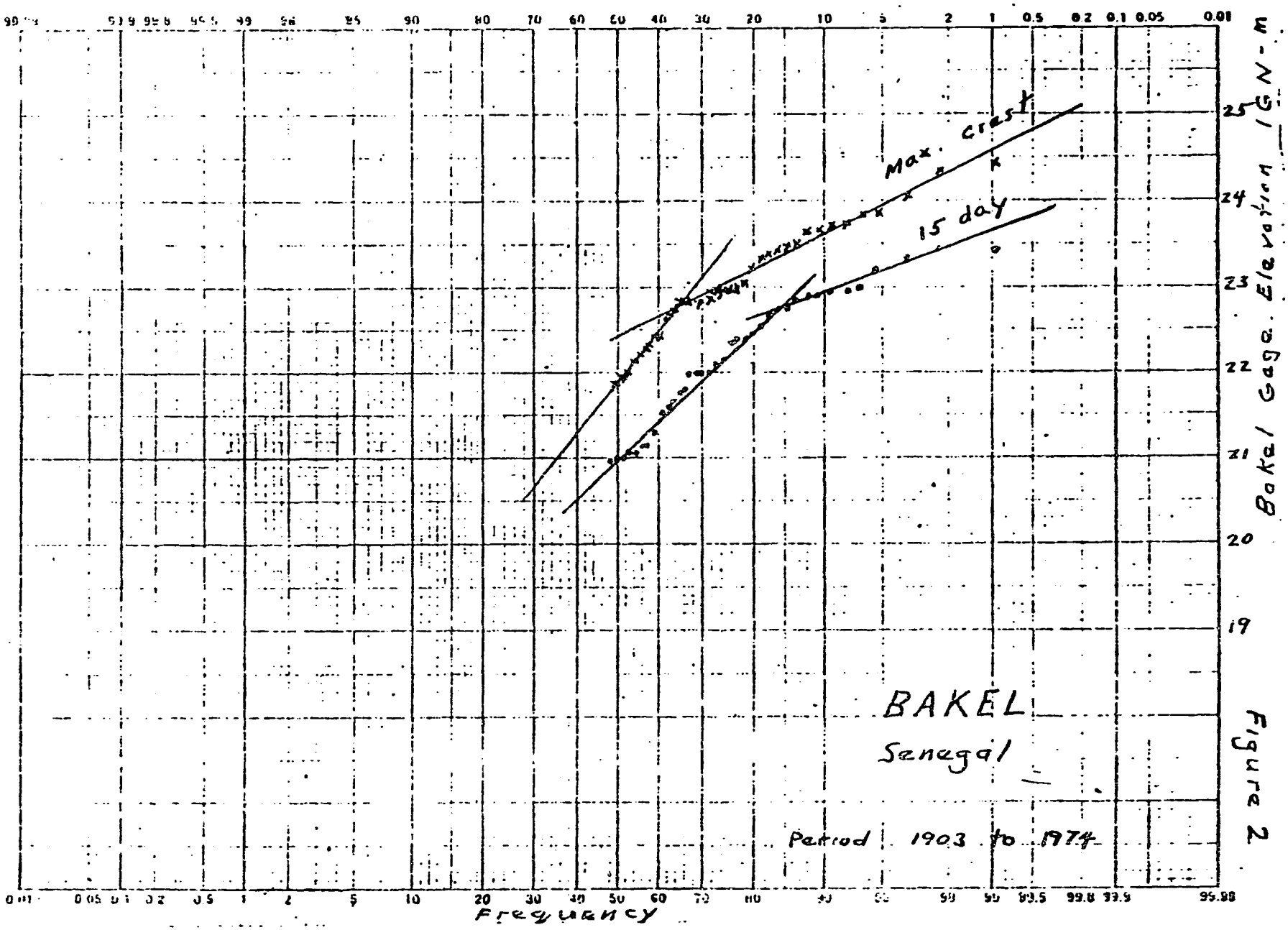


Figure 2

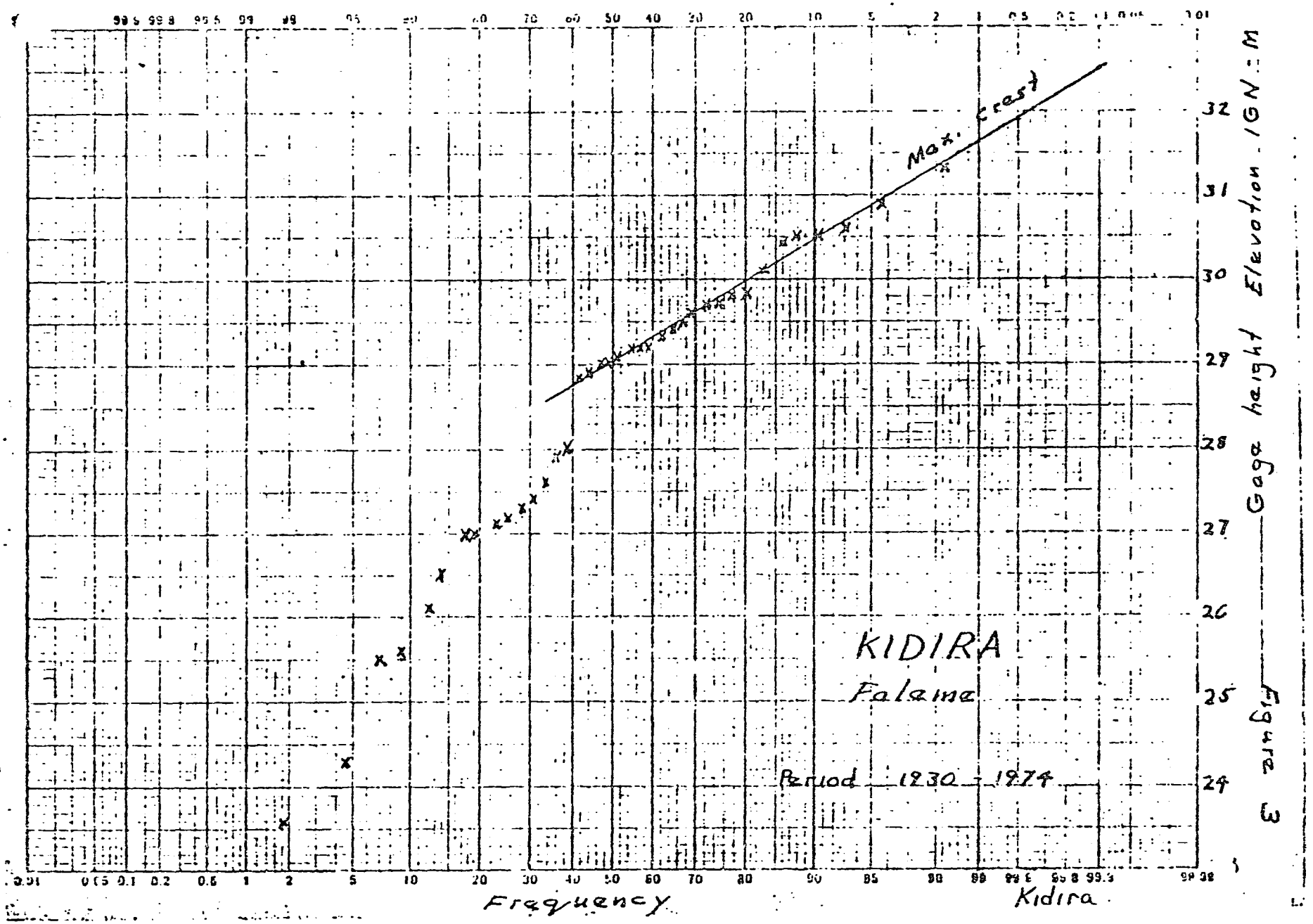


Figure 3

Best Available Document

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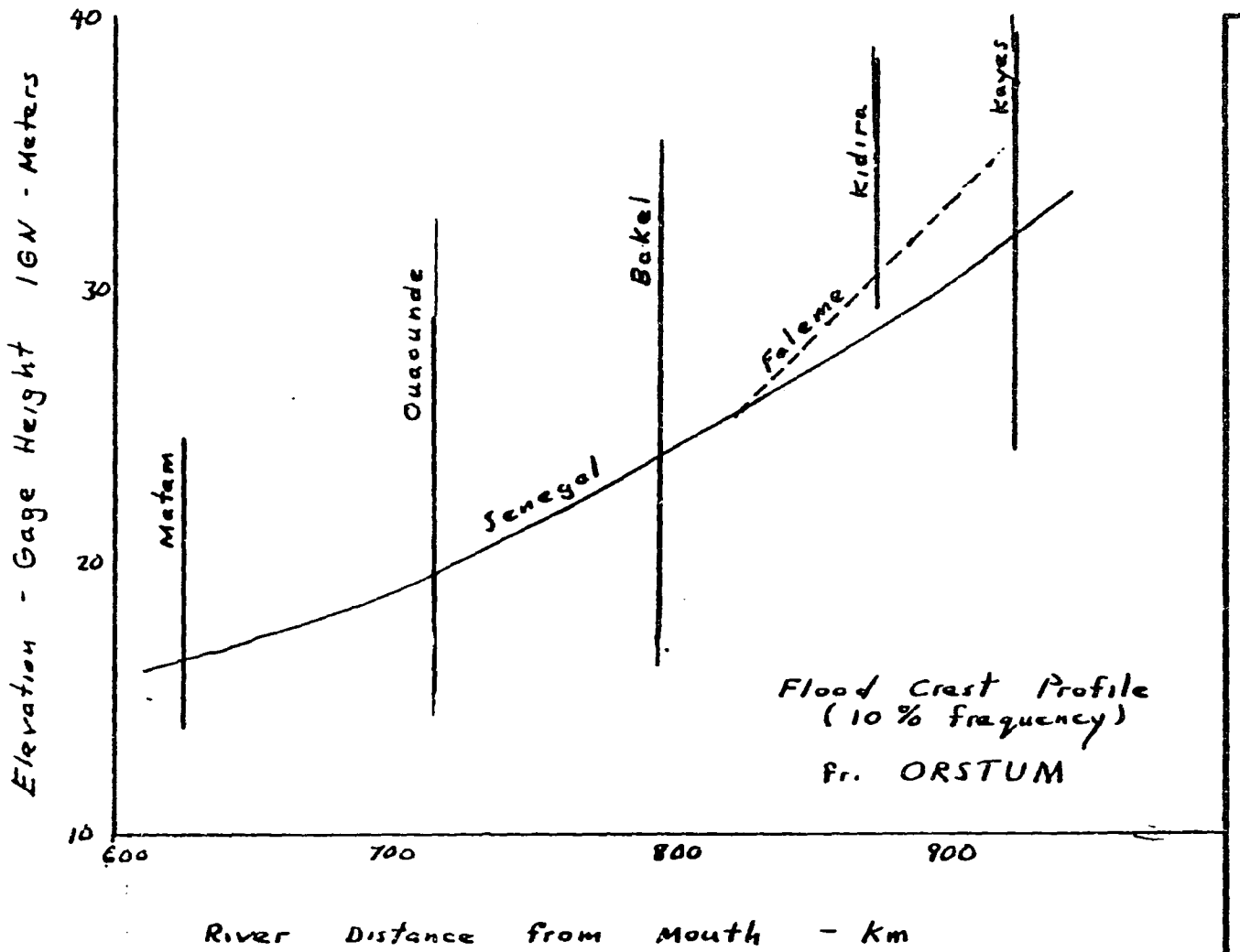


COMPUTATION SHEET

BY | DATE | PROJECT | SHEET ___ OF ___

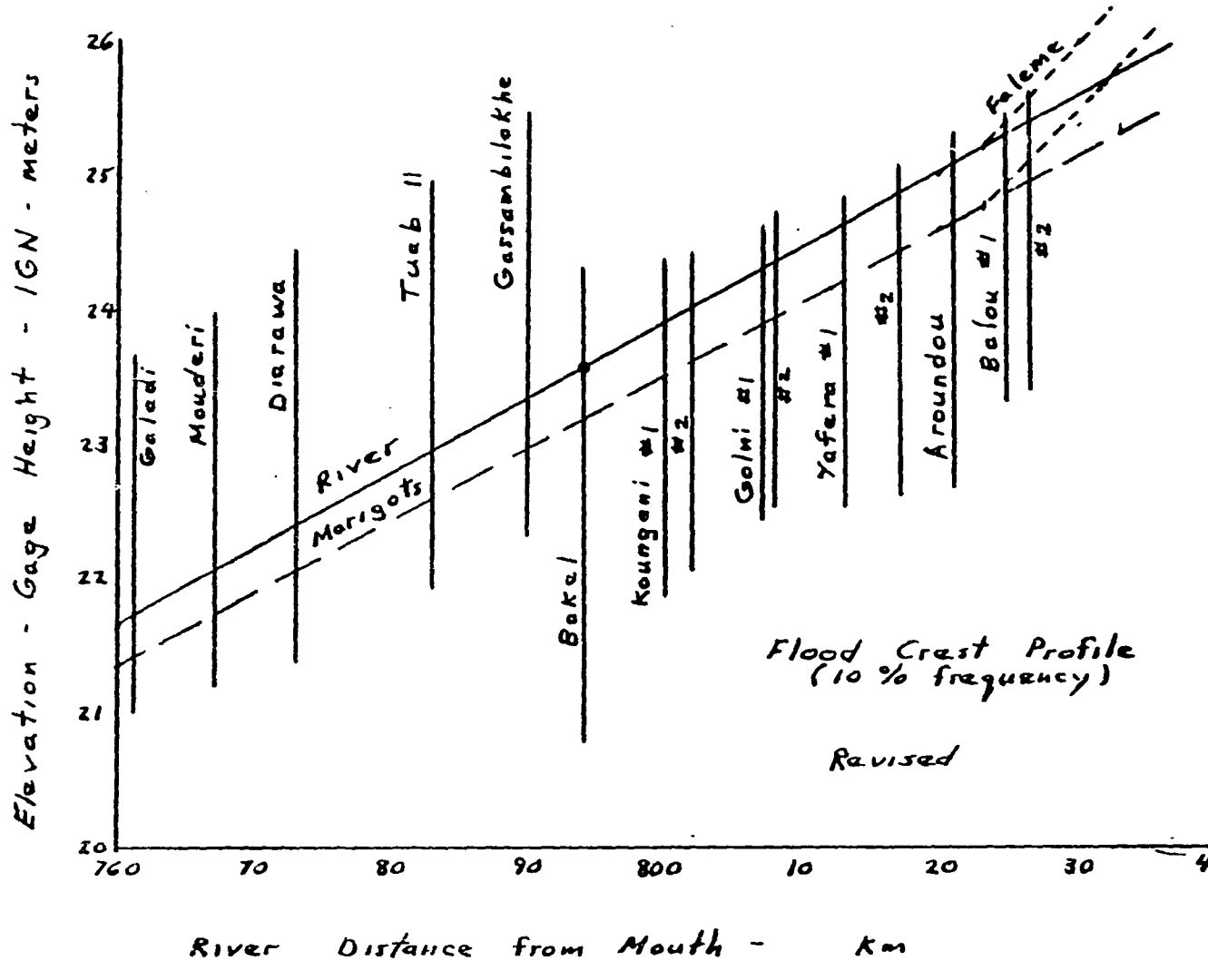
CHKD BY | DATE | FEATURE

DETAILS

Figure 4

7-1884 (7-73)
Bureau of Reclamation

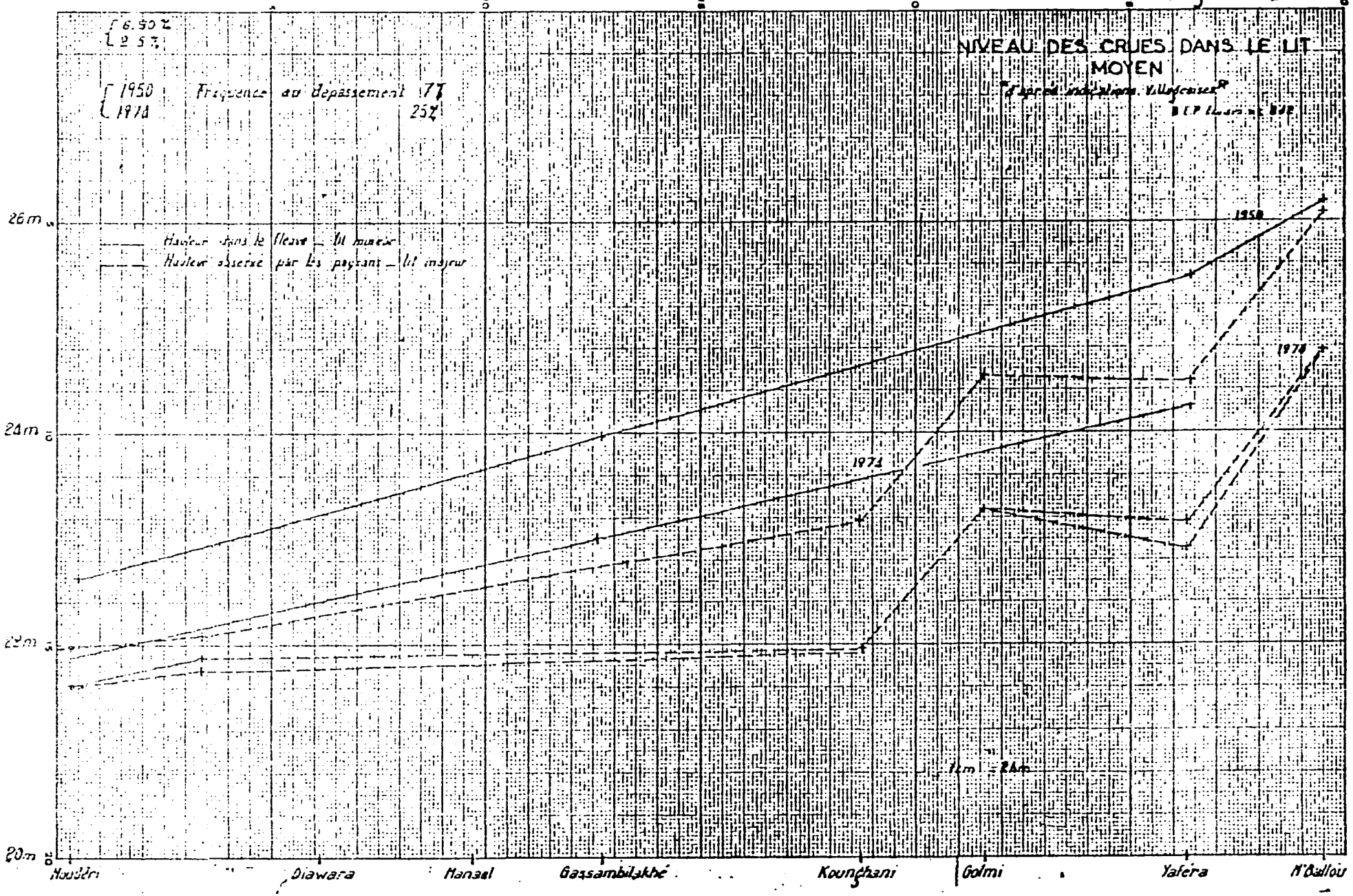
U.S. Government Printing Office: 1973-516-215/1141 Region 1



COMPUTATION SHEET

BY	DATE	PROJECT	SHEET ___ OF ___
CHKD BY	DATE	FEATURE	Figure 5
DETAILS			

Figure


NIVEAU DES CRUES DANS LE LIT MOYEN
6.50 %
≥ 5 %
1950
1974
Fréquence au dépassement 17 %
25 %
Hauteur dans le fleuve – lit mineur
Hauteur atteinte par les paysans – lit majeur
1950
1974
1974
1km = 24m
26m
24m
22m
20m
Houdéri
Diawara
Manaal
Gassambilakhé
Kounchani
Gomi
Yafera
N'Ballou

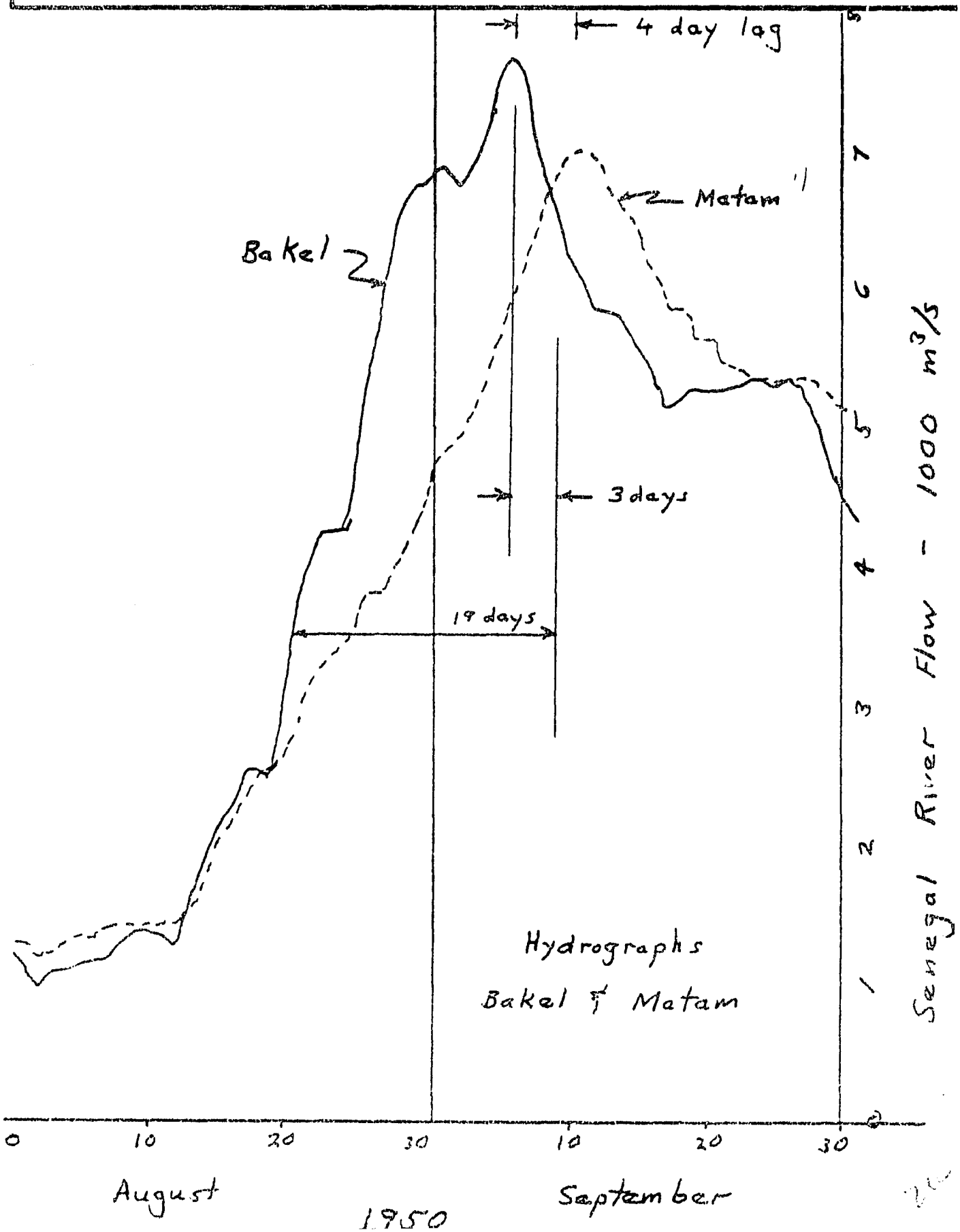
7-1054 (7-73)
Bureau of Reclamation

COMPUTATION SHEET

*U.S. Government Printing Office: 1973-784-219/1142 Region

BY	DATE	PROJECT	SHEET ____ OF ____
CHKD BY	DATE	FEATURE	
DETAILS			

Figure 7



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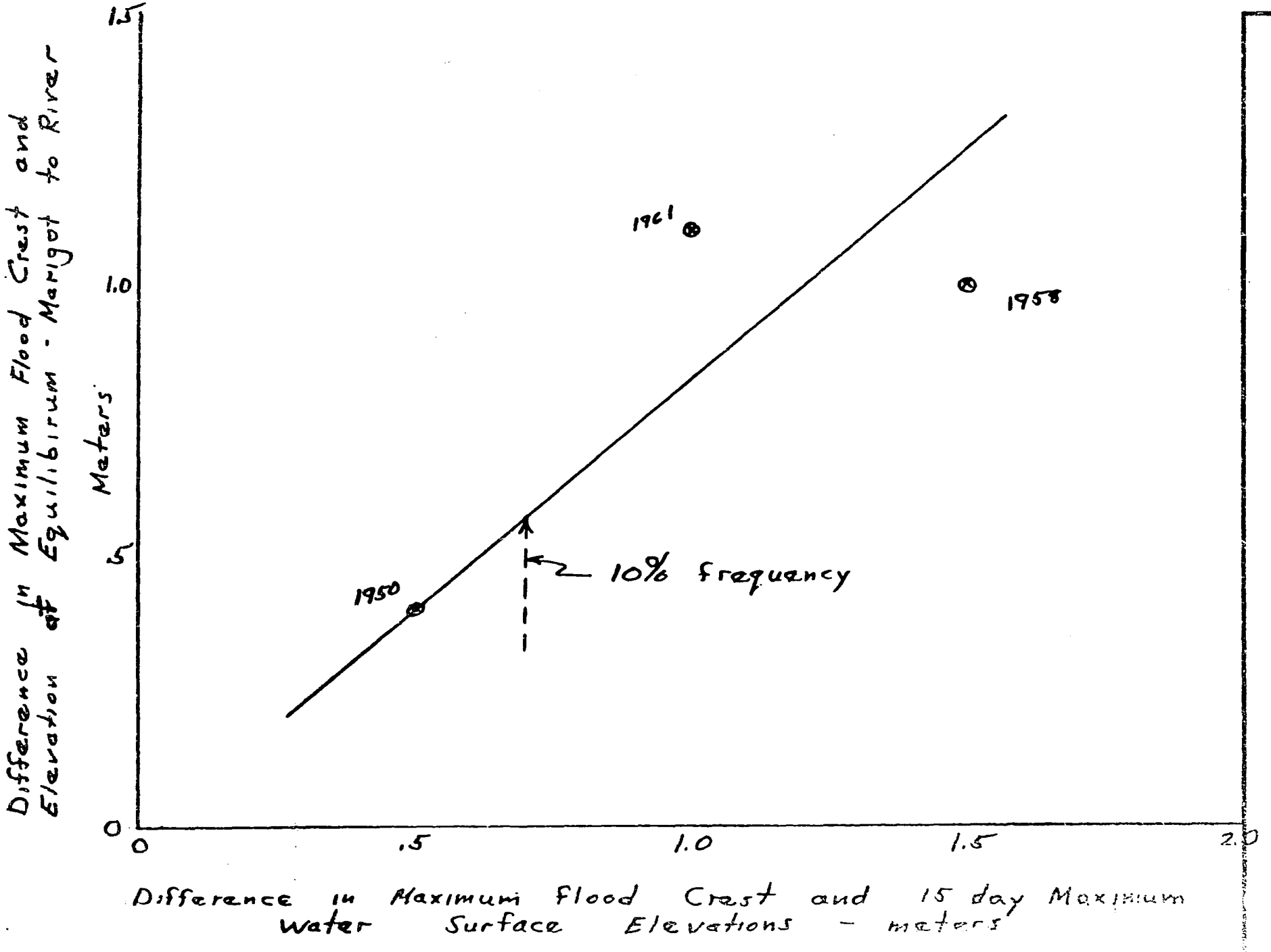

BY	DATE	PROJECT	SHEET ___ OF ___
CHKD BY	DATE	FEATURE	
DETAILS			

Figure 9

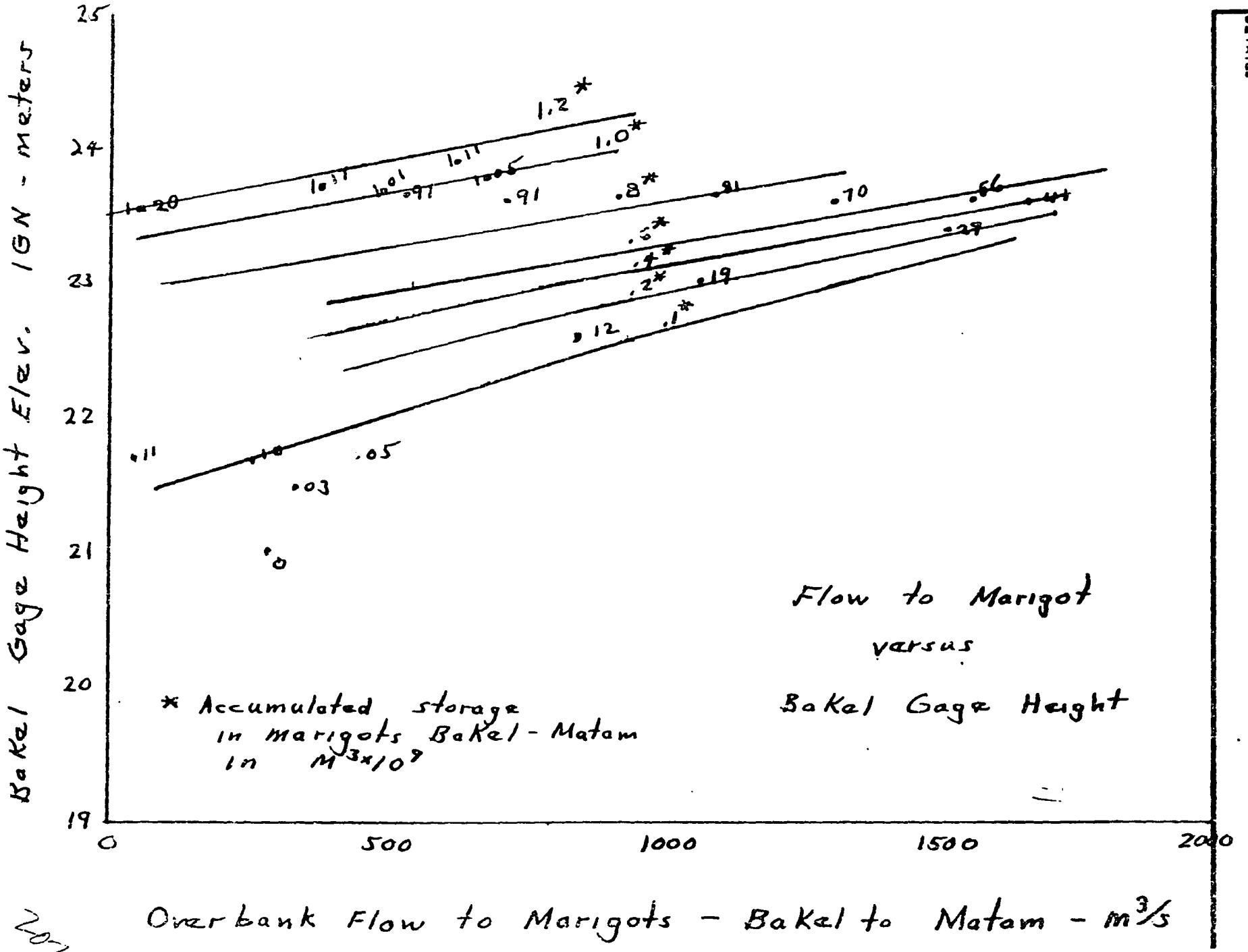

Figure 8

BY	DATE	PROJECT	SHEET ___ OF ___
CHKD BY	DATE	FEATURE	
DETAILS			

U.S. Government Printing Office: 1973-784-219/1142 Region 4

TABLE A-1

ANNEX J

POPULATION AND PRESENT CROP HECTARES AND PROSPECTIVE IRRIGATED HECTARES BY VILLAGE (BAKEL)

VILLAGE	NO. PEOPLE (1976) TOTAL	NO. PEOPLE (1976) ACTIVE (ADULT)	1975-76 HECTARES OF TRADITIONAL CROPS PLANTED RAINED	1975-76 HECTARES OF TRADITIONAL CROPS PLANTED FLOOD RECESSION/
BALLOU	1835	1001	375	188
AROUNDO	951	585	219	110
YAFERA	996	563	212	106
GOLMY	1617	1116 x	418	209
KONGHANI	1095	873	327	164
BAKEL	5500	4485 x	1682	841
TURBOU	1067	722	271	135
MANAEL	970	642	241	120
YELINGARA	538	385	144	68
DIAWARA	2865	1958	734	367
GOUDERY	2104	1731	650	325
FAIADE	574	387	146	73
GANDE	445	301	112	56
SEBOU	340	197	74	37
DJIMBE	362 x	250 x	94	46
DIALIGUEL	275 x	190 x	71	36
DURO AMADOU	281 x	194 x	73	36
GELLINY	258 x	178 x	67	33
DEMBAKANE%	3000	2070 x	776	388
DOKOLADJI	2000	1380 x	518	259
GOBALI	957 x	660 x	248	124
GOUREL DARA	590 x	410 x	151	75
WAOUNDE	3000 x	2277 x	854	427
TOTAL	31917	22555	8457	4223

x Estimated

xx Estimating procedures: for each active adult, allow 0,369 Ha. rained and 0,184 Ha. decrue cropland.

SOURCES: Repertoire des Villages,
Direction de la Statistique, Dakar 1972
C.I.D.R/SENEGAL, No. 10, Sept. 1974
C.I.D.R/BAKEL TEAM, and Prefet du Département de Bakel

J 2

TABLE A-1 (CON't)

HECTARES PREPARED FOR IRRIGATED RICE AND OTHER CROPS

TOTAL	1976-77	1977-78	1978-79	1979-80	1980-81	TOTAL
563	34	16	30	30	40	150
329	5	10	15	15	15	60
318	9	7	24	30	30	100
627	5	5	20	--	--	30
491	14	16	25	35	30	120
2523	30	46	90	70	80	316
406	8	12	10	20	--	50
361	5	10	15	20	20	70
212	7	8	15	20	10	60
1101	18	12	30	40	50	150
975	8	12	20	30	30	100
219	---	15	15	20	10	60
168	8	12	20	20	20	80
111	--	5	10	15	10	40
140	--	8	7	15	10	40
107	--	8	12	10	20	50
109	--	5	10	15	10	40
100	--	5	10	15	10	40
1164	--	10	20	30	40	100
777	--	55	10	15	10	40
372	--	5	10	15	10	40
226	--	5	10	15	10	40
1281	--	10	30	40	40	120
12680	151	247	458	535	505	1896

TABLE A - 2

PRESENT[*] AND PROJECTED HECTARES CROP PRODUCTION (BAKEL AREA)

	RAINFED	FLOOD RECESSION	TOTAL	IRRIGATED LAND[◆] 1976/77	77/78	78/79	79/80	80/81
SORGHUM	2579	2445	5024	75	199	428	695	948
MAIZE	2994	1778	4772	76	199	428	696	948
MILLET[*] (SOUNA)	677	-	677					
RICE (SWAMP)	338	-	388	151	398	856	1391	1896
PEANUTS[*]	1869	-	1869					
NIEBE	-	-	-	16	40	86	139	190
	8457	4223	12680	318	836	1798	2921	3982

[*] Will not be grown on irrigated land.
[*] Préfet du Département de Bakel.
[◆] Estimates of C.I.D.R./Bakel team.

TABLE A - 3

PERSON-DAYS OF LABOR PER HECTARE BY CROP

(BAKEL)

	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	ANNUAL TOTAL
DIERI AND FONDE:													
SORGHUM AND SOUNA	6	5	12	12	72	10	14						131
MAIZE	6	5	12	12	-	12	-						47
WALO													
SORGHUM					6	5	12	12	24	48	12	14	133
MAIZE					6	5	12	12	12				47
PEANUTS		6	7	12	12	12	16	18	-				83
SWAMP RICE		12	18	18	18	48	49	17	-				180
IRRIGATED CROPS:													
RICE	2	7	30	30	17	53	84	15	1				239
MAIZE									6	15	15	11	47
SORGHUM	15								4	15	87	10	131
NIEBE								17	21				38

*Use of oxen or other draft animals used to assist in plowing, levelling, seeding, and transportation of harvested crop from the field to storage, primarily on the irrigated cropland. Labor estimates made by C.I.D.R./Bakel team.

TABLE A - 4

TOTAL TRADITIONAL NON IRRIGATED CROP LABOR REQUIREMENTS: PERSON-DAYS BY CROP AND MONTH

(BAKEL)

	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
DIERI AND FONDE**												
SORGHUM AND SOUNA	19,536	16,280	39,072	39,072	234,432	32,560	45,584					
MAIZE	17,964	14,970	35,928	35,928	-	35,928						
WALO *												
SORGHUM					14,670	12,225	29,340	29,340	58,680	117,360	29,340	34,[illegible] 220
MAIZE					10,668	8,890	21,336	21,336	21,336			
SWAMP RICE		4,056	6,084	6,084	6,084	16,224	16,562	5,746				
PEANUTS		11,214	13,083	22,428	22,428	22,428	29,904	3,642				
TOTALS	37,500	46,520	94,167	103,512	288,282	128,255	142,726	90,064	80,016	117,360	29,340	34,[illegible] 220
MAXIMUM SUPPLY *	554,650	554,650	554,650	554,650	554,650	554,650	554,650	554,650	554,650	554,650	554,650	554,[illegible] 650
NET LABOR AVAILABLE FOR IRRIGATED AND NON-CROP ACTIVITIES	517,150	508,130	460,483	451,138	266,368	426,395	411,924	464,586	474,634	437,290	525,310	520,[illegible] 430

* assuming 300 days of labor per year per adult.

** see other sections of this P.P. for explanations of these terms.

TABLE A - 5

CROP YIELDS* PER HECTARE, BAKEL AREA (KG)

	TRADITIONAL CROPPING		IMPROVED CROPPING	
	HIVERNAGE(⊕)	DECRUE(⊕⊕)	FERTILIZED	FERTILIZED & IRRIGATED
SORGHUM	800	530	2000	2500
SOUNA	600	-	2000	3000
MAIZE	750	600	1500	3000
RICE	1125	-	2500	4000
PEANUTS	900	-	2500	-
COWPEANS(***) (NIEBE)			1000	1500

* Adjusted for 15% loss to birds and rodents before harvest. Estimates made by V. Lateef, team member.

(***) Not now grown locally.

(⊕) Rainy season.

(⊕⊕) Flood recession period.

TABLE A - 6

TRADITIONAL CROP PRODUCTION, BAKEL AREA
(M. TONS)

	HIVERNAGE	DECRUE	TOTAL NORMAL	TOTAL ADJUSTED FOR FLOOD LOSS*
SORGHUM	2063	1296	3359	2687
SOUNA	406		406	325
MAIZE	2246	1067	3313	2650
RICE (SWAMP)	380	-	380	304
PEANUTS⊛	1682	-	1682	1346

*Average animal yields adjusted downward by 20% to allow for estimated complete crop loss due to flood or drought damage one year out of 5.

⊛It appears that most of the peanut production is exported as a cash crop from the Bakel area.

TABLE A-7

NORMAL° PROJECTED CROP YIELDS (MT/HA) ON IRRIGATED LAND

YEAR	RICE	MAIZE	SORGHUM	NIEBE
1	2.5	1.5	1.0	0.5
2	2.7	1.7	1.2	0.7
3	2.9	1.9	1.4	0.9
4	3.1	2.1	1.6	1.0
5	3.3	2.3	1.8	1.1
6	3.5	2.5	2.0	1.2
7	3.7	2.7	2.2	1.3
8	4.0	3.0	2.5	1.5
9	4.0	3.0	2.5	1.5
10	4.0	3.0	2.5	1.5
11	4.0	3.0	2.5	1.5
12	4.0	3.0	2.5	1.5
13	4.0	3.0	2.5	1.5
14	4.0	3.0	2.5	1.5

° Before adjustment for flood damage. Estimates made by the team.

J 9

TABLE A-8

TRADITIONAL CEREAL PRODUCTION AND CONSUMPTION

(BAKEL AREA)

	M. TONS PRODUCER (°)	(000000) CALORIES °°	CALORIES/PERSON + PER DAY
SORGHUM/MILLET	3012	10000	858
MAIZE	2650	9514	817
RICE (SWAMP)°	198°	719	23
RICE (IMPORTED, MILLED)	500°	1815	156
WHEAT FLOUR ++	300	999	86
TOTAL	6660	23,766	1940 ²²

(°) Adjusted for flood loss

° Milled equivalent = 65% yield from paddy.

°° Calorie equivalents per 100 grams: Maize = 359; Sorghum/Millet = 332; Milled rice = 363; Wheat flour = 333.

\+ Total population of 31,386.

²² Range of cereal needs (75% of 2000 - 2500 calories per day) = 1500 - 1875 calories per person per day. Estimate by nutritionists.

++ Local merchant estimates.

Table A-9

FARM BUDGET

Cost of Production Per Hectare of Irrigated Land-
Bakel - Double Cropping

(8th year of Project)

	CFA
Field Labor on Crops: 152 person-days (a) 75 CFA 132 person-days (a) 25 CFA)	= 16,100
Earthworks: repair and maintenance	= 150
1 Yoke oxen for 20 days (a) 100 CFA	= 2,000
Fertilizer, mixed	= 54,640
Seed : Rice = 4650/Ha Cowpeas= 1200/Ha Maize = 850/Ha Sorghum = 340/Ha (Adjusted for rotation)	= 5,240
Amortize tools/Machinery	= 150
New Household storage	= 30
Pumping costs (fuel, repairs/maintenance)	= 22,640
TOTAL	=100,950

Normal Production (adjusted) and value of crops

	Prod. (Kg)	Adj. Prod.	Price (official)	Value (CFA)
Rice	4000	3200		208,000
Maize	1500	1500	35	52,500
Sorghum	1250	1250	30	37,500
Niébé	150	150	28	4,200
			Total Value	302,200
			Costs	100,950
			Net Value	201,250

Table A - 10

FARM BUDGET N°2

Cost of Production Per Hectare of Irrigated Land-

Bakel - Single Cropping

(8th year of project)

Field labor on crops 111 person-days (a) 75 CFA Field labor on crops 96 person-days (a) 25 CFA	10.725
1 yoke oxen (a) 100 CFA/day	1.000
Fertilizer mixed	30.930
Seed: rice	4.650
Amortize tools/machinery	150
New household storage	30
Pumping costs (fuel, repairs/machinery	9,570
Total	57,055

Normal Production (adjusted) and Value

	Prod (Kg)	Adj.Prod.	Price (CFA)	Value(CFA)
Rice	4,000	3,200	65	208,000
			Total	208,000
			Costs	57,055
			Net Value	150 945

A-10 (a)
Income Stream per ha.
at Constant Prices
Base Case Gross Returns

	rice yield	CFA	yield	maize	Sorg yield	CFA	CP yield	CFA
Yr. 1	2.5	162,500	.7	24,500	.5	15,000	.05	1,400
2	2.7	175,500	.8	38,000	.6	18,000	.07	1,960
3	2.9	188,500	.9	31,500	.7	21,000	.09	2,520
4	3.1	201,500	1.1	38,500	.8	24,000	.1	2,800
5	3.3	214,500	1.2	42,000	.9	27,000	.11	3,080
6	3.5	227,500	1.3	45,500	1.0	30,000	.12	3,360
7	3.7	240,500	1.4	49,000	1.1	33,000	.13	3,640
8	4.0	260,000	1.5	52,500	1.2	36,000	.15	4,200

Variation 1- slower adaptation
of double crop

	rice CFA	maize CFA	sorg CFA	CP CFA	Total CFA
Yr. 1	162,500	-	-	-	162,500
2	175,500	-	15,000	-	190,500
3	188,500	12,000	18,000	-	218,500
4	201,500	16,000	21,000	-	238,000
5	214,500	22,000	24,000	1,500	261,500
6	227,500	27,000	27,000	1,900	283,400
7	240,500	32,000	33,000	2,500	308,000
8	260,000	37,000	36,000	2,800	335,800

Variation 2- 100% increase in fuel
Costs on base case

Base cost	fuel cost increase	new total cost
100,950	22,640	123,590

Farmers Cash Flow Sensitivity Analysis
per hectare

Year	Base Case costs	Base Case return	Base Case net	Single Crop costs	Single Crop return	Single Crop net	Variation 1 * 1) costs	Variation 1 return	Variation 1 net	Base Case Variation 2 * 2) costs	Base Case Variation 2 return	Base Case Variation 2 net
T	100,950	203,400	102,450	57,055	162,500	105,445	57,055	162,500	105,445	123,590	203,400	79,810
2	100,950	223,460	122,510	57,055	175,500	118,445	70,000	190,500	120,500	123,590	223,460	99,970
3	100,950	243,520	142,570	57,055	188,500	131,445	80,000	218,500	138,500	123,590	243,520	119,930
4	100,950	266,800	165,850	57,055	201,500	144,445	83,000	238,500	155,500	123,590	266,800	143,210
5	100,950	286,580	185,630	57,055	214,500	157,445	86,000	261,500	175,500	123,590	286,580	162,990
6	100,950	306,360	205,410	57,055	227,500	170,445	90,000	283,400	193,400	123,590	306,360	182,770
7	100,950	326,140	225,190	57,055	240,500	183,445	93,000	308,000	215,000	123,590	326,140	202,550
8	100,950	352,700	251,750	57,055	260,000	202,945	96,000	335,800	239,800	123,590	352,700	229,110

1. Slower adoption of double cropping
2. Fuel costs increased by 100%

A-12(d)

Farmer Income Streams
per hectare

Acres	Double Crop net income	Double Crop net after pump rep fund	Double Crop net after total crop amort.	Single Crop net income	Single Crop after pump replacement	Single Crop after capital amort	Variation 1 net income	Variation 1 after pump replacement	Variation 1 after capital amort
1	102,950	64,157	(74,700) 60,000	105,445	66,652	(60,725) 50,000	104,445	66,652	(74,700) 60,000
2	122,510	83,717	(74,700) 60,000	118,445	79,652	(60,725) 50,000	120,500	81,707	(74,700) 60,000
3	142,570	103,777	(74,700) 60,000	131,445	92,652	(60,725) 50,000	138,500	99,707	(74,700) 60,000
4	165,850	127,057	(74,700) 60,000	144,445	105,652	(60,725) 50,000	155,500	116,707	(74,700) 60,000
5	185,630	146,837	(74,700) 60,000	157,445	118,652	(60,725) 50,000	175,500	136,707	(74,700) 60,000
6	205,410	166,617	(74,700) 60,000	170,445	131,652	(60,725) 50,000	193,400	154,607	(74,700) 60,000
7	225,190	186,397	(150,614) 135,914	183,445	144,652	(69,314) 58,589	215,000	176,207	(98,014) 83,314
8	251,750	212,957	(227,657) 212,957	202,945	164,652	(174,877) 164,152	239,000	201,007	(215,707) 201,007

(*)
includes labor returns

TABLE A-11 (REV)

Adjusted Crop Production° and Values Ô on Irrigated Perimeters

YEAR	RICE PROD.	RICE VALUE		MAIZE PROD.	MAIZE VALUE	SORGHUM PROD.	SORGHUM VALUE	COWPEAS PROD.	COWPEAS VALUE.	TOTAL CROP VALUE
1	302	22.6		91	3.2	60	1.8	6	0.2	27.8
2	860	64.5		238	8.3	159	4.8	22	0.6	78.2
3	1986	141.1		650	22.8	479	14.4	62	1.7	180.0
4	3450	236.6		1170	41.0	895	26.9	111	3.1	307.6
5	5006	338.0		1744	61.0	1365	41.0	167	4.7	444.7
6	5309	358.1		1896	66.4	1517	45.5	182	5.1	475.1
7	5612	378.1		2048	71.7	1669	50.1	197	5.5	505.4
8	6067	408.0		2275	79.6	1896	56.9	227	6.4	550.9
9	6067	408.3		2275	79.6	1896	56.9	227	6.4	551.2
10	6067	408.7		2275	79.6	1896	56.9	227	6.4	551.6
11	6067	409.0		2275	79.6	1896	56.9	227	6.4	551.9
12	6067	409.3		2275	79.6	1896	56.9	227	6.4	552.2
13	6067	409.6		2275	79.6	1896	56.9	227	6.4	552.5
14	6067	410.0		2275	79.6	1896	56.9	227	6.4	552.9

°Average yields reduced by 20% for case of 1 flood in 5 years
ÔValues in 000,000 CFA. Rice consumed locally valued at 75 CFA per Kg paddy.
Rice shipped out of area valued at 65 CFA per Kg paddy. Official prices: Maize 35, Sorghum 30, Cowpeas 28.

TABLE A - 12 (REV)

Paddy Rice Consumption and Sales From Local Irrigated Production

YEAR	Local Consumption		Sales From Area		Total Value Rice Production (000.000 CFA)
	Metric Tons(*)	Value (*) (000.000 CFA)	Metric Tons	Value (* *) (000.000 CFA)	
1	302	22.6	-	-	22.6
2	860	64.5	-	-	64.5
3	1199	89.9	787	51.2	141.1
4	1232	92.4	2218	144.2	236.6
5	1265	94.9	3741	243.2	338.0
6	1298	97.4	4011	260.7	358.1
7	1331	99.8	4281	278.3	378.1
8	1364	102.3	4703	305.7	408.0
9	1397	104.8	4670	303.6	408.3
10	1430	107.2	4637	301.4	408.7
11	1463	109.7	4604	299.3	409.0
12	1496	112.2	4571	297.1	409.3
13	1529	114.7	4538	295.0	409.6
14	1562	117.2	4505	292.8	410.0

(*) For year 1, a maximum of 1100 MT of rice has been added to the previous production from traditional sources. This added consumption (if available) would bring the per capita per day intake up to 2300, the estimated caloric average for Senegal. Increases in rice consumption thereafter are assumed to reflect population rises

* * Price at 65 CFAF, the paddy equivalent of a retail price of 115 CFAF with 10 CFAF deducted for transport and marketing costs from Bakel to urban markets.

TABLE A-13

Person-Days Per Hectare Needed for Different Farm Operations

By Irrigated Crop — Bakel — Double Cropping

Seasons:	Hivernage		Decrue	
Operations	Rice	Maize	Sorghum	Niebe
Plow, level, harrow, prepare land (using oxen)	2	2	2	2
Ridging land (using oxen)		2		
Seeding crop (using seeder)	1	1	1	1
Fertilize	3			
Irrigate	25	8	8	3
Weed	60	24	24	16
Birdwatching	96	--	72	--
Harvesting	36	9	9	10
Threshing (using pedal thresher)	15	--	14	5
Transport to storage (use oxcart)	1	1	1	1
Total person-days	239	47	131	38

TABLE A-14

Benefits of the Bakel Project with Irrigation and Double Cropping.

	1976	1986
Estimated total population (3% annual increase)	31,920	42,550
Active Adult population	22,560	29,780
Estimated members of irrigation coop.	x	22, 340 xx
Total net benefits for traditional crops (CFA)	117,763,000	157,010,000
Increased net benefits from irrigated crops (CFA)		
Traditional cropland per active adult (HA)	0,56	0,56
Irrigated cropland per active adult (HA)	--	0,06
Traditional cropland: net benefits per person for total population (CFA)	3690	3690
Irrigated cropland: increase in net benefits		16,540
Per cooperative member (CFA)	--	12,41o
Per adult worker (CFA)		
Per person for total population (CFA)		8 690

xSeveral thousand members at present xx 75% of active adults.
63% of gross crop value produced is assumed for worker subsistenc

TABLE A-14

Two Crop Pump Operating Costs (CFA/Ha)

Estimated Water Requirements

1st crop (Hivernage)	= 2500 m3
2nd crop (Decrue)	= 7000 m3
Total for year	= 9500 m3

Costs of Pumping

(for 2500 m3) Fuel + Oil	= 1920 CFA
(for 7000 m3) " "	= 5375
Total " "	7295
Repairs & Maintenance	=15340
Total Operating Costs	=22635 CFA

Table A - 15 (REV)

Summary of Project Costs of 1st Four Years

	76-77	77-78	78-79	79-80
Central Infrastructure	320	14	27	16
Farm Infrastructure	1149	290	363	336
Technical Input	100	160	224	111
Administration	56	56	58	60
Miscellaneous	77	36	44	52
Sub-total	1702	556	716	575
Contengency (15%)	255	83	107	86
Total	1957	639	823	661
Inflation (12%)	235	163	333	379
Grand Total	2192	802	1156	1040

* It will be noted that costs in this table are not precisely equal to costs in table 3 F2 giving the budgets. This is due to the fact that some of the costs are not chargeable totally against the project. For example, T.A. and some contral construction. Also the economic analysis table is based on projected cash expenses not accrued obligations as is the budget tables.

TABLE A-16 (REV)

Maintenance and Replacement Costs Not Itemized Elsewhere ($000)

Item — Project Year:	5	6	7	8	9	10	11	12	13	14
Building maintenance	30	30	30	30	30	30	30	30	30	30
Vehicles Landrover	12	12	12				12	12	12	
Peugeot	5	5	5				5	5	5	
Truck		17	17					17	17	
Boats	9	9					9	9		
12 pumps & Equipment	127									
TOTAL	183	73	64	30	30	30	56	73	64	30
Contingency (15%)	27	11	10	4	4	4	8	11	10	4
Total	210	84	74	34	34	34	64	84	74	34
Inflation (12%)	160	82	90	50	60	72	159	243	249	132
GRAND TOTAL	370	166	164	84	94	106	223	327	323	166

TABLE A-17 (REV)

Economic Rates of Return

YEAR	BASE CASE ($US 000) COSTS	BASE CASE ($US 000) INCOME	BASE CASE NET BENEFIT	LOW LABOR COST ($US 000) COSTS	LOW LABOR COST ($US 000) INCOME	LOW LABOR COST NET BENEFIT	ONE CROP : RICE ($US 000) COSTS	ONE CROP : RICE ($US 000) INCOME	ONE CROP : RICE NET BENEFIT	COSTS INCREASE 25% ($US 000)		
1	1957	73	(1884)	1957	77	(1880)	1957	67	(1890)	2446	73	(2373)
2	639	200	(439)	639	209	(430)	639	187	(452)	799	200	(599)
3	823	460	(363)	823	481	(342)	823	397	(426)	1029	460	(569)
4	661	770	109	661	813	152	661	657	(4)	826	770	(56)
5	210	1176	966	210	1243	1033	64	980	916	262	1176	914
6	84	1308	1224	84	1384	1300	84	1067	983	105	1308	1203
7	74	1440	1366	74	1524	1450	74	1154	1080	92	1440	1348
8	34	1638	1604	34	1735	1701	34	1284	1250	42	1638	1596
9	34	1639	1605	34	1736	1702	34	1285	1251	42	1639	1597
10	34	1641	1607	34	1738	1704	34	1287	1253	42	1641	1599
11	64	1642	1578	64	1739	1675	64	1288	1224	80	1642	1562
12	84	1643	1559	84	1740	1656	84	1290	1206	105	1643	1538
13	74	1645	1571	74	1742	1668	74	1291	1217	92	1645	1553
14	34	1647	1613	34	1743	1709	34	1293	1259	42	1647	1605
I.R.R:			26%			27%			20%			20%

TABLE A-17 (REV)

YEAR	PRICE DROP 25% ($US 000) COSTS	INCOME	NET BENEFITS	COST UP = 20% PRICE DROP = 20% ($US 000) COSTS	INCOME	NET BENEFITS	COOPS, CREDIT & MARKETING ($US 000) COSTS	INCOME	NET BENEFITS
1	1957	43	(1914)	2348	48	(2300)	2057	73	(1984)
2	639	114	(525)	767	132	(635)	739	200	(539)
3	823	260	(563)	988	300	(688)	923	460	(463)
4	661	436	(225)	793	503	(290)	761	770	9
5	210	693	483	252	790	538	310	1176	866
6	84	792	708	101	895	794	184	1308	1124
7	74	890	816	89	1000	911	174	1440	1266
8	34	1039	1005	41	1159	1118	134	1638	1504
9	34	1038	1004	41	1160	1119	134	1639	1505
10	34	1041	1007	41	1160	1119	134	1641	1507
11	64	1042	978	77	1162	1085	164	1642	1478
12	84	1043	959	101	1163	1062	184	1643	1459
13	74	1044	970	89	1164	1075	174	1645	1471
14	34	1046	1012	41	1166	1125	134	1647	1513
I.R.R.:			14%			13%			21%

ANNEX A-17 (a)

Flood one years in 10

Costs of dike repair included

YEAR	FARM INCOME	COSTS	NET
1	82	1981	(1899)
2	225	663	(438)
3	517	847	(330)
4	866	685	181
5	1323	234	1089
6	1471	108	1363
7	1620	98	1522
8	1842	58	1784
9	1843	58	1785
10	1846	58	1788
11	1847	88	1759
12	1848	108	1740
13	1850	98	1752
14	1852	58	1794
			28%

TABLE A - 18

SENSITIVITY ANALYSIS

CASE N°		IRR %
1	Base Case	26
2	Base with low labor wages	27
3	Base with Pre-Project Costs Included	22
4	Base with Cooperatives Operations Credit & Marketing Costs Included	21
5	Only one crop (Rice) Produced per Yar	20
6	Base with Capital Costs Increased 25%	20
7	Base with Crop Prices Reduced 25%	14
8	Base with Crop Prices Reduced 20% and Capital Costs increased 20%	13

Annex J Table A-19

Economic Profile of Farm Family

	Present	With Project
Family members	6	6
Hectares cultivated		
Dry land	2	2
Flood Recession	1	1
Irrigated	0	4
Grain Produced		
Sorghum		
Dry land (3/4 ha)	600	650
Flood rice (1/2 ha)	300	350
Irrigated (.2 ha)	-	160
Total	900	1320
Maize		
Dry land (3/4 ha)	600	650
Flood recession (1/2 ha)	300	350
Irrigated (.2 ha)	-	420
Total	900	1420
Peanuts & Niabe		
Dry land	850	850
Irrigated	-	60
Total	850	910
Rice		
Irrigated (.4)	-	1200
Income - CFA		
Subsistance food (1300 hg)	41,600	41,600
Stored surplus (500 hg)	16,000	16,000
Peanut sales	22,140	22,560
Grain sales	-	30,080
Rice sales	-	78,000
Total Income	79,740	188,240
Additional cash expense	-	40,380
Net Income	79,740 ($332.25)	147,360 ($616.08)
Of which cash	22,140 ($92.25)	90,260 ($376.08)

ANNEX K

SOCIOLOGY OF THE IRRIGATED PERIMETERS
(Bakel, Senegal)

by

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July 1976

SOCIOLOGY OF THE IRRIGATED PERIMETERS

(Bakel, Senegal)

1. This study covers around thirty villages located between SELIN (OLOLDOU arrondissement), BAKEL department, in the upper GOYE a few kilometers from KIDIRA, and WAOUNDE, a large market-village in the SEMME arrondissement, in the MATAM department.

   WAOUNDE being located 60 km from BAKEL, the area in question therefore covers 140 km along the River Senegal and in the country back of it.

   With the exception of KADIEL, DIABAL, BEMA, TOURIME, GOUNIA and BOLOKADJI which are rain agriculture areas, all the villages use simultaneously rain fed agriculture (DIERI) and flood recession farming (WALO).

   The River's floods have rhythmed the life of the communities for centuries and one cannot understand the ways the society operates without shedding a proper light on the land system upon which it is based.

2. A large part of the area we are concerned with is a Sarakolle region; it would have been better to say a region of Sarakolle civilization.

   As a matter of fact, even (in) the villages where the Sarakolle are a minority - such as TOURIME, BEMA (villages with a BAMBARA majority), KADIEL, DIABAL, GOUNIA (villages with a Toucouleur

majority) or even GABOU - which has a specific type of people (which) explains its dividing up into GABOU Toucouleur, GABOU Bambara and GABOU Sarakolle, the social organization still bears the stamp of Sarakolle influence.

3. This is the reason why we stress the social organization and way of life which prevail among the Sarakolle.

The relations of exchange which were established between the Peul and the Sarakolle in villages such as DJIME, DIATIGUEL, LOBALI have indeed influenced the Peul or Toucouleur societies which differ in may ways from the Peul societies of other regions (FERLO or MACINA). It would be, however, wrong to assimilate these Peul societies to their Sarakolle neighbors.

Linking the Peul groups of the areas visited to such an innovative project as the Irrigated Perimeters is an action which runs the risk of facing innumerable difficulties if, in its pedagogy and the way it approaches individuals and the whole of society, it took the easy road of the standardizing tendencies which characterize most social change undertakings in areas of pre-capitalist economy. The Peul villages must be approached quite differently from the Sarakolle or related (Bambara) societies. The fact is, the social organization among the Peul rather follows the theocratic type, and the production and consumption units, the structure of decisions totally differ from those of other societies. Here, the

molecular family has a lesser importance. The centrifugal forces participate in dividing up the extended family into independent nuclear families. These nuclear families indeed constitute autonomous units of consumption, production and decision-making which reflect the individualistic character of Peul society.

4. The Irrigated Perimeters are not set up (as) "new lands" where people would be settled with an optimum work-capital combination in mind. They are a civilization project. In that sense, they have a potential of change which the social structures must be able to bear. The Irrigated Perimeters are being set up in a human environment which has stood the test of time. We know that, in spite of a certain number of facts which may objectively be considered as constraints in a set of problems inherent to a goal which is to organize the mental and technical-economic structures in order to achieve a cumulative and lasting increase in the well-being of the population, the societies we studied have been able to overcome serious crises - droughts, floods - thanks precisely to the strong structure of the society based on the pre-eminence of a few great families, seniority, and the sharing of work among men and women, young and old.

5. One can thus understand that our method of investigation did consist of a functional interrogation of the groups as to the set of problems inherent to the Irrigated

Perimeters. This eliminated from the start a repetition of monographic studies village by village.

Such studies are undoubtedly interesting. Particularly if, during the time the project was being set up or extended, some villages have presented "deviations" or offered resistance. Rather, we tried to determine who, in the community, were:

a) the decision-making centers (Chief class, supreme village council, extended council or youth management committee).

b) the centers for the broadcasting of decisions (GNAKAMALO, FEDDE).

A particular mechanism of information does exist and the decision-making centers know well the points of impact, the key persons and the basic institutions which enable the decisions taken to be known to the entire community in an acceptable manner.

c) the centers for the implementation of the decisions (youth group, women or even adult group).

Determining these centers is fundamental, most of all as far as work organization is concerned.

The communities we studied have a specific type of work organization that the Irrigated Perimeters cannot afford to ignore. The project will be a success provided it can connect with, or better, integrate the traditional management of work.

There must not be any insuperable contradictions between the management of the Irrigated Perimeters at the SAED level and management at the village community level. It is up to the promoters of the Perimeters to keep the traditional work management from becoming disfunctional in relation to the goals of productivity increase. This seems to have been undertaken. As we have been able to see, the dividing up into work teams organizing their own control on one hand , and the distribution of the roles of team leaders on the work site by the cooperators themselves on the other, give evidence of the effort of research and observation undertaken by SAED.

6. The understanding of the centers for the broadcasting and implementation of decisions must be done in an articulate manner. In other words, a village can be understood only as a structured aggregate of centers in constant interaction.

   Global understanding of the village has revealed the existenc of interdependent groups, a society which is not pyramidal or totalitarian as some sociological studies would have it, but a vast organism which elements have functions that are just as indispensable.

7. A last point on method: referring to just the political-administrative aspects (traditional authority structure) or to institutions which assure the reproduction of the social system (institutions with an ideological vocation: FEDDE -

or age groups - and families) is not enough to understand the society. It is important to understand the material basis upon which it rests (its production means) but also the traditional mechanisms of distribution of the social product.

How can an increase of the social product induced by a work increase concretely improve the individual standards of living (?). It is important to consider this fundamental question even before the project is set up.
Indeed, we know of numerous projects which failed for lack of sufficient consideration of the changes in the process of circulation of the social product.

If a project bringing extra work,particularly for the most vulnerable groups (women, children, small sized families), is recovered for the benefit of the great notabilities who already "have it", and therefore does not satisfy the yearnings and expectations of these groups, a general disinterest of the poorest towards the project would not be surprising after a while.

8. Although it is conventionally called an enclave, the area we studied is not completely shut. It is open to the outside world on two levels:

- the market,where we could see important quantities of manufactured goods (radios, fabrics, various food products, bicycles, motorcycles).

- at the level of the work-factor: as a matter of fact, we are in a particular area of manpower supply for european economy (manily french economy) and for the urban indutries of Senegal (all concentrated in Cap Vart.)

In the face of the long-standing tendancy of a price structure unfavorable to basic food products and the little interest presented by this region (a remote backcountry) for capital, ~~which found~~ (in Cap Vert, salary rates) that were interesting for the Sarakolle, the Toucouleur have understood that they had to catch up with capital. The first stop was Dakar and the big shipping companies. Quickly, they took the struggle for survival to the center of capitalist economy. In spite of what eminent economists and sociologists may say, they understood that there were no better choice in the present context of the linking up of their social training to the social training of the center.

It is quite clear to them that they were able to make it during the last droughts thanks mainly to the income of those who emigrated. As far as economic policy is concerned, this entails a reconsideration of the price structure. Any action which, in the long run, would have the region produce important excess (manpower) (who, through appropriate education and sensible advice, would be oriented towards the production sectors) should take the price structure into account in order to avoid heavy departures to the profit of more industrialized regions (in Senegal or elsewhere).

The following is a brief characterization of the region.

9. A general description of the Sarakolle and Peul societies.

Social life is dominated by a differentiation into several castes. This is still very strong. Society is divided into:

9-1. The "HORRO" (equivalent of the "TORODO" among the Toucouleur and the "DIMO" among the Peul).This is the nobility in the high est sense of the word.

In general, they are the ones who reign and govern. Village chiefs and religious chiefs always belong to the nobility.

Thus, there are, among the HORRO, ruling families within which power is hereditary.

In a single Sarakolle village the ruling family includes three or four branches that each have a chief. The oldest one in the family automatically becomes village chief in the case of a vacancy in the power (death, physical disability).

Sarakolle society is particular in that not only power is not handed down from father to son, but also filiation lines are ignored: often village chiefs have younger uncles on their father's side among their subjects.

The Sarakolle chief system thus appears to belong to the gerontocratic type. However, power remains within the ruling family.

Decisions are taken in the village council which is made up of notable families. It must be stressed that there are several degrees in the decision-making process.

- The supreme council or restricted council of the villages is made up of the ruling family and of two or three senior members of the other "HORO" families. The example of YELINGARA which can be extended to all the villages visited is a good illustration. The supreme council (there) is made up of three persons (the oldest man of the SOUMARE family who is at the same time the oldest one in the ruling family and therefore the village chief, the oldest man of the SIBI family and the oldest one of the SY family, these families being the second and third ranking influential families in YELINGARA.) All issues of great importance to the village are discussed at this council. Common positions are decided upon at the end of the meetings of this council.

Nowhere has a ruling family appeared strong enough to us not to be aware of the usefulness of a supreme council.

The extended council or village council includes in addition to the members of the restricted council, the oldest members of the "HORO" families and sometimes the oldest one among the "NIAKAMALO" or among the "DJONKOUROUNKO".

The extended council discusses the decisions taken by the supreme council but this is done in a rather consultative manner.

Although age is a determining factor in the choice of the chief in the ruling family as well as in the other great families among the village communities, there is slight difference in the Sarakolle community as a whole. All the marabout (religious leader) or warrior families agree that they came to the region after the BATHILY family who themselves came from the east of Mali. This is why the BATHILYs are considered the oldest aristocracy in the region. Consequently when a BATHILY and other village chiefs gather at the same meeting, chairmanship falls to him by right, whatever his age. This order of precedence still prevails although the supremacy of the BATHILY was eliminated by the colonial (regime). Let us note that TUABOUT and ARONDOU were the capitals of the Sarakolle country in pre-colonial times. Theoretically, there is no matrimonial segregation among the "HORRO". A Soumare man or woman can marry in any family: BATHILY, SIBI, TRAORE, etc...

However, although nothing forbids a man from a warrior family from having a wife from a marabout family, there are in fact no marriages between marabout and warrior families. The DRAMEs, the CISSEs, the TANDJIGORAs, who

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are the great religious leader families of the region do receive women "given to God" from warrior families as wives, but our investigations did not reveal any warrior family wives who came from the marabout group. This certainly creates some problems. The example of "GANDE" where the GOUNDIAM family refuses to marry their daughters to religious families is typical of the thinking which prevails in some areas about this specific problem.

We have tried to find some explanations as to why the marabout class refuses to give away their daughters. The first explanation is that here, there is a sharp dividing line between temporal power and spiritual power. The latter, although apparently subordinated to the former, has an extremely powerful function in a strongly and totally islamised society. The most serious disputes are often taken to them for judgment and their opinion is almost always a determining factor in solving these problems.

Second, the maraboutic "HORO" are endogamous. Religious leader families have been marrying into each other for a long time. Now, in these societies the exchange phenomena are related to the hierarchy structure. There are equivalent exchanges between equal parties. Gifts are given between parties of unequal importance but not necessarily from superior to inferior.

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Each gift is a specific case and as such takes on a meaning which can only be understood within its own cultural context.

Although the marabout class knows in theory and sometimes in fact that they depend on the village chief class who settled them and gave them fields and houses, the absence of matrimonial ties,which is seen by the warrior class as a unjustified pretension on the part of the marabout class, does not create serious tensions. This contradiction appears secondary in regard to the absolute necessity of social cohesion of which marabouts are indispensable agents.

9.2 The second social category that we met is made up of the "VANAKOUNKO" or "DJONKOUROUNKO" who are free men, neither rulers nor marabouts. This class is made up of waves of migrants (two to three families most often).
There are no marriage relations between the"VANAKOUNKO" and the "HORO" any more than between the "COMO" and the "VANAKOUNKO". In the villages we visited there are no marriages between different social classes.

Except for GANDE, where the chief from the TOURE family is a DJONKOUROUNKO, nowhere have we found the political-administrative or even religious power in the hands of a DJONKOUROUNKO.
Yet in GANDE the chief's power is purely formal. Since decisions really fall to the GOUNDIAM whose opinion is decisive at the supreme council.

9.3 The third social class: the "GNAKAMALO" (blacksmiths, weavers,

mat makers) plus the "DIAROU" and a special class the "THIOU-BALO" (fishermen). These people have professional activities related to their caste in addition to agriculture. The griots (praise-singers) and the blacksmiths have an important role in regard to social organization.

It must be stressed that in the villages we visited economic status has no incidence on matrimonial relations. For instance, economic success (as a consequence of migrations or commercial activities) means no promotion in social status. A blacksmith remains a blacksmith and is seen as such by the community in spite of his economic status. Our talks with the school teacher of TUABOU, an intelligent and dynamic woman, as well as with a young griot who came back from FRance, reveal that intellectual promotion has no more incidence on the status of persons of caste than the prestige which goes along with jobs in the Administration.

9.4. The fourth social class is the "COMO" group (descendants of slaves). Although they do not work for any group whatsoever, they have the lowest rank in relation to the village's criteria. This group is made up of (people with) WASSOULOUNKE-BAMBARA-MANDINGUE sounding names. They arrived in the region following exchange operations which happened at the time of the great soudanese empires.

We know that not long ago SAMORY still exchanged slaves captured

in the WASSOULOU (therefrom the names of SIDIBE, DIAKITE often found among the slaves of the region) for powder that the Dioulas merchants procured for him on the Coast of Guinea. We also know that the numerous slaves natives of present day Mali (therefrom the names COULIBALY, DIARA) arrived in the region at the time of the Toucouleur invasion against the animist Bambara group allied to KAROUNGA who also fought the muslim Toucouleur penetration.

These slaves have constituted here as everywhere else, an important labor force and an important element in the exchange with the Arab neighbors.

In spite of official laws forbidding slavery, they still bear the stamp of history. If some social science specialists still write that traditional structures are now empty (of their meaning) it seems to us an exaggerated assertion as far as Sarakolle-Toucouleur country is concerned.

We must take into account the social stratification we just discussed and the role played by the various social classes in order to begin any significant change. The antecedence of knowledge of the society over starting the project seems to us obvious. Here, social structures have not lost their meaning, they remain strong, compelling (factors). They are built on a material basis which is far from transformed by the contacts it had with capitalist economy.

The tensions we saw between the "HORO" of the marabout group

and the "HORO" of the political-administrative group could not be found among the Peul societies. In these societies, there is no actual dividing line between the spiritual and the temporal. The Peul societies are of the theocratic type.

10. THE TRADITIONAL AUTHORITY STRUCTURE. ITS MATERIAL AND INSTITUTIONAL BASES.

10.1. The traditional authority structure.-

We have seen that the ruling family along with the two or three great families of the village , makes up the restricted council. The senior members of these great families first consult with one another in order to agree on a common position after they have discussed matters in depth. Then the extended council made up of the chiefs of the main families is informed. Council membership varies from village to village (seven to ten persons). The village chief and his direct successor are members of the extended council.

The extended council generally includes a GNAKAMALO or a DIAROU whose opinion is often listened to. The DIAROU is in charge of communicating the decisions taken by the council to the community: meeting of all the village's men for such and such undertaking, for instance.

Unlike the Peul societies, we have not encountered serious power conflicts in the Sarakolle area. Although the Sarakolle discuss the matters concerning their community life in the smallest detail, they take their decisions in a relatively

democratic manner (between decision-makers, that is). Once the decision is taken, it is enforceable and no one would think of contesting the orders of traditional authority.

One thing is certain, decision-making power is concentrated in the hands of the "HORO" - among whom existing contradictions have always been overcome due to the necessity of maintaining social cohesion. Thus the council of notables actually holds great power. If the village chief is responsible for the land and if meetings are held at his home, if he represents the whole of the community which is willingly subject to his authori it is in fact because here there is no misuse of power. This also explains why here, unlike in the Peul societies, there is never any serious opposition to the ruling family (as in LOBALI)

Judgments are passed by the common law court and appeals to the formal official administrative authority are avoided. People prefer to settle disputes at the village level.

The marabouts whose religious influence is still very strong in this 100% islamised area, preside over the prayers. They have an important arbitration role to play mostly in matters of inheritance or divorce. They have the monopoly in teaching and all children without exception, girls as well as boys, are taught by them. School is compulsory as the child must know very early in life the indispensable verses for prayer. To understand the role of the marabouts, we give further down the peopling pattern of Sarakolle villages. We explicitly refer to WAOUNDE where the relation space organization/social structure

is particularly obvious.

PEOPLING PATTERN FOR WAOUNDE: (see figure in annex I)

WAOUNDE is made up of: the AERE neighborhood, inhabited by five "HORO" families: the SOUMARE, who are the village chiefs, the N'DIAYE, the DIOP, the SIBI and the CAMARA. The COMO group is found on the outskirts of the AERE-HORO neighborhood. Each HORO and COMO social group has its imam who was always born in the CISSE family (the great marabout family of WAOUNDE).

The "MODYGOLOU" neighborhood (neighborhood of the MODY or marabouts) shelters three families: the CISSE, the FOFANA and the DIAKITE. MODYGOLOU also has its outskirts area peopled by the slaves of the MODY. As in AERE, there are two mosques here. The imam of the HORO is a CISSE, that of the COMO is a DIAKITE.

East of the village: the SINTHIANE neighborhood which is an isolated unit exclusively peopled by descendants of slaves. The COMO of SINTHIANE and those of MODYGOLOU go to the same mosque. They therefore have the same imam.

Due West, another separate neighborhood inhabited by the THIOUBALO (Toucouleur fishermen assimilated, as we said earlier, to the Sarakolle) and the SOMONO (Bambara fishermen also assimilated). The relations between the SOMONO and the THIOUBALO are very close. However, each group has its own mosque. The THIOUBALO have a DIENG family imam whereas the SOMONO's imam comes from the HAIDARA family.

The marketplace separates the huge COMO neighborhood in AERE in two parts. Which shows the material basis upon which the village's aristocracy was built.

Northeast of the market one finds the WAOUNDE central mosque. It is the Friday mosque where all the men meet once a week. The two great prayers of the year , the Ait El Kebir and the Ait El Fitr, are also held in this mosque. Here also, is consecrated before all, the religious authority of the CISSE, who themselves are close dependents of the SOUMARE and of the other HORO families of AERE.

But the peopling pattern described above also allows one to sense a slight discrepancy in the relation peopling and social hierarchy.

A new neighborhood called HLM, next to the school and the dispensary,groups individuals of various ancestry. This is also the strangers' neighborhood (school teachers, male nurse(in charge of the health post)). But one must not be deceived by this apparent "melting pot". The forces of restructuration along the lines of traditional criteria tend to reorganize the social life. The COMO in HLM do not feel they belong to some new community. The allegiance ties with the COMO remain just as strong.

What we just described is found as well in DIAWARA, the seven mosque city. Same type of space organization, same authority structure, same manner of organizing religious life. If the same

space organization is found in the various villages with more or less variations, let it be stressed, however, that it is not in the least forbidden for a HORO to go to the traditional prayer place of the COMO or of the THIOUBALO. Anyway, COMOs are often seen praying in the Horo mosques.

We have insisted on the religious organization because the prayer place is an important meeting place for the adults and the mosque, through the religious families, is a connecting point between the various castes and the political-administrative authority.

Furthermore, the mosque serves as a vehicle for ideological conditioning; it is its traditional vocation. And here, during prayers or in case of a tragedy, (the fact of) belonging to a community appears to the individual consciousness (deaths, prayer for the end of a great drought or so the village would be spared particularly serious calamities).

10.2 THE INSTITUTIONAL BASES OF THE TRADITIONAL AUTHORITY STRUCTURE.

10.2.1 THE FAMILY:

Sarakolle society appears to us as a gerontocratic society, and the whole of political and economic power is in the hands of the men. One should start out from family organization to understand how the society as a whole works.

Just as in the chief class, all members of families of the same name come under the authority of the oldest person in the family.

If there are four related KAMARA families in the same village, it is the oldest one among them (doyen) who will set the pace for all of their social life.

However, the authority of the doyen is based on an authority hierarchy. Every married man lives in the same compound with his brothers and children. The compound comes under the supreme authority of the doyen. He is the one who decides for all. He is responsible for the life of the family as a whole.The family granary is at the disposal of the head of the compound who can dispose of the individual families' granaries as needed. As a matter of fact, every man,married or not,has an individual field for his personal use.

The head of the family shares his meal with his grandchildren and brothers. The sons, married or single, eat together.

When family size becomes large, new cells are created in the image of the parent family. It is obvious that this in no way hinders the authority of the doyen.

Whereas for the village, being a chief depends on one's age within the family, authority depends on the order of succession. For instance, the head of the family may be younger than some members of the family if he belongs to a generation which is older in the kinship relations.: an uncle always has authority over his nephews, whatever his age. In many cases, we have seen a duplication of power. Formal power would be held by an uncle (the doyen) and actual power would be held by an older nephew.

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One often hears that Sarakolle women have no authority, but this is not quite true. For in case of disagreement in the family, the decision of the older sister of the family head remains undisputed.

Knowing the mystical respect Sarakolles have for their parents, we feel that it is exaggerated to deny any authority to women in Sarakolle society.

This does not quite mean that women are directly involved with conducting community life. They are doubly handicapped: by society as a whole and by traditional subservience of a wife to her husband.

One hears the message of unity and becomes aware of society's articulate organization in one's family. A great part of the girls' education takes place within the family. In daily contact with their mothers, they very early get an image of what women represent in the home. It is within the family that they get a definite idea of the opportunity of sexual specialization within work. They cook, fetch water, do the laundry, grow rice, work with crafts (tie-dyes).

As far as boys are concerned, they are separated from their mothers very early in life and become aware of their manly role and of what society expects from them. They follow the elders to the fields, grow crops, look after the land. It is within the family that they also learn that it is up to them to

stand in stead of the brothers who went to foreign countries on everyone's behalf.

10.2.2 THE FEDDE.

The FEDDE are age groups. There are FEDDE for boys and FEDDE for girls. Each fedde has its own management structure. Solidarity between men and women of the village is expressed in the FEDDE for the six to seven-year old youngster. One leaves the FEDDE only when one dies, since adults over sixty told us they had their FEDDE. These age groups are organized in the image of society. The chairman is always a member of the ruling family. The other members come from the great families. Here also, just as in total society, a young GNAKAMALO is in charge of communicating the decisions of the management committee to the other FEDDE members.

Among the men as well as among the women, the structure of the notables council and that of the FEDDE are practically superimposed. For the purpose of any organization of society around a project such as the Irrigated Perimeter, it is important to understand who are the key persons within the FEDDE, how the Fedde overlap and how the whole of the FEDDE is connected to the notables council.

This must not be done in a mechanical way, for there are deviants in the villages, who are strong personalities. THey have acquired a new dimension. Education, awareness of new

techniques of resource development, their intrinsic ability for organization have bestowed upon them a status that they could have never had by birth.

This is the case of the president of the cooperative groups federation who is at the same time the first "animator" of the village in KOUNGHANI. In MANAEL, DIAWARA and GABOU we have met what we may call deviants from traditional society. They are the ones who introduced farming with animal-drawn equipment. We believe that they are the ones who will be the actual agents of development. They are the vanguard, the project must rely on them as much as far as the analysis of the society is concerned as on the process of their intervention and for identifying the constraints (to be encountered). They have more motivations than other members of the community and therefore can help change the economic aspect of the region provided they are properly trained.

The FEDDE is thus an element of social cohesion in the sense that it constitutes a matrix for total society. Indeed, here, not only do the HORO, the ANAKOUNKO, the COMO, the THIOUBALO and the NIAKAMALO find themselves organized in the image of social structure, but the FEDDE of boys and girls of the same generation overlap in ways that become explicit on the occasion of weddings, circumcision ceremonies and village feasts.

10.2.3 CORANIC SCHOOL

Here, as in all of the Sudano-sahelian region, children meet to learn the elements indispensable to prayer.

We found that all the marabouts we interviewed are of maraboutic ancestry. In general, only the adults of marabout families or of great HORO families have a thorough knowledge of the Coran.

When we asked why the COMO, the SOUBALBE "THIOUBALO" and the NIAKAMALO do not let their children go to school, the answer came that the child was sent very early in life to work the fields and that the poverty of these families did not allow them to do without this manpower. Study of the land system (and above all the metayage system) is quite interesting and in any case necessary for the villages chosen. This sharecropping system is used in SELIN just as widely as in all of the river valley. Although profit is insignificant, sometimes even non-existent, it is obvious that with population expansion (50 inhabitants per sq. Km in some areas of the Senegal river valley) the great families will recover the land they lent to the slaves. The land system is the foundation of various ties of allegiance which negate the meaning of the official laws. This is a fact that must not be ignored.

Having not had the opportunity to study on one hand the land system as related to the structure of social relationships,

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and on the other hand the demographic structure in order to identify types of relations: size of the family/castes, we have oriented our investigations on a qualitative basis. It became apparent that the lack of education among the families of caste is partly linked to the way things are conceived in total society. Even if a man of caste had the opportunity to get a solid education,.nobody, probably not even the slaves, would send their children to him. He would lack the traditional prestige of the marabout family.

Thus, the traditional school tends to maintain social stratification. In any case, it is a place where this stratification is justified. It is within the traditional school that future chiefs, marabouts, THIOUBALO, NIAKAMALO, COMO wake up to the role the marabout class plays.

School losses (in pupils) which are directly function of the role played by each stratum of society, distribute knowledge in a pyramidal manner. This permanently maintains knowledge within the marabout families who become points of reference for decision-making in an important number of fields.

As for the COMO, the condition of intellectual degradation in which they are maintained deprives them of all critical sense.

10.3 THE MATERIAL BASIS OF THE SOCIAL STRUCTURE.

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We have only dealt with the land system. However, it would be interesting to complete the study of the ownership of the land with the ownership of the cattle. In numerous areas, the two types of ownership are indeed related.

The land system allowing a hoarding of excess which permits cattle purchasing.

We have not been able either to study the structure of income which importance is obvious in the context of a modernization project such as the Irrigated Perimeters. The structure of income automatically entails an incitation to study economic behaviors and also the relation between income and the decision-making structures. Thus, a study of the types of motivations to participate in the project could be done much more accurately. SAED should make an in-depth analysis of all these aspects for such an analysis would undoubtedly help to formulate relevant policies for the development of rice-growing in the region.

So, this is not an exhaustive study of the material basis of society.

10.3.1 THE RULING FAMILIES.

Let us keep in mind that although the land belongs to the chief class by "right of fire" in the DIERI, they practically have no land problems, there.

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It is in WALO land that one encounters interesting land problems. Each family in fact works one field in WALO and another in DIERI, but only the great noble families own WALO fields.

For the ruling family, there is the large family plot which passes from one household to another depending on which head of family is in power. This plot is worked by the chief's family who is entitled to renting it to a metayer, if he so chooses. When the chief dies, the family plot goes to the new chief who works it or puts it in the trust of a metayer. The family field's crops may be sold by the chief or kept in the family granary. In the case of a sale, the income is deposited in the joint fund which is at the same time an insurance fund against disasters or for helping on various occasions: death, weddings, baptism or circumcision ceremonies.

10.3.2 HORO AND DIONKOUROUNKO.

In every Dionkourounko family there is a family field called "FOROBA" which belongs to the family head, just as in the other HORO families. The men in the family work on this field every day. The afternoons are devoted to the personal fields. The family field's crops are shared by the whole family. The head of the family manages it.

As far as individual fields' crops are concerned, they belong to each household head in the compound.: (several households heads living in a same compound).

The singles also have their plots and use their income to buy animals or to provide for their personal needs.

However, singles' granaries as well as those of the household heads come under the authority of the compound chief who may use them for the survival of the family community in thecase of shortage.

This custom has never been contested. Our talks with young married men or singles, as with the elders who still live with their father or an elder brother, revealed that this was far from being felt as a constraint. It harmoniously integrates the Sarakolle concept of society. One is a social being totally depending on the other members of the society.

10.3.3 THE COMO.

The COMO work their masters' land in the WALO. THey also have their own plots in the DIERI. Their advantage is that they have a solid knowledge of the cadastral plan and know the boundaries of the irrigated lands. Veritable walking cadastral plans, the "diagrafes" often are called upon to referee disputes over field boundaries.

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11. COMMUNITARY AND COOPERATIVE NATURE OF THE SOCIETY.

There is no communitary tradition in the Peul societies. Family chiefs are independent from one another. Yet, individually, every married man still acknowledges the fatherly authority. Here, the strongest call seems to be the head of the household and his "milk brothers" (this is used to indicate children of a same wife). The tendancy to break up is very strong among the Peul. Women play a catalytic role in the breaking up of the family.

Any parcelling and restructuration in the future with a common undertaking such as the cooperative groups in mind, should take into account the individualistic nature of Peul society on one hand and the division of the family among children of a same wife, on the other.

We have already reviewed the communitary nature of the Sarakolle society. Let us recall here that if unity is stronger than among the Peul, There is, however, no common farming tradition outside of the familial context. Common work comes under the authority of the family doyen and we saw that he leaves enough time to every active man to provide for his own needs. This is the reason why (work does not appear as) compulsory as one would think.

In all the villages we visited men and women work separately. Women are busy growing rice, groundnuts, indigo, okra.

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Men grow millet, corn and sorghum. Women are not required to work on the family plot.

12. THE AGRICULTURAL TIMETABLE.

12.1 RAIN CROPS.

Beginning May to 15 June:	- fields are cleared of stumps. - preparation of the land. - cleaning.
Mid-June to beginning July:	- preparation of the fences. - continuation of work on the fields. - cleaning of the fields.
Beginning July to end of July:	- after the first rains - sowing (millet, corn, sorghum, souna, okra) - ploughing - 1st weeding - starting mid-july, women sow indigo and rice
Beginning AUgust to end of August:	- 2nd and 3rd weeding - end of the main work - fields are watched by the children starting mid-August - boys watch the family plots and the girls look after their mothers' fields

End of September:

- corn is harvested (70 to 75 days after sowing)
- corn is harvested by the men
- women pick the indigo leaves, ground them, roll them in balls and dry them up.

Last week of October to beginning November:

- women harvest the rice
- men harvest the millet

From May to October, the activities of the population are devoted to rain crops. The people are very busy as soon as the first rains fall. This is a critical period for the farmers.

The period between the preparation of the fields and the first sowing is a crucial moment during which any delay could endanger the whole crop.

Second critical period: first, the corn harvest, starting mid-September and then, the millet harvest towards the end of October. There should be no delays in this period either, since the birds feed on the last fields to be harvested.

12.2 RIVER FALL FARMING.

The critical period here is also the sowing time when the water retires (first or second fortnight in October depending

on the rains). There is superposition of the work of end of DIERI (rain agriculture) and the sowing period of WALO (riverfall farming).

October:	- sowing time: Guedieba (sorghum), corn, seme, niebe beans, sweet potato, squash and calabash are sown.
November:	- weeding
December-Mid-January:	- the WALO crops are watched - the DIERI millet is brought back to the village - the millet is threshed for eating right away (in poor families), or for storing in the granaries. - the niebe and the corn are harvested - fending off the parrots and porcupines which devastate the area's fields.
January:	- Brick-making for construction - Collecting straw for roofing - building of woodwork for rooves.
February:	- fencing of the WALO fields - watching for the predators - harvesting of the Gudieba and the Seme(5 months after sowing)

March:

- the Guedieba and the Seme are carried to the village
- construction work begins at this time. The whole family participates, men as well as women.
- once construction of the house is finished (the men did the heavy work), women start rough-rendering and decorating.
- the older women, helped by the young, work on crafts: preparation of calabashes but also dyeing of clothes.
- already this is an active enough period for women, with a particular overload in the beginning of the dry season: fetching water from afar for construction and drinking.

Two periods appear critical in this calendar:

1) The beginning of the rainy season: beginning of the preparation of the fields up to sowing time.

2) The period of harvesting, just as in the DIERI.

These periods therefore require the totality of the manpower, not only the active adults but even the youngest ones participate in the work. During this period, the men leave home around 6 a.m. and return around 7 or 8 p.m. The lunch break is minimal, about an hour.

Thus, here, any action which could make on one hand, preparation work and sowing, and, on the other hand, harvesting easier, would fit in with the immediate preoccupations of

the area. Wherefrom individual attempts to introduce farming with animal-drawn equipment by those who, during their migration period, could realise the enormous advantages of modern farming techniques.

As for the women, it is clear that they are permanently overwhelmed with work (with particularly noticeable peak periods at the time of sowing, harvesting and at the beginning of construction o f the houses.) We think that any perspectives for easing up women's work and therefore facilitating their promotion, should be oriented towards the small unpretentious projects: village wells equipped with pumps.

These are observations in fact directly related to the Irrigated Perimeters project.

The Irrigated Perimeters will indeed necessitate an increase of efforts during the time it is being set up. We have seen everywhere how available the population, men as well as women, made itself for the achievement of these Perimeters. But we know from experience that the populations' enthousiasm will rapidly fade if these people who do not have a long-term forecasting ability, do not see their efforts become something tangible. Women will keep working under the men;s constraint if necessary, but it is clear that their productivity will be negative or non-existent should they lose their motivations. The project should give women, who

here, work more than anywhere else, an opportunity to develop themselves.

There is here an important educational aspect which must not be ignored. The project will entail important excesses and they may be used either for comsumption purposes, or for ostentatious buildings or else profitably invested.

Investments demanding a choice in priorities, we think that it is up to the technical structures to orient them. Thus, the Perimeters imply a planning which is modest perhaps, but which responds efficiently to immediate needs. If the choice of priorities must be oriented, it should be done at a distance, for Sarakolle people are extremely reticent about the state's intervention.

Wherefrom the pedagogy will be persuasion and not a discussion between unequal representatives of the State and the populations.

The agents of education in rural areas will be valid development agents only if they have a right understanding of the whole social environment. But the most fundamental quality needed from them is an open mind and modesty towards the environment they are to change, that is they should know that teaching the populations first means learning from them. We know that production levels may be raised with appropriate technical input but we are not sure

that the social cost of production would not finally be higher than the excess production. This will be discussed further on.

13 SETTING UP THE PROJECT.

The genesis of the Irrigated Perimeters project shows that the goals of the Senegalese State and the deep motivations of the peasants who are the true promoters (of the project) fit together. As a matter of fact, the Government put SAED in charge of carrying out an expansion plan for rice-growing in order to provide for the country's needs. Being concerned, the State provided SAED with the human and materia means necessary to attain self-sufficiency objectives in food crops.

Second part of the genesis of the project:

The common will of the peasants to organize themselves on the basis of the village communities to make their region, of which they are aware that it remains the poorest and one of the most backward in the country, an area of modern agriculture. The peasants are also very much aware of the great potentialities in their land. They have come to (understand) the necessity of a jointly organized action through an accumulation of isolated experiments which, even if they were failures, constitute the basic explaining factor of the cooperative group.

Those who attempted those isolated experiments now lead

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the various groups. DIABE SOW in KOUNGANI is a good example.

As some emigrants do, he took advantage of his vacations during his stay in Europe as a workman to make contact with the French farmers. There, the one who was to become later on the president of the federation of village groups, became aware of the wide gap separating means and methods of work of the KOUNGANI peasant and his French counterpart. He then decided to buy equipment and was the first to introduce animal-drawn equipment in farming when he purchased two Canadian ploughs.Two yokes of oxen and two ploughs which he shared with a childhood friend, CAMARA, should, if all goes well, convince the KOUNGANI farmer and later on the whole region, of the merits of modern agriculture.

In DIAWARA, another farmer back from Europe introduced some ten years ago, animal-drawn farm equipment as well as traction by cart.

In TUABOU, three farmers who were in FRance introduced fertilizers and ploughs.

These experiments were not convincing, first because of the enormous preparatory work in the fields prior to animal-drawn ploughing (stump removing and eventually

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evening out) beyond the possibility of the individual farmer and his family.

Second, the introduction of fertilizers in two of the above cases, implied new work for which the farmer had not been prepared (unfortunately, say those who introduced them, weeds as well as grass benefit from fertilizers). Weeding work increases two-fold, sometimes three-fold. In addition, the peasants, unaided, had difficulties training the animals. During the off-season, the animals forgot all they had learnt.

Thus, one understands that the vanguard farmers were able to sense the necessity of joint work, when CIDR decided to put competent and dedicated technicians at their service.

CIDR as an institution has served its purpose, since now those three technicians have integrated in SAED's team.

A third important factor: the motivations of SAED Director General who himself comes from the region. He knows better than anyone that the great potentialities of his region should be exploited. He is aware that he cannot allow himself to fail in front of his community. Even in the most remote villages, the farmers place great hopes in him. Our talks with the farmers revealed that they hope to be heard by SAED's management who have just carried out heavy work in a number of villages at a remarkable speed (bull-dozer, and grader).

HOW THE AREA'S COOPERATIVE GROUPS ACTUALLY OPERATE.

13.1 MEMBERSHIP.

All individuals, without any distinction of sex, age or caste, may join.

What is important is the work-capital that each member brings (human investment). In fact, every family has at least one representative within the group. We could see on the field that all castes worked together, that the society itself established its management regulations and dividing up in teams.

Where the collective gardens have already worked, the members said they were very satisfied.

However, some villages had to make some changes in their rules. The profit from the first harvest of the gardens came to about 150,000 CFA. In addition, there were the fines for absenteeism (150 to 250 F per day of absence) as well as the annual contributions of those who emigrated (1,000 F in some villages, other villages requesting from the emigrant to pay 3,000 F upon his return).

Collaboration being a village concern, there are no strict rules for joining the group. What is remarkable in the village cooperative system is that the leaders are willing to make regulations in all villages less strict; they want to avoid letting cooperation become the apple of

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discord.

When we asked if the cooperative would not shut itself to the outside world if it accumulated enough capital, we got the answer in several villages that mosques worth sveral millions CFA francs had already been built by local people. That the "village funds" had helped set up pharmacies which gross hundreds of thousands of francs.

In DEMBAKANE, after having built, thanks to the village fund, a dispensary and a school, the village is getting ready to build a mosque right after the rainy season.

These investments were made, we were told, for the whole community and not just for some privileged groups.

Everybody stated that cooperation should fit in the community concept of the Sarakolle or else it will not become reality.

13.1.1 CRITERIA FOR MEMBERSHIP.

All the members of the community are members of the cooperative group. We have already stressed the villagers' concept of the common fields which must not become a factor of dissension.

13.1.2 MOTIVATING FUTURE MEMBERS.

There is motivation at several levels. At the level of the groups' leaders, we saw dynamic individuals who had

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become aware of the economic advantages of a modern agriculture, but the constraints of environment had impeded (their efforts). For them, collective work seemed an urgent necessity.

These leaders also understand the economic advantages irrigated agriculture will provide for them.

A second group of participants is made up of those who have close relations with the natural leaders. The relations fit in the traditional context (FEDDE and kinship) and seem to be determining factors in the motivation of this second group.

We could see this with leaders such as CAMARA and TAMBADOU in KOUNGANI, who happen to be childhood friends of the cooperative group chief. In KADIEL, two of the leaders of the group are, for one the childhood friend, and for the other the brother, of DIENG, chairman of the group. Similar examples exist in BALOU, GALADI and MOUNDERI. All participants have joined the cooperative group "since it is a village undertaking". One would be marginal in relation to the community if one did not participate in work which the elders as much as youth leaders thought worthwhile.

So we see that for almost all members, the determining factors are of a psycho-sociological nature. Only a small group of privileged persons is quite aware of the economic advantages of this project.

What we have come to call a creativity competition between the various villages has become a recent tendency among the villages where the new groups are being installed. Sarakolle country is made up of villages which are watching one another. The setting up of the cooperative groups is a phenomenon not unlike the construction of the great and sumptuous mosques alongside the roads.

In addition to these psycho-sociological factors, there is another motivation which can be perceived only in areas where the collective fields experiments have been carried out to a great extent. For the farmers of these areas, the work of the group must teach them modern methods to be applied on the family "FOROBA" and the individual fields. It is significant that all the cooperative members we met, without exception, thought much more about the advantages as individual farmers. Family structure has more significance for the Sarakolle than a collective field of which they really have no experience. Are the women and the youth really motivated? As far as youth is concerned, we could not find an answer.

We know that, within the family, the young single man works on the family field at the same time he gets an income from his personal field.

These young people do not clearly see the method of circulation which is going to be put to work after the production operations (talk with a group of young people

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at the TUABOU school and at GALADE).

Ways of utilizing excesses must be found which would correspond to what the young people want.

As for the women, just as the young people, they are here because the pater familias wants it. Now, Sarakolle women already are overworked as one can tell with the following timetable established in BOLOKADJI during the season.

5:30 - 7:30	: - wake up - prepare breakfast - bathe the chidren
7:30 - 12:00	- leave for the fields - work on the cotton or rice field - return to fetch water - ground and wash the millet - prepare lunch - return to the field
13:30 - 16:00	: -ploughing
16:00 - 22:30	: - return from the field - prepare dinner - wash dishes - spin cotton

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The collective field therefore will demand an increase in work. Already in MANAEL, a group of around thirty women have manifested their dissatisfaction by not going to the collective field any longer. One must not conclude from this that women are not at all motivated by the collective group.

1) They constitute an indispensable manpower within the family and their presence on the collective field deprives the chief of appreciable manpower. Anyway, in the MANAEL case, we know that they have been encouraged by the family chiefs themselves.

2) They have not been convinced that this project may fundamentally change a lot in their subservient condition. The training and information part has not worked for this project which is far from the mere placing of a technology upon a given society.

Programming of relevant investments should be done to maintain present enthousiasm.

Can excesses be used in priority to ease the work of women (well drilling, purchase of a mill which would decrease women's extra work by 25 to 50%) ? The cooperation must clearly state its objectives. The weakest point of the operation seems to us to be the way the leading members of the groups are made responsive (to the project).

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13.2 THE LEADERS.

The study of the leading teams clearly shows that the social structure and the management structure of the cooperative are superposed. This is not surprising. Any profitable project in any society tends to be recovered by the leaders. This may mean in certain groups, an increase of the number of economic statuses. In other societies, on the contrary, this may mean a reinforcement of status, authority, entailing a differentiation in incomes.

In six villages taken randomly, four group chairmen are sons of chiefs. One group is chaired by the nephew of the village chief, the sixth group is led by a member of the second great family.

However, there is one innovation in the work teams, in spite of a certain rigidity in the social stratification. The work teams (average number 5 to 7) depending on the villages, have either someone of slave ancestry, or a THIOUBALO, or a member of the ruling family as their chief.

Now, the team is characterized by a self-imposed discipline. The team leaders are always obeyed for they are acknowledged for their honesty, their competence, their eagerness at work and their experience. Almost all the team leaders have travelled abroad (mainly Europe). The group introduces an unknown dimension in the village society. New criteria have determined the profile of team leaders: technical com-

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petence, an open mind, his education (speak French, read and write) outside element to the definition of the traditional authority structure. Thus, an individual who, by right of birth or age, would be placed at the level of the centers for implementing or broadcasting the decisions, may be placed at the leading level within a team. Undoubtedly this is a positive factor but it is not desirable or realistic to go too fast, in our opinion. The project must be acceptable, that is it must bring the society to a gradual and generalized change.

Another important fact, the cooperative is not based on seniority. The oldest members of the ruling families are not necessarily the presidents. The president is always the one who has travelled a lot, who has met many people in BAKEL, DAKAR, who is able to discuss with the political-administrative authorities.

13.3 THE DISTRIBUTION OF THE PROFITS.

It is premature to speak of profit within a group.To our knowledge, crops are sold in the villages and the money is always kept but not distributed. MANAEL is an exceptional case where the crop was self-used, a sack of millet having been distributed to each family.

The income from the gardens, which we will keep from calling profit, from an accounting point of view, have served here

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and there to purchase yokes of oxen, shovels (1,500 F a piece) or fertilizers.

We see that there has been no distribution of the income but the money available has been used to make progress in the action undertaken.

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14. MINIMUM PROFILE OF THE PARTICIPANTS.

As already mentioned, the criterion for membership is free participation of all villagers. Actually, wherever we went, almost all villagers were members of the cooperatives. One recent tendency is that new comers (emigrated once to France) are requested fees for joining.

Financing was obtained owing to an input of CIDR staff, to the equipment supplied by USAID and SAED. This has served as basis for starting the gardens in areas where the use of pumps was completely ignored.

The remainder of the investment was made under the form of work performed by the villagers. We were impressed with the great care that the cooperative groups gave to pumps which have been supplied to them. It would be desirable to help villagers in solving minor technical problems (pump lift capacity and maintenance).

The technical aspects must be seriously considered, especially for the motor-pumps which are going to be installed, because technical deficiencies during the critical period for crops would have a disatrous effect on the cooperators morale.

Farmers know that they own the motor-pumps. What they totally ignore is the cost of the motor-pumps which are put at their disposal, the life-time of the pumps, the availability of spare parts and of competent technicians with SAED on which

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they rely with total confidence (the General Management having always satisfied their requests) and the average time it takes for the company to repair these pumps.
It would be desirable in the future, to emphasize the problems of financial management because the notion of providing for depreciation which is fundamental for a project such as the Irrigated Perimeters must be assimilated by the farmers.

14.1 STATE OF MIND.

The following observations are raised by the state of mind we met with: the refusal on the Sarakolles' part to sit and watch which appeared clearly from our discussions.

1) The refusal to be enrolled by the State and its services:
The president of the federation of cooperative groups did state that it would be desirable to define the contractual obligations between the groups and SAED: "We are prepared to reimburse SAED for the services provided if that can make us the masters of our projects."

What is striking in the whole region is the awareness that cooperation under its previous form was a failure. This is not surprising since the cooperative move was compelled in the beginning, to emphasize the problems of peanut commercialization, because of the way things were.
Here, these are self-managed production groups.

The leaders of these groups found themselves faced with

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insuperable difficulties. Thus, union appeared to them imperative. But, cooperation should in no way jeopardize the existence of individual exploitation. On the contrary, collective fields are a place for learning new techniques.

We think that at present, considering the mentalities, staff guidance must be done from a distance, indeed in an unperceivable manner.

2) The great availability of funds:

Important sums were collected from the absentees, for here, one does not like to be in debt.

The Sarakolle, traditional tradesmen, do not want to be considered bad payers either by individuals or by the State (bad payers bring shame to their families, a village in debt loses its reputation in front of other villages.) No village chief wishes to appear a bad payer towards the State.

3) The third element is the notion of common solidarity appearing in the social context in GANDE:

A villager advanced money (76,000 F) to the group with no other guaranty than his trust in the leaders: "We are all relatives". When we asked the president what he would have done in case the collective field's crop had been destroyed, he answered that all villagers would have contributed money or that members would have made bricks to reimburse him.

We met the same phenomenon in KADIEL. Because of the prestige conferred by the status of president of the group, president

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DIENG's younger brother willingly lent an ox to the cooperative group. His friend COULIBALY from the same FEDDE, brought in his only ox. His deep motivation being that DIENG is linked to him by the indestructible ties the FEDDE has created between them.

Incidentally, COULIBALY is a COMO (slave ancestry).

15. Difficulties in accepting or participating in the project.

The difficulties we have been able to notice are of two types.

The first one is relative to the schedule or to the overload of work among some classes: women and small-sized families.

The second one which is exceptional, is of a political nature.

15.1 DIFFICULTIES DUE TO TIME CONSTRAINTS.

We have already mentioned this point which is quite important for small-sized families. Membership modalities must be found which would take into account the ratio of active men and family size. For, in spite of the motivation which does exist among all the populations, absenteeism is relatively higher in smaller families.

As for women who are permanently mobilized by their ploughing activities or their domestic activities, it is difficult to consider increasing their workload. The problem of area increase will thus face serious constraints.

16 PROJECT IMPACT ON THE SOCIAL STRUCTURE.

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16.1 THE STRUCTURE OF AUTHORITY.

The project is an innovation in the Sarakolle environment. It is the first time indeed that families of all social conditions and castes meet for a project addressing the whole community. These people are going to discuss the conditions of implementation of the project and its orientation. Together they are going to make a critical appraisal of what has already been achieved. All age classes so gathered are going to be able to judge the leaders of the cooperative groups. It is impossible to know if the society is not going to generate, as the project progresses, inhibitory means towards younger members and women.

Other structures of authority not based on village tradition and related to technical competence, ability as team leader and manager, are going to appear. These factors are not linked to the status of the individual at birth.

For the collective field as a matrix for experience where people of all social conditions are going to meet daily on a new basis, will surely create a critical awareness.

16.2 THE ECONOMIC STATUS OF THE VARIOUS CLASSES.

The Irrigated Perimeters will surely change the status of the various social classes. Already, the fines assessed for absenteeism certanily affects more the poorest families, considering their workload, which is relatively heavier than that of larger families. In spite of the fact that the project

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will raise the standard of living of each social category, the rules set for the group's operation and the process of the circulation of the social product among the various strata must not be unfavorable to the poorest classes.

16.3 THE ROLE OF WOMEN.

For the first time in the history of the region, a project overlooking the sexual division of work is undertaken. For the time being, women are mobilized under the men's absolute authority. But, as for youngsters, the presence of women working alongside the heads of families will certainly bring discrepancies in the structure of authority. Unless the collective fields are divided up into plots according to the structure of society, it is obvious that it will occur to the women that they play an equal role in the project. Will this lead them to formulate judgments on the overall society and consequently to a modification of the role they play in it ? It is impossible at present to answer this question.

17 PROJECT IMPACT ON EMIGRATION.

One should not expect emigration to slow down in the short or medium term. All 14, 15 and 16 years old youngsters intend to leave the country to replace a brother or cousin in Europe. This is justified by the relatively important sums provided by emigration. Income from the collective fields are presently very low, enough to justify in the

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Sarakolle's or Toucouleur's opinion, the seeking of additional income abroad.

One should not expect a significant slow down of the emigration in the medium term. There will be four or five years between the pilot experiment with the collective field and the application of the techniques learned.

18. As a conclusion, it should be recalled that transformations of a sociological nature are an extremely slow process, almost unperceivable in the short-term.

In our opinion, the objectives of the Irrigated Perimeters should not be centered around providing for the needs in food crops, for the next three or four years.

Present day Sarakolle society seems to give a minimum of security to the individual at the least cost. What in this society is still viable and could provide the project with a reason for being must be sought.

As for the project's sociological results, they must be evaluated after a two-year operation period in the following manner:

1) At the cooperative group management committee level: Check changes in the team's make-up. Greater or lesser participation of youngsters who could have a representative in the leading team. Participation of certain

social strata, for example the COMO, the THIOUBALO. Representation of women in the management committees.

2) At the level of the work teams: (evaluate) what changes have occured in present day teams: (has there been) a withdrawal of the HOMO for prestige's sake when the team leader is a COMO or THIOUBALO or on the contrary, (is) team work more efficient ?

Also, it would be desirable to investigate whether the project has had an impact on individuals' motivations, particularly on vulnerable groups. A rapid investigation should determine the concrete achievements benefiting these groups. A short and retrospective questionaire will appraise the evolution of mentalities especially among the young and the women.

As for the relation traditional structure of authority/ cooperative group, it can only be appraised, in our opinion, in the ways the social product is really distributed and how it is finally appropriated. A greater mobilization of the young ones will be the most patent evidence that this appropriation of the social product has had a positive impact on youngsters and women.

7/23/76:yd

Annex I — Social structure and peopling pattern - E.g. village of WAOUNDE

☆ I: Decision of the village's supreme council (Horro chiefs - marabouts chiefs)

VII. the decision being communicated to the community (Hen)

DIAKHITÉ : amits (?) the Imam

DIAGANA : CORANIC TEACHING.

☆ Mosque

✝ Cemetery

ANNEX - L -

I N I T I A L

E N V I R O N M E N T A L

E X A M I N A T I O N

3.B.1.

Figure - Environmental Impact Assessment Matrix

Significant Impact

Relative magnitude of the interaction

Relative importance of the interaction

10 is the greatest magnitude

	A. Modification of regime	b. Biological controls	c. Modification of habitat	d. Alteration of ground cover	e. Alteration of ground water hydrology	f. Alteration of drainage	g. River control & flow modification	h. Canalication	i. Irrigation	B. Land transformation & construction	i. Canals	C. Resource extraction	f. Clear cutting & other lumbering	D. Processing	a. Farming	i. Food	E. Land alteration	a. Erosion control terracing	F. Resource renewal	c. Ground water recharge	d. Fertilization applicate	I. Chemical treatment	a. Fertilization	d. Weed control	e. Insect control (pesticides)	J. Accidents	c. Operational failure
A. Physical & Chemical characteristics																											
1. Earth																											
c. Soils									6/6									7/7		6/3							
d. Landform															7/6	7/7		7/7									
2. Water																											
a. Surface									6/5		7/3				7/7	8/7		7/7									
d. Quality									2/7		7/1				7/7												
4. Process																											
a. Floods							7/3									7/7		7/4									
b. Erosion									4/6		1/6				5/7			7/7									
B. Biological conditions																											
1. Flora																											
a. Trees			5/7	7/7									7/7														
d. Crops	6/4	7/4							7/5						7/7	7/7					7/4		7/5	7/5	7/5		7/5
f. Aquatic plants				3/6					5/6		5/6				6/6	7/7					7/5			7/6			
2. Fauna																											
a. Birds															6/4												
e. Insects															7/6	7/5									7/6		
C. Cultural factors																											
1. Land use																											
d. Grazing				6/3					6/3						6/3												
e. Agriculture				7/7		6/5		6/5	7/5		7/6		7/5		7/5	7/7		7/6			7/4		7/5	7/5	7/5		7/6
4. Cultural status																											
c. Employment									7/5						7/6												
D. Ecological relationships such as																											
4. Food chains									[illegible]						6/5						7/6		7/5		6/6		

The reduced matric of numerically rated environmental aspects is shown in Table 3 (B)1. Analysis of the rating matrix indicates the following:

Resource Linkage: No significant changes are anticipated in the total ecosystem of the Bakel region. The land use pattern of the area irrigated will be altered, but the total area irrigated will be relatively small. Initially a total area of 200 - 300 hectares increasing to about 1800 hectares widely spread among 24 villages is being proposed for irrigation development. Most of the lands being proposed for irrigation development are presently virgin or devoted to dry land crops of largely millet and maize. The PP team observed that only a very small portion of the activity was truly virgin land which had not been cultivated sometime in the past showing natural regrowth.

The present labor force of villagers will not be significantly altered, as the labor analysis shows that adequate labor is available to implement off-season activity as an adjunct to traditional cultivation. The villagers regard irrigated culture as a supplement to traditional farming, which will continue to remain the mainstay agricultural activity. Thus, the population distribution will be altered but slightly. If the irrigation culture area grows to larger proportions, say to 3,000 - 4,000 hectares or more perimeters in the 10-20 year future (if the initial irrigation activity efforts prove successful) there may be

population shifts and immigration to support expanded irrigation and other related activities. No new villages are predicted, but population in some villages near irrigated perimeters may increase.

Fish and wildlife ecosystems will be altered significantly on those areas to be irrigated. However, the total area affected is very small and will not significantly effect the total fish and wildlife ecosystem. Water withdrawals, largely from the Senegal River, are relatively small and will not affect fish life systems to any significant extent. In some rice paddy areas of Southeast Asia, fish for human consumption are propagated in the paddy ponds and add important protein to the diet. This practice is unknown in the Senegal River Valley. Since the paddy areas in the Bakel region will be permitted to dry up intermittently during the growing season, paddy fish culture will not be feasible.

The increased produce of rice and maize may generate additional transportation requirements. During the third year of the activity, surpluses of products (rice and maize) may begin to appear and will need to be exported to other regions of Senegal for sale. Both road and river transport will need to expand to provide the required increased service. Railroad shipping facilities are only 30 kilometers from Bakel connected by a fair road. The crops to be produced (rice and maize) are readily storable for railroad transport. No great transport constraints are envisaged. Transport can grow gradually to provide the demands that may generate from the activity. The environmental effects of improved roads, ect. will have to be addressed as the roads are developed.

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The marketing train will have to be expanded. During the initial phases (2 - 3 year period) produce (rice and maize) will be absorbed into the local village markets and Bakel. As surpluses begin to appear, traders will gain experience over prolonged time as the surpluses will generate slowly and no great constraints are predicted in the marketing train and/or required facilities. No major milling facilities are planned under the project, therefore effects caused by the mill or by-products are not considered.

Physical Aspects:

Sedimentation and erosion were considered on the canals and drainage. Since the river flow carries a small bed load, water borne sediment will be very small and no significant problems are anticipated with silt from the river water. The irrigation systems will be served by relatively small capacity pumps and adequate structural erosion controls are being emplaced in the main canals (which are relatively small) and in the laterals, so minimal erosion is expected in the channel ways. Since pumped water is being utilized on ponding rice fields, a relatively low runoff waste will be developed and drainage will not be a problem. Drainage ways are provided but will not be required extensively, as the pumps will be shut off during periods of non-water demands.

The activity intends to irrigate land areas formerly in rainfed crops or not being cropped. Through necessity, only the higher lying lands or those most flood free will be developed for irrigation. The soils in those areas are the most recent alluviam, relatively deep and fertile (See Annex 2).

The predominant soil types on the perimeters are fonde soils which constitute about 65 percent of the surface project area. These soils have up to a 44 percent clay content. They are well aerated with good capillary action, permeability and drainage. They are irrigable and usually suitable for wheat, sorghum, peanuts, corn, cowpeas and vegetables. About 35 percent of the area is of the Faux Hollaldes soil type, a medium heavy soil with up to 50 percent clay content. These soils are irrigable and suitable for rice, sorghum and other cereal grain crops. The soils, since they are recent alluviam and not heavily stratified are well drained, particularly in the higher lying zones. No drainage problems are anticipated in the proposed irrigation areas.

On the other hand, the best rice paddy soils are those that have or can be developed over an impermeable clay pan about 30 - 40 cm below the ground surface that will reach the water table, thus providing conditions for efficient

water utilization. An impermeable soil layer is usually accomplished by "puddling" the soil or disturbing the soil texture until a compact layer is developed producing an ideal rice growing ponding water environment. If the area is expanded greatly, the long term effects on the soils of this rice growing culture will need to be assessed by an irrigation land classifier well versed in tropical rice culture. However, initially with a total area being proposed for development of less than 2,000 ha. spread over a large area, the project will not have a significant overall effect on the soil environment. With the project developing slowly, as planned, those effects can be assessed before widespread rice development occurs.

Water withdrawals from the Senegal River are relatively insignificant and will have little effect on River flows due to limited project demands. Water use for rice will become more efficient and reduced as the farmers become aware of the relation of diesel costs to water volumes pumped.

The types of irrigation facilities being planned would not cause much area to be continuously wet for long periods. Because the plan has a separate system for each village, the pumping of water will be intermittent. The pumps will be run and the canals filled only for so long as needed to deliver water to the fields. Then they will stop and dry

out. In general, the fields will have a dry surface for a period before the next irrigation is applied. The soils have excellent moisture retention characteristics so that frequent irrigation is not necessary. Even the surface of a rice field can be dried without harm to the crop and the cloudy water requires lowering of the water surface to allow sun to reach the lower stalks during the early stage. Later the deeper roots extend the period before added water is required, also assuring against constantly standing water.

There is a likelihood that in the first few years, poor land leveling might result in spots in the fields that will not fully drain and thus remain inundated between irrigations, but in time such spots will be eliminated because the crops do not produce well in such wet spots, so the farmer will fill them in.

Waste water going into the natural watercourses and drains will tend to extend the life of swamps and pools in nature. However, due to the fact that the villagers and farmers must pay for the cost of pumping water, they will try to reduce water wastage. Thus the area of such natural ponds or swamps should not be greatly increased.

It is desirable to emphasize that in this area of single village systems, irrigation canals, etc. will be used intermittently, not constantly as in larger project areas.

Aquatic plant vegetative growth will be encouraged in the rice paddies. The ponding water, as it is designed to do, will inhibit much of the weed growth. To produce a good rice crop the farmers will intensively eliminate all undesirable growth. Since water deliveries are limited to the requirements of the paddy fields and are shut off there will be little waste water to promote swamps and wet areas adjacent to the irrigated areas. And since the water deliveries will be intermittent, those areas and ditches and laterals will dry up, thus preventing excessive ponding and unwanted aquatic growth.

The Senegal River water has a very low salt content, and no salt buildup in the paddy areas is predicted. Chemical fertilizer use is relatively low (250 kg ha) on rice and will have minimal effect on the salt content of the groundwater. Although it is anticipated, due to the high permeability of the soils that a portion of the applied chemical fertilizer will be leached into the groundwater reservoirs and will find its way back into the river, the buildup of groundwater saline conditions will be very slow and will pose no problem in the predictable future.

No impact is anticipated from construction activities. The irrigation systems are largely village hand labor construction facilities and will be relatively very small

construction features. No major field construction activities are planned. The perimeter dikes are also small construction facilities and will have low impact. Since the rice culture will be practiced during the rainy season, excess ponding may occur inside the dikes, if constructed on some perimeters, and a means of draining those possible ponded areas will be provided.

Climate will not be discernably affected as the total area of the activity is small and scattered.

Socio-cultural Aspects:

As noted above, there will be little population relocation or resettlement as the activity is included into the existing village social structure. The utilization of a single village water system in this proposal is good because it uses an existing social organization and does not complicate the existing social structure by a new entity. The responsibility and authority remain within the village. The suggested size of the perimeters permits this type of irrigation system.

Population growth may occur in the long run if the activity grows to massive proportions, but the growth if any, as a result of the activity will be very slow and problems if any develop, can be resolved within the normal village structur

Esthetically, the general environment will be improved by the presence of green growing fields of rice during the season in an otherwise very drab-appearing environment.

Public Health Aspects

The population growth will not be accelerated significantly above normal growth due to the activity, therefore health and diseases aspects will be aggravated very little beyond that already existing.

Disease vector mosquitoes are not expected to increase due to ponding of water in the paddies. Since the water will be delivered intermittently and the paddy fields will be permitted to dry out occasionally, the vector producing environment will be disturbed and it is anticipated this will be no greater problem than now exists in the area. Similarly bilharziasis (schitosomiasis) are not expected to increase. The area ponded is relatively small compared to the existing areas of swamps and ponded marigots zones in the region and again will be dried occasionally thus inhibiting development of a large snail population. The overall effects of the project on public health in the area will be minimal.

Pesticide/herbicide usage will not be part of the initial technical package in the activity.

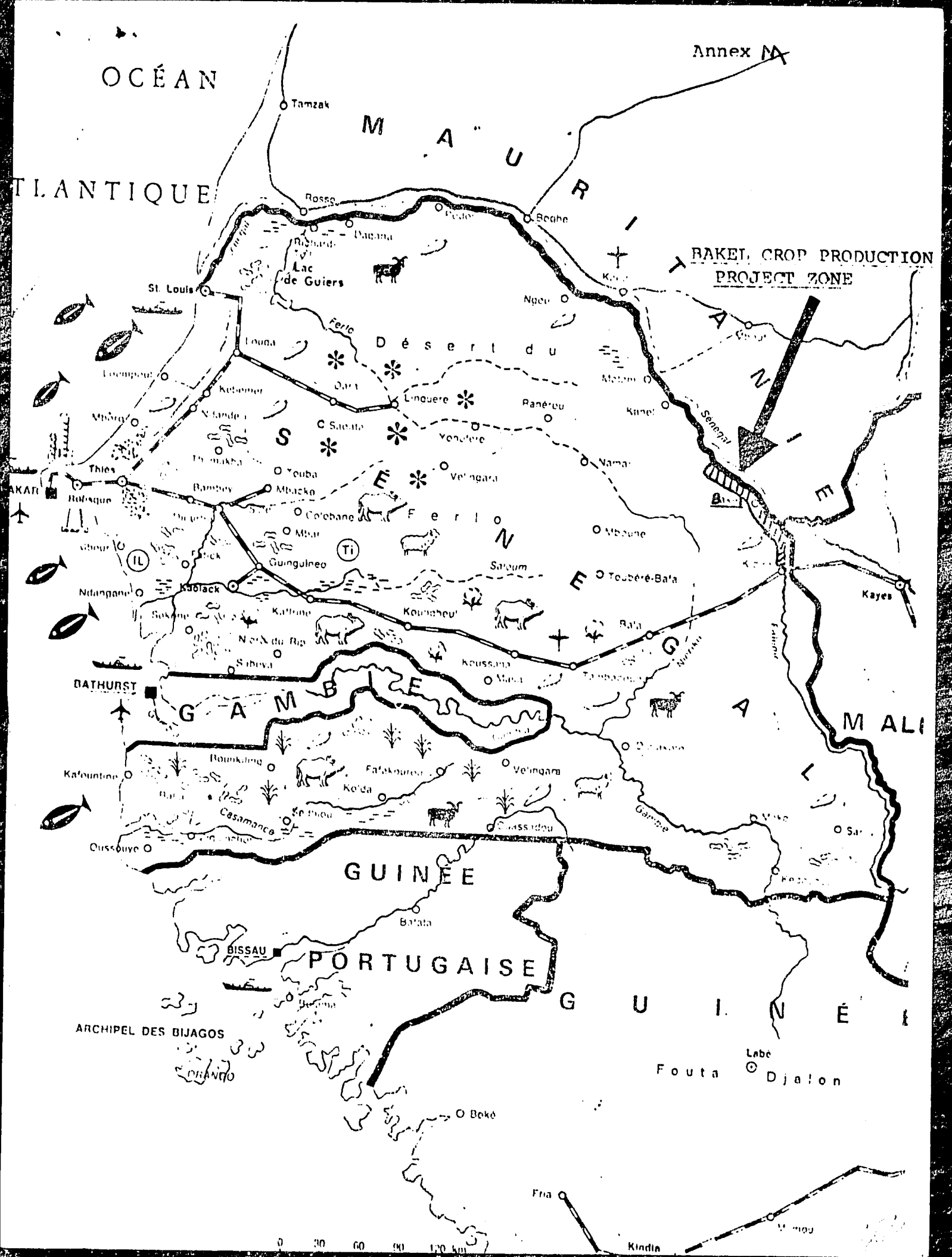
The villagers obtain their domestic water largely from the Senegal River and some shallow village wells. The activity may augment the groundwater supply in the upper aquafiers. The water thus added of equal quality as that now utilized

by the villagers and will not significantly alter the health hazard.

Increased food storage requirements as a result of the activity may generate an increased rat and rodent population. The villagers now store the crop in elevated bins on stilts, and frequently install "rat shields" on the stilts to prevent invasion of rats and rodents into the stored crop. Improved storage facilities and rat prevention will need to be developed over time and the problem will be appropriately resolved by the villagers.

All environmental aspects have been examined by the PP team and the project committee and they are of the opinion that there will be no significant adverse environmental effects due to the project, therefore an environmental assessment is not required.

Annex A


OCÉAN
ATLANTIQUE
MAURITANIE
BAKEL CROP PRODUCTION PROJECT ZONE
Tamzak
Rosso
Boghe
Richard-Toll
Dagana
Lac de Guiers
St. Louis
Louga
Ferlo
Désert du Ferlo
Linguere
Ranérou
Kanel
Matam
Ngeo
Kebemer
Mbour
Thiès
DAKAR
Bambey
Mbacké
Colobane
Mbar
Guinguinéo
Kaolack
Ndangane
Kaffrine
Koungheul
Tambacounda
Bakel
Kayes
Toubéré-Bala
Bala
Keussana
Sabéva
BATHURST
GAMBIE
MALI
Kafountine
Bounkiling
Fatakourea
Velingara
Kolda
Casamance
Ziguinchor
Oussouye
GUINÉE
Bafata
BISSAU
PORTUGAISE
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ARCHIPEL DES BIJAGOS
Fouta Djalon
Labé
Boké
Fria
Kindia
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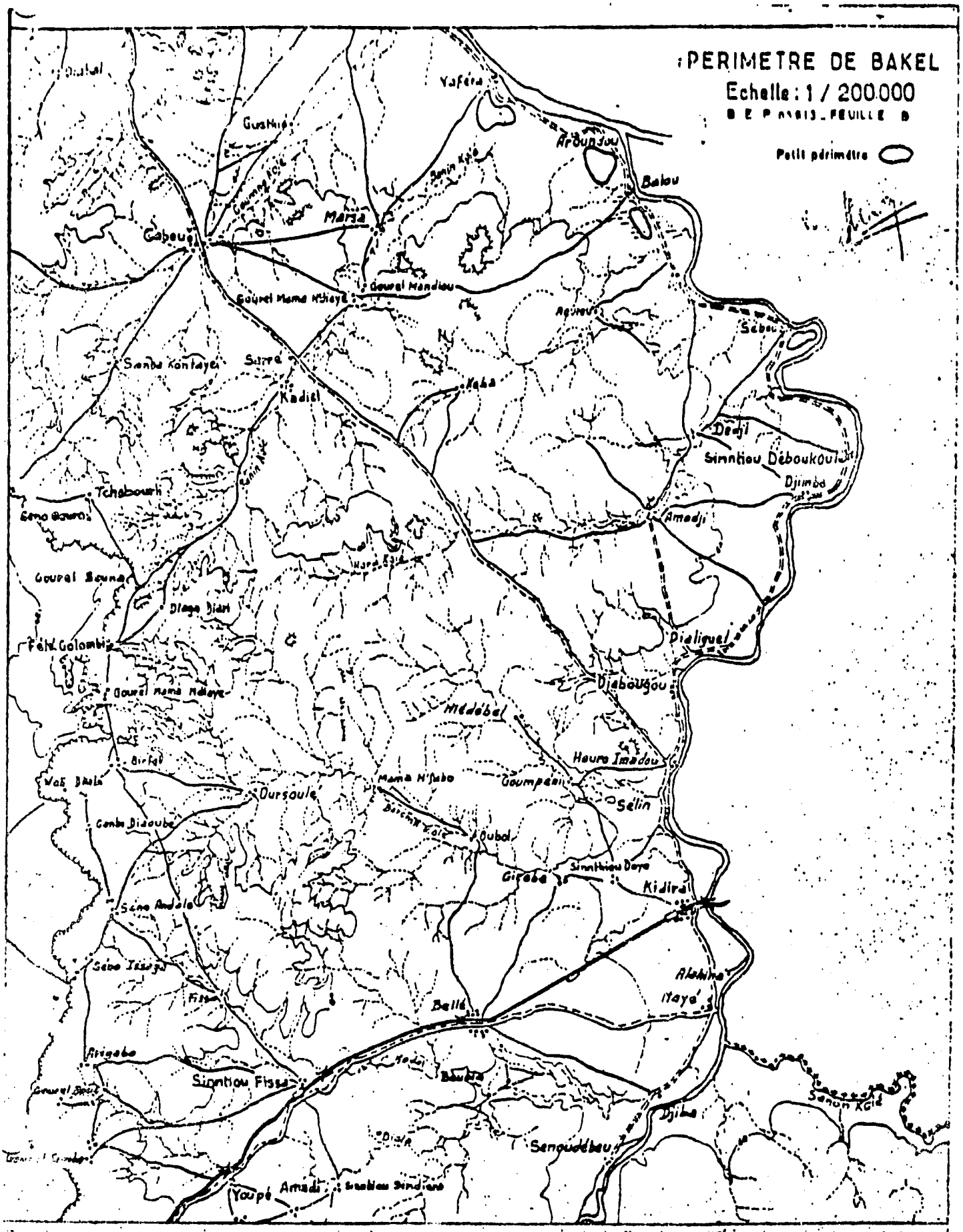
PERIMETRE DE BAKEL
Echelle : 1 / 200.000
Petit périmètre
Yafera
Gustiré
Arounjou
Balou
Marsa
Gabou
Gourel Mandou
Gourel Mama Mbaye
Sabou
Senba Kontaye
Sarré
Kaba
Kadiel
Dedji
Simntiou Déboukoulé
Djimba
Tchabouch
Amadji
Gourel Sounar
Diage Diam
Dialiguel
Fele Golombé
Gourel Mama Mbaye
Djabougou
Mbédébal
Birfal
Heure Imadou
Wal Diala
Mama N'Jabo
Goumpani
Oursoule
Selin
Gomb Diaoube
Dubol
Simntiou Dere
Girabe
Kidira
Senn Andale
Senn Issaga
Alakina
Itaya
Fissa
Belé
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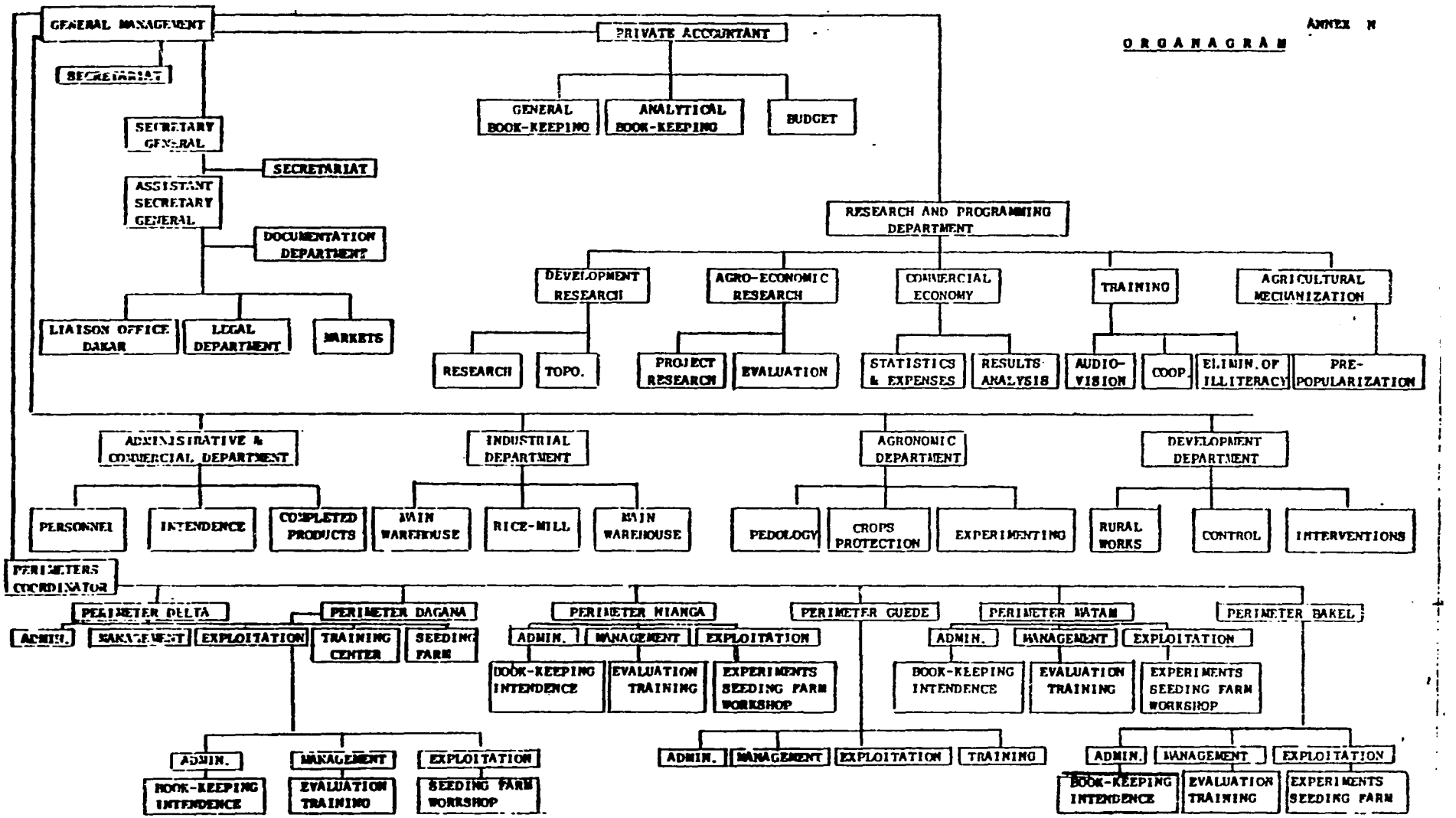
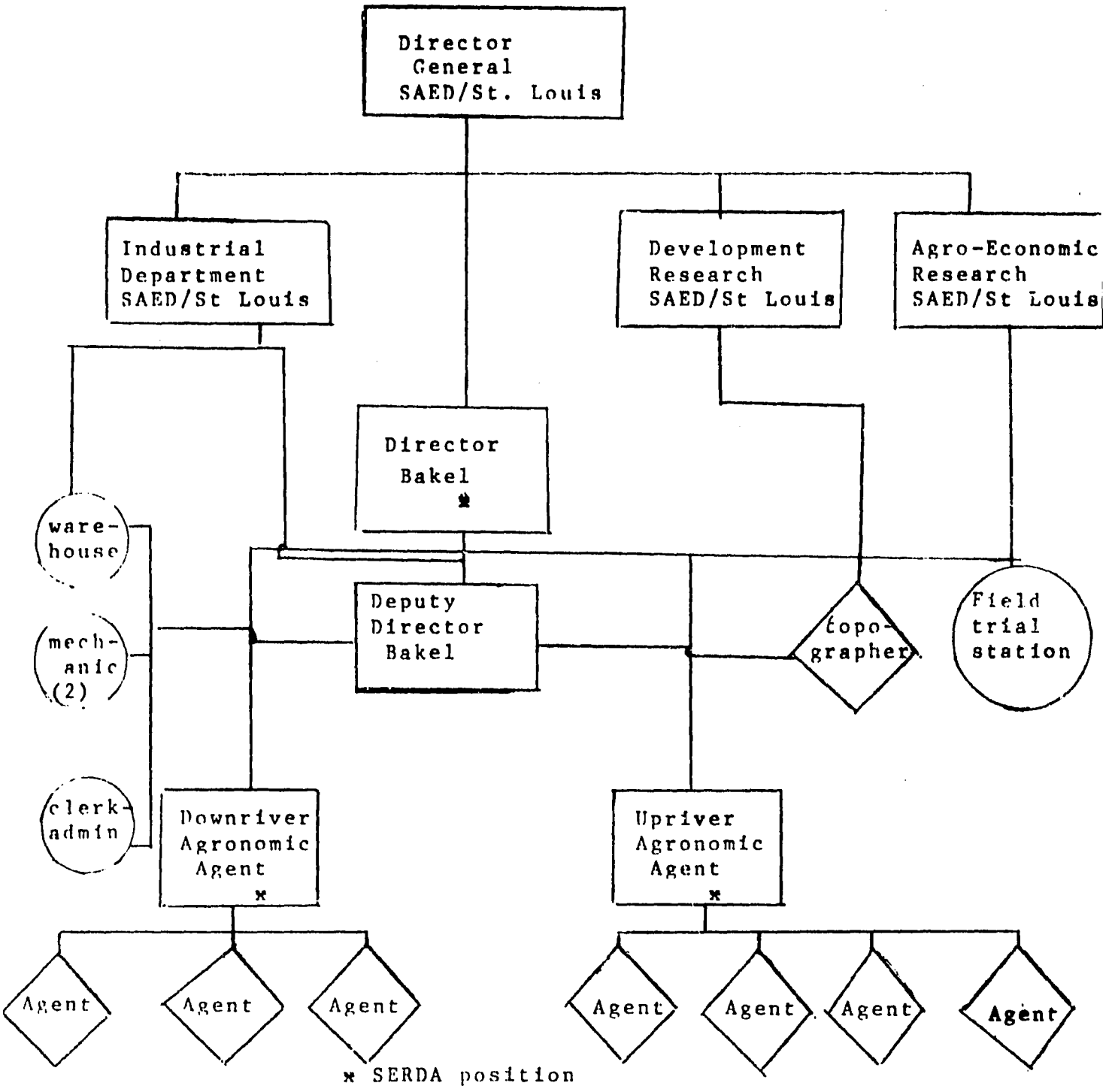
Djiba
Senoudebou
Youpé
Amadi
Simntiou Bindiane

ANNEX N

ORGANAGRAM





Organagram SAED . BAKEL