PROJECT PAPER

O.M.V.S. AGRICULTURAL RESEARCH PROJECT.

625-0605

(VOLUME I)

USAID/SENEGAL
B.P. 49
Dakar, Senegal

AGENCY FOR INTERNATIONAL DEVELOPMENT

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: A (A = Add, C = Change, D = Delete) — Amendment Number: ____

DOCUMENT CODE: 3

2. COUNTRY/ENTITY: O.M.V.S.

3. PROJECT NUMBER: 625-0605

4. BUREAU/OFFICE: AFR — 06

5. PROJECT TITLE (maximum 40 characters): OMVS AGRICULTURAL RESEARCH

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 12 DD 31 YY 87

7. ESTIMATED DATE OF OBLIGATION (Under 'B.' below, enter 1, 2, 3, or 4)
A. Initial FY 82 B. Quarter 1 C. Final FY 86

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY 82 B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total						
(Grant)	(2424)	( )	(2424)	(12,890)	( )	(12,890)
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1. Title III		0	0		1,090	1,090
Other U.S. 2.						
Host Country OMVS		900	900		2,900	2,900
Other Donor(s)	200		200	1,200		1,200
TOTALS						18,080

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) SH	S121	080		0		12,890		12,890	
(2)									
(3)									
(4)									
TOTALS									

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 963, 053

11. SECONDARY PURPOSE CODE:

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)

A. Code	B/AG	BS	XII				
B. Amount							

13. PROJECT PURPOSE (maximum 480 characters)

To search for ways to increase the efficiency of utilization of land, labor and other inputs, particularly water, in existing agricultural production systems in the Senegal River Valley.

14. SCHEDULED EVALUATIONS
Interim MM 10 YY 83 — MM 11 YY 85 — Final MM 12 YY 87

15. SOURCE/ORIGIN OF GOODS AND SERVICES: [X] 000 [ ] 941 [ ] Local [ ] Other (Specify) ____

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a ____ page PP Amendment.)

1. Design of research program and implementation support for Phase II of project.
2. Change of name of project to OMVS Agricultural Research as requested by O.M.V.S.

17. APPROVED BY
Signature: David Shear
Title: David Shear, Director, USAID/Senegal
Date Signed: MM 8 DD 28 YY 81

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM DD YY

AID 1330-4 (8-79)

O. M. V. S

Agricultural Research Project

625-0605

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II. PROJECT AUTHORIZATION

Name of Grantee : OMVS

Name of Project : OMVS Agricultural Research

Number of Project : 625 - 0605

1. Pursuant to Part I, Chapter 1, Section 121 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the OMVS Agricultural Research Project for the Senegal River Basin Development Organization (OMVS) involving planned obligations of not to exceed Twelve Million Eight Hundred and Ninety Thousand Dollars ($ 12,890,000) in grant funds over the planned life of project of six years from the date of initial obligation, subject to the availability of funds in accordance with the A.I.D. OYB/Allotment process, to help in financing foreign exchange and local currency costs for the project.

2. The project consists of technical assistance, construction, commodities, training, and operating support to the OMVS to contribute to regional economic development through increased agricultural production in the Senegal River Basin by undertaking research to increase the efficiency of utilization of land, labor and other inputs, particularly water, in existing agricultural production systems.

3. A Project Agreement, which may be negotiated and executed by the Officer to whom such authority is delegated in accordance with A.I.D. regulations and Delegations of Authority, shall be subject to the following essential terms and conditions, together with such other terms as A.I.D. may deem appropriate. OMVS and Member State contributions to the project shall be not less than Two Million Nine Hundred Thousand Dollars ($ 2,900,000) including in-kind costs for personnel, land, etc.

a) Source and Origin of Goods and Services

Goods and services, except for ocean shipping, financed by A.I.D. under this project shall have their source and origin in the United States or in Senegal, Mauritania or Mali except as A.I.D. may otherwise agree in writing. Ocean shipping financed by A.I.D. under the project shall, except as A.I.D. may otherwise agree in writing be financed only on flag vessels of the United States.

...

b) Conditions Precedent

Prior to any disbursement or the issuance of any commitment documents under the Project Agreement the OMVS will (1) appoint a Project Coordinator who shall be responsible for project implementation, (2) establish a project accounting and audit system acceptable to USAID, (3) obtain assurances from the Member States that land will be made available for construction and research trials, and (4) obtain a letter of agreement from the Title III Management Commission in Senegal's Ministry of Finance concerning the use of Title III funds for project construction.

c) Waivers

I approve a waiver to A.I.D. regulations to permit procurement of agricultural equipment and vehicles from Code 935 (Special Free World) for a total not to exceed Two Hundred Thousand Dollars ($ 200,000). I certify that the interests of the United States are best served by permitting the procurement of services from free world countries other than the cooperating countries and countries included in Code 941, and that procurement from the recommended sources is necessary to the attainment of U.S. foreign policy objectives. I find that special circumstances exist which justify the waiver of the requirement of procurement of U.S. manufactured motor vehicles under Section 636 (i) of the Foreign Assistance Act of 1961, as amended.

4. Clearances:

	Name	Office	Date	Initials
A.	David Shear	USAID/Senegal	8/26/81	DS.
B.				
C.				
D.				
E.				
F.				

5. Approval:

M. Peter McPherson
Administrator
Agency for International Development.

Approved _____
Disapproved _____
Date _____

III. Project Description

A. Summary and Recommendations

A.	Country	: OMVS (Senegal River Basin Development Organization)
B.	Project	: Agricultural Research (625-0605)
C.	Funding	: $12.9 million
D.	Life of Project	: 6 years
E.	Waivers	: Code 935 waiver of $200,000 for equipment and vehicles.
F.	Conditions	: Appointment of OMVS Project Coordinator

This project paper amendment represents the completion of Phase I of Agronomic Research II (625-0605) FY 79 which provided for a complete redesign of the Senegal River Basin Development Organization (OMVS) regional agronomic research program in the Senegal River Basin (SRB) (Figure 1). This redesign was undertaken by the Consortium for International Development (CID) under the Collaborative Assistance mode. Approval of this Project Paper (PP) amendment will begin Phase II or the implementation of Agronomic Research II* FY 81 through 87. AID grant assistance proposed under this project will total about $13 million over six years (FY 82 through FY 87). In addition there will be about $1.1 million in local currency (Title III) funds.

The overall program is built around a set of comprehensive agricultural research activities focused on small-scale farming systems in community settings. There are six main categories of inputs:

1. Technical Assistance or a core team of agricultural scientists stationed at each of three existing research stations, in Fanaye, Senegal; Kaedi, Mauritania; and Samé, Mali; project administrators and staff, and various short-term scientists as needed. (Estimated cost $6.5. million)

2. Construction and Facilities Development consisting of field research site preparation, and construction of laboratories, office space, staff housing and infrastructure. (Estimated cost $3.5 million + $0.6 million in Title III funds.)

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* The project title is being changed to Agricultural Research. However, the PP sometimes refers to the old name "Agronomic Research II" in order to clearly present the origins of the project.

3. Equipment including vehicles, farm and laboratory equipment, tools, and spare parts. (Estimated cost $0.7 million.)

4. Formal and Informal Training to be done in-country, in third countries, and/or in the U.S. (Estimated cost 0.9 million.)

5. Local Operating Expenses (Estimated cost $1.2 million + $0.5 million in Title III funds.)

6. Miscellaneous Support (Estimated cost $0.5 million.)

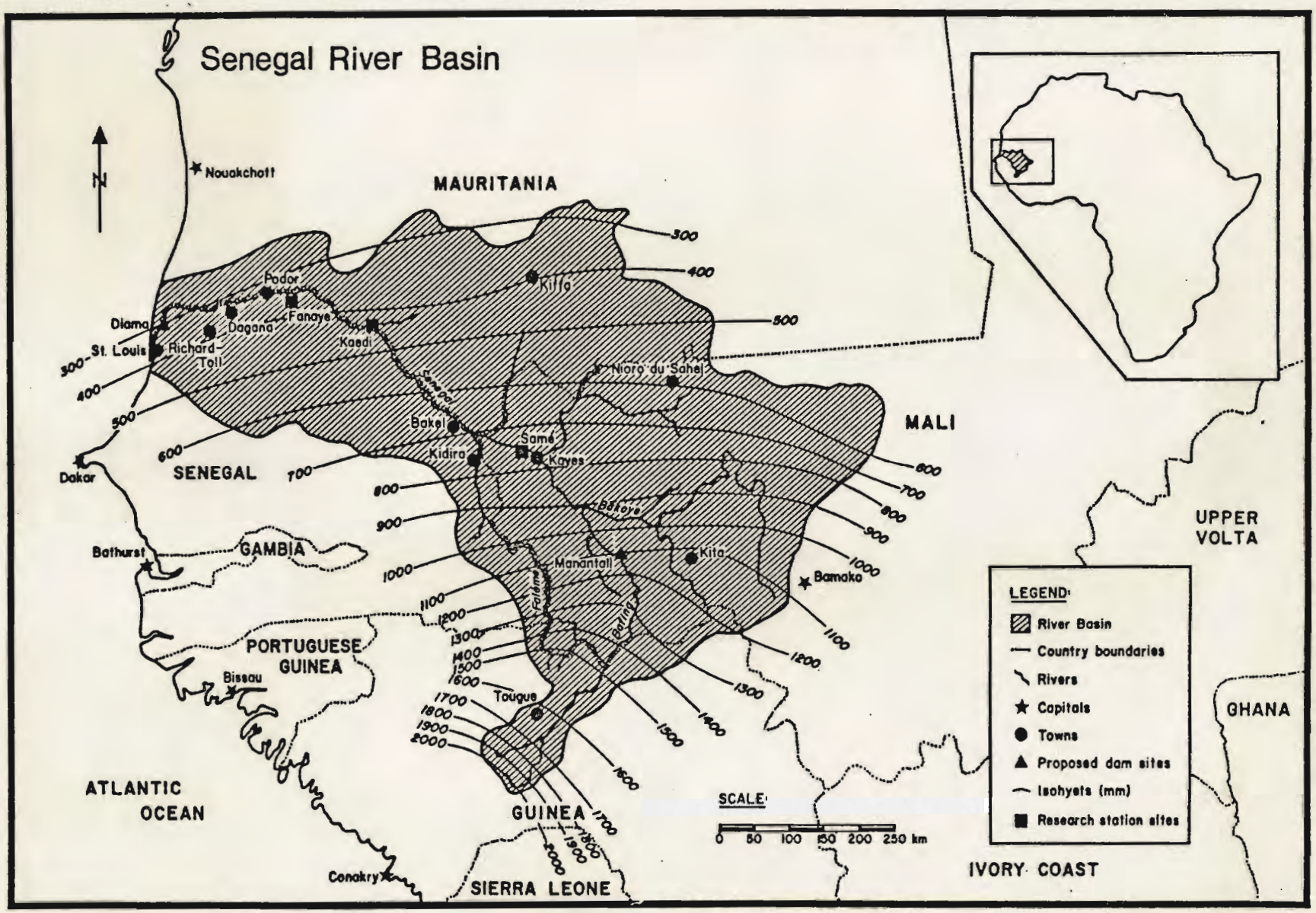

Figure 1. Location of Senegal River Basin and AR II Research Stations.

The SRB is an arid area the majority of whose inhabitants are subsistence farmers. It is viewed as a target for agricultural development and long term relief from the effects of periodic drought; numerous completed studies and ongoing irrigation projects point to the great social and technical potential of the valley for eliminating a chronic food deficit situation.

Central to the realization of the valley's agricultural potential is the harnessing of the river through the construction of two dams which are expected to open up thousands of hectares for irrigated agriculture and provide a year-round navigable waterway upon their completion by the end of this decade. Irrigated agriculture will continue to be introduced through the help of large infusions of multilateral aid from the traditional donors making up the Club du Sahel.

AID's role in the overall strategy is to promote a regional approach to the development of the SRB through the OMVS. The actions taken by the U.S. government are designed to prepare the groundwork for continuing multilateral assistance, concentrating primarily on the development of the agricultural sector. To date AID has committed its resources to building up the information base for planning and design of development projects. Activities include a major environmental impact study, aerial mapping and survey, agronomic research, and a planned survey of ground water in the basin. In addition, the UNDP has completed a major socioeconomic study of the SRB which serves as an important base document for planners (OMVS 1980a).

AID and the other donors of the Club du Sahel are anticipating that more irrigation techniques can be introduced that will make significant positive changes in the agricultural sector and lead to the transformation of the SRB into a net food production area for the OMVS member states, Mali, Mauritania, and Senegal.

AID is planning a major integrated rural development project that will put another 5000 ha under irrigation, lay the groundwork for more multilateral donor irrigation projects, and plan for the eventual social, political, and economic reforms necessary to maintain the momentum of development in the valley. AID's integrated rural development project is expected to play a catalytic role in attracting further assistance into the valley.

As part of the above development strategy, the purpose of Phase II of the OMVS Agronomic Research Project II is to seek improvements of existing production systems consistent with the Senegal River Basin development plans. The proposed research is designed to build upon farmers' existing knowledge and practices, and agricultural research results reached during the past fifty years, but not yet fully tested on-farm with local farmers. This approach is expected to yield results in a relatively short time that will be usable by farmers as well as be accessible to the developers of the basin to verify and test in small irrigation project development. Such accessibility will help establish a strong research-development link with the na-

tional development agencies such as SAED, SONADER, and OVSTM. To enable the research to continue throughout the development process, a systematic training program for all levels of the research cadre is planned as part of the institution building component of the project.

The primary impact of this activity is institutional, but the intended ultimate beneficiaries are the small-scale farmers in the rural communities of the SRB. The establishment of a research capability and subsequent improvement of crop varieties, cultural practices and irrigated agricultural production systems in the SRB will have a favorable impact on all farmers in the basin.

A waiver is requested for the procurement of agricultural and irrigation machinery and vehicles from Geographic Code 935 (Special Free World.) The total value of this procurement is not to exceed $200,000. The justification for this waiver is attached in Annex G.

B. Previous Agricultural Research

Agricultural research is not new to the SRB. It started in the early 1800's with the establishment of an experimental garden at Richard-Toll, Senegal (OMVS 1980a). About 1960 the French Institute of Agricultural Research and Technology (IRAT) started experimental plots in the Guede, Senegal area and continued research there until 1967, when the United Nations Development Program/Food and Agriculture Organization (UNDP/FAO) took over most of the activities. Work was concentrated on improving traditional rainfed crops, irrigated rice, and sugar cane.

In Mauritania, the Kaedi station was started in 1968 by the French IFAC* (now IRFA), and was given assistance through OMVS by UNDP/FAO and USAID in the 1970's. It was chartered in November 1974 as the National Center of Agricultural Research and Development (CNRADA).

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* See Appendix, Section VII, for explanation of acronym which are not defined in the text.

In Mali, the Samé station was started as a state farm in 1965. It later became a training center and a seed production farm and finally a research and training center in 1968. In 1969/70, UNDP/FAO provided some equipment for the station.

By 1970, it was concluded that water remained the prime limiting factor for development of agriculture in the SRB, and that agricultural research should be focused on irrigated agriculture or a "modern high-yielding and rationally organized agriculture " (UNDP 1976). With this new focus, FAO assumed full responsibility for the direction of agricultural research at the three stations mentioned above, under the policy guidance of the OERS secretariat which in 1972 became the OMVS. This arrangement terminated in 1976, although some FAO experts remained.

The FAO regional research effort was to determine the agricultural potential of the SRB. Despite many difficulties, FAO advisors succeeded in demonstrating substantial potential, and in conducting useful variety trials for several crops. Forage production and crop rotation research were carried out at Kaedi. Some useful data were obtained, and although the intent was not to establish a permanent capability for agricultural research, the FAO program did, nevertheless, result in a skeletal operating structure.

1. Agronomic Research I (Project 625-0616)

Upon request by OMVS and FAO/UNDP, USAID granted $960,000 in 1975 to the three centers to provide machinery, an equipment adviser for one year, and local operating funds for one year. In 1977 and 1978 additional grants of $300,000 and $550,000 were made to the OMVS for local costs of the three centers. FAO provided the technical assistance.

AID inputs enabled the centers to continue functioning, and even to expand field trials. The AID-financed equipment, amounting to nearly $600,000 in value and distributed about evenly amont the stations, was put into use with operators and mechanics trained by the equipment.

2. Limitations of Previous Research

Previous research activities in the SRB have fallen short of their stated objectives, for the reasons described below.

a) Lack of Administrative Structure

OMVS had little experience in managing agricultural research. Technical advisors had to divert time from research to administrative matters. Furthermore, there was little coordination of research with development and extension agencies.

b) Lack of Long-Term Commitment

Neither OMVS, its member states, nor the donor community made the necessary long-term commitment to the OMVS agricultural research program. A fragmented, intermittent program has resulted. There was no assured financing for the program to meet needs for equipment, operating funds, and employment of counterparts.

c) Wrong Program Emphasis

In most cases, agricultural research paid little attention to farmers' needs, existing knowledge, or the constraints under which they operate. There was no accompanying social and economic research to help direct the agricultural research. The limited coordination with development and extension agencies compounded the program. Usefulness of results as a base of subsequent research and/or development is thereby restricted.

d) Inadequate Infrastructure

The stations were not developed fully. Most of the land was not leveled, and rew facilities (buildings, laboratories, were constructed. What was built or installed was inadequately maintained and has become less useful or even destroyed.

Staff housing and other personal amenities were provided in limited quantities, resulting in an absentee staff and an unwillingness of local scientists to be assigned to the program. Maintenance of staff housing was also inadequate.

e) Lack of Counterparts and Support Personnel

There were few counterparts for the expatriate advisors. Advanced education was seldom provided to improve their capability. There was little emphasis placed on developing the local capacity for continuing the program. Only a small cadre of technical support personnel was created; they also received limited training.

C. Project Description

Having realized the necessity for a continuing research capability, the OMVS member states agreed that the research centers should be continued after the FAO project terminated and asked the OMVS secretariat to design a plan. Although each research station continues as part of a national system, the OMVS is charged with directing and coordinating the work.

The research objectives, cost estimates, and host country contributions for a new four-year program were presented at the Club du Sahel meeting in Ottawa, Canada in May 1977 (OMVS 1977). Subsequently, OMVS asked the assistance of AID in elaborating and funding the same far-ranging, ambitious research plan it had presented in Canada, embracing irrigated and other crop production and including forestry, fisheries and livestock.

The first CID design team went to the SRB in the summer of 1978. Their report recommended a two-phase project for Agronomic Research II (AR II). Phase I was to take 18 months and consist of interim support for research at the three stations, construction of new facilities, and elaboration of research design. During Phase II, research programs were to be implemented.

Subsequently, this plan was altered. Phase I, which ends in March 1981, included no construction and a minimum level of support at the centers. Those activities now have been integrated into this Project Paper amendment as part of Phase II.

1. Goal

The project goal is to contribute to regional economic development through increased agricultural production and to improve the quality of life of farm families in the SRB.

2. Purpose

The project purpose is to search for ways to increase the efficiency of utilization of land, labor and other inputs, particularly water in existing agricultural production systems. These improvements will assist farmers in taking advantage of the water resources of the SRB through small scale irrigation projects which are part of regional development plans.

Research results which are technically, socially, politically, and economically feasible will lead to increased production and greater returns to farmers and thus contribute to attainment of the project goal.

3. Outputs

The major aim of the research program is to develop information that will be useful in the SRB as a whole. At the same time there will be more limited but significant improvements in human, physical, institutional and social resources.

a) Research Outputs

Additional knowledge will be gained about:

- existing farming systems and how to make them more efficient over the long term through increased production and economic return per unit of land, water, labor (energy), and other inputs;

- characteristics of the physical environment;

- water quantity, quality;

- soil physical and chemical characteristics;

- climate and weather;

- crop ecology;

- methods to improve soil fertility and increase its resistance to erosion;

- procedures to stabilize and improve the environment, thereby avoiding desertification, depletion, and degradation;

- social-political-economic factors affecting agriculture in the SRB.

b) Human Resources Outputs

Human resources will be developed in the following ways:

- A small group of farmers in selected communities will become better trained in new techniques and more motivated, innovative, receptive, and involved in development activities. They will become more productive and have surplus production to barter or sell. This will permit them to increase food consumption, leading to better nutrition and health.

- Counterparts will become trained, motivated researchers and administrators. They will gain more understanding of farmers' needs and of the need to involve the farmers in the research process; they will be well grounded with knowledge of farming systems in the SRB.

- Research assistants and field assistants also will be trained.

- Contractor team members will gain a greater understanding of SRB problems.

c.) Physical Resource Outputs

- Participating farmers will have improved farm units yielding crops of higher quality and greater quantity. Their farming systems will become increasingly efficient, providing them with more income and opportunities for re-investment.

- Viable agricultural research stations will be established and operating at three locations in the SRB.

d.) Institutional Resources Outputs

OMVS:
- A regional research management system will be established and integrated with national research and development agencies.

Member States:
- National research agencies will have improved capability for appropriate agricultural research, more facilities, and researchers.

- National development agencies will have greater involvement in the research program leading to more, sucessful, development projects in the SRB.

CONTRACTOR:
- Member institutions which participate will have greater expertise in regional technical and social aspects.

USAID:
Staff will have greater appreciation of how agricultural research can contribute to SRB development.

e.) Social Resources Outputs

- Communities involved in the research will have increase capability for involvement in development activities, ultimately leading the countries of the SRB to greater food self-sufficiency and improved nutrition and health of their populations.

- Communities which participate will gain a measure of control over their own destiny through involvement in a successful development activity.

- Overall economic development in the region ultimately will be boosted.

4. Inputs

The project inputs from which the outputs are derived are the Phase I activities (essentially completed) and the proposed Phase II activities.

a) Phase I Inputs

Phase I began in May 1979 following an interim funding stage which had permitted AID to maintain continuity of the OMVS agricultural research program. USAID/Dakar requested and received authorization for pre-project expenditures totalling $165,000. These funds were required for continuation of minimal required activities at the three centers.

The principal activity of Phase I has been the elaboration of the research design of Phase II. Following initial site visits in July 1979, CID/University of Arizona (lead university for CID) administrators proposed that because of the complexities involved, a multi-disciplinary team approach be used. During the next year CID team members visited the SRB and the research stations.

Information was obtained by observation and interviews, from the OMVS documentation center in St.Louis, from the national research agencies, and from other government agencies in the three countries and in France. Discussions were held with representatives of other multi-lateral and bi-lateral donor agencies and with staff members of other AID projects. (See Appendix VI for capsule summaries of other projects, and Appendix VII for list of persons contacted).

First drafts of the amended Project Paper and an extensive background report (Status Report) on the SRB were prepared. The Status Report has supplied background material useful in preparing this project paper amendment. It will also be used to orient team members for Phase II activities and as a base line for assessing change in the SRB during the course of AR II. A two-day meeting was held in Dakar in May 1980 at which the CID team presented its preliminary plan for the research to representatives of OMVS, the three countries, and USAID. Suggestions for revision in size and scope of the project were received, and USAID requested that additional background information on previous agricultural research be obtained. This was done.

A special activity of Phase I was an observation-study tour to the western U.S. for five OMVS and national research and development agency administrators. Copies of the report of the tour were distributed.

A series of design team meetings was held in Tucson, and this amended Project Paper was prepared. This completes Phase I.

b) Phase II Inputs

This Project Paper amendment provides for about $13 million in AID grant assistance and about $1.1 in Title III funds over six years (FY 82 through 87) to the OMVS to coordinate and conduct agricultural research. Activities to be undertaken by the Contractor, AID, OMVS and its Member States during Phase II of the project are detailed in the following sections.

5. Project Activities

A comprehensive program of research and related activities is proposed. Information is provided on the problems to be addressed; the PP approach; the agricultural research program; local (counterpart) and contractor personnel requirements; construction, facilities, and equipment needs, training schedules; and administrative/management relationships. Collectively, these activities will resolve or reduce the gravity of the identified problems and make positive steps toward the project purpose and goal. Estimated costs are given for each component of the program.

a) Problems to be Addressed

This project obviously cannot resolve all of the development problems of the SRB nor make up for all the limitations of previous research. However, many of the problems and limitations related to the research program or its administration are addressed.

1. Technical Problems

- Lack of information on farming systems;
- Little attention to farmers' needs and constraints
- Low, variable productivity per hectare;
- Need for more effective water management;
- Low soil fertility, significant erosion hazard, and high potential for soil salinity and alkalinity problems;
- Need to try a greater variety of crops;
- Need to increase inputs to improve production;
- Low returns to farmers, low cash income, limited economic opportunity;
- Limited development of human resources, especially women.

2.) Research Management Problems

- Lack of effective permanent research management system;

- Limited coordination among research, development, and extension agencies;

- Lack of long term commitment to OMVS agricultural research programs by donors and member states;

- Limited research facilities--land, buildings, equipment;

- Inadequate maintenance;

- Limited number of counterparts;

- Limited personal amenities at stations.

b) The PP Approach

The Contractor design team has taken a unique approach to agricultural research and supporting activities. Elements of the approach include the following:

1.) A comprehensive research program clearly linked to agricultural development activities in the SRB, particularly small irrigation projects.

2.) Emphasis on farming systems research with a multidisciplinary team analyzing and integrating social, economic, and agricultural factors.

3.) Research limited to food crops and related production technology as the greatest need within station capability.

4.) Team size large enough to have a significant impact yet not so large that the local capacity to absorb it is exceeded.

c) Proposed Research Program

The proposed research is aimed at long-term sustainable improvement of staple food crop yields per unit of land, labor, and other inputs on small farms in the SRB that can be easily adopted to the development effort now taking place and in years to come. It will do this in ways that are economically viable, socially acceptable and advantageous to farm families, and which improve and stabilize the individual farm and overall environment. New water management concepts will be introduced, particularly as related to irrigated agriculture.

The proposed research builds on the results of previous work done in the SRB. This includes that of the Agronomic Research I and UNDP/FAO projects as well as efforts of national and international research and development agencies. It also builds on the farmers' knowledge of the production system. It is flexible and adaptable to the changing needs of farmers in the SRB, and is developed directly from analysis of their problems and the need to seek solutions to them. While initial activities are intended to address immediate problems, the larger ones will be kept constantly in mind. Research will be carried out as much as possible under conditions like those under which solutions will be implemented.

The proposed research program is composed of six closely related types of research to be carried out in different parts of the physical and social environment.

The relationships of the six types of research and the social/economic base in the SRB development programs are shown in Figure 2. Also shown are the inter-relationships of the research types.

All of the research is founded on the social/economic conditions in the SRB. ON-FARM and COMMUNITY AND REGIONAL RESEARCH will be started first to ensure relevance of APPLIED RESEARCH initiated soon afterwards. SUPPORTING RESEARCH will begin in the second year of the project and will use the results of the other research to forge linkages with development activities on small irrigation projects. INNOVATIVE and FUNDAMENTAL RESEARCH will be started after the second project year when the other types are well established. Summary details of the research types are given in Table 2.

At the same time, the program is limited in geographic and topical scope. Furthermore, it recognizes the difficulty of establishing the vital counterpart relationship and the companion problem of "overloading the system" with experts. The total research program will evolve and be modified as a result of experience. (Section VI) Resource allocations shown in Table 2 are approximate and for the initial period only.

The proposed research program is based on our belief that there is a logical series of steps between fundamental research (discovery of "new" information) and consequent increased agricultural production (widespread adoption of research findings). These steps include applied research (experiments), demonstrations (usually comparisons) pilot projects (testing on a larger scale), extension of results to a wider audience, and finally adoption by large numbers of farmers. The scope of this project limits the effort primarily to the first three steps of the process, but attention will be given to the need for feedback information and consequent modification of the program from the other parts of the system, i.e., extension agents, representatives of development agencies, operating projects, and most important of all, the farm families.

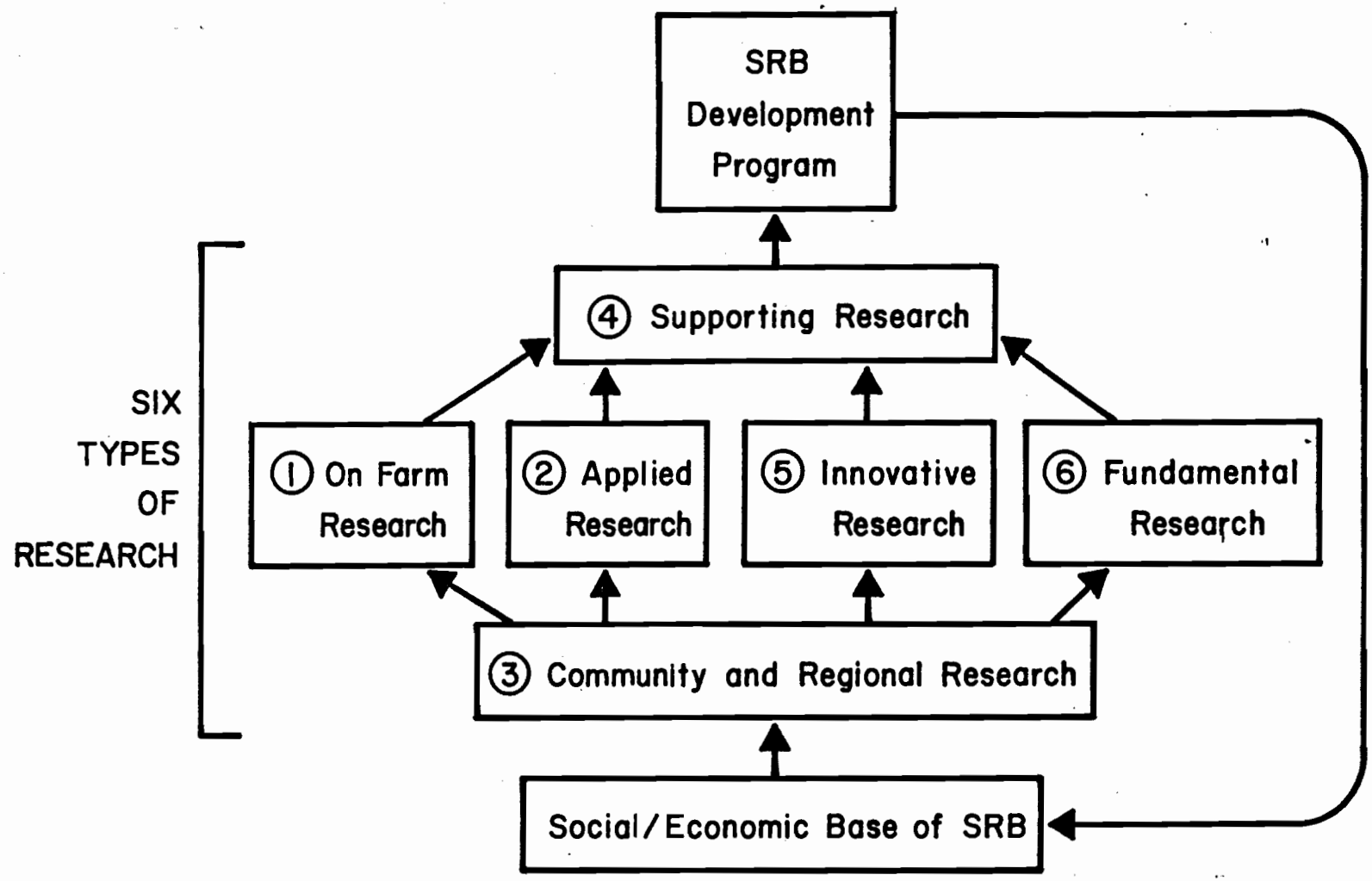

Figure 2 Research Organization and the Social/Economic-Research-Development Linkage

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Table 2. Research Program Summary

Type	Approximate Per cent of Resources	Location	Capsule Description
ON-FARM	25	Communities near research centers on selected farmers' fields with various soils, and on farmers' plots in small irrigation projects	Study existing systems, make limiting factors analysis, use diverse crops in rotation, improve cultivation practices, especially water management, make economic and social analysis, conduct demonstrations
APPLIED	30	Research centers	Similar to ON-FARM but under controlled conditions, test research findings under typical farm conditions
COMMUNITY AND REGIONAL	15	SRB in general, emphasis in communities near research centers	Continuing study of agricultural, economic, and social factors, monitoring of environmental factors
INNOVATIVE	10	Research centers, selected farmers' fields	Test appropriate but locally untried technology with high risk potential
FUNDAMENTAL	5	Research centers	Breeding, physiology, new crops, soil physical and chemical characteristics
SUPPORTING	15	Small irrigation projects, research centers	Cooperate with development agencies in defining and solving problems in establishing and operating small irrigation projects

A six year time frame is proposed for Phase II. Some information already available from previous research can be moved rapidly to the demonstration level after verification, but most research will take several years before valid findings result. In addition, newly leveled research fields require at least two years for standardization of results.

Field days, seminars, and conferences will be organized to disseminate information about the research program, its activities, and its findings among project personnel, other researchers in the three countries (national and international), extension agents and representatives of development agencies, and farm families.

The six types of research are described in more detail below. While listed and discussed separately, each will be integrated with the other types. A multi-disciplinary team approach is proposed, using all available human resources. The purpose, a description of steps to be taken, locations where implemented, resources committed, and time (year) initiated are given for each research type.

IV. Feasibility Analysis

A. Technical Feasibility

1. Proposed Research Program

a) On-Farm Research

The purpose of On-Farm research is to learn more about local farming systems and farmers' needs, and find ways of assisting farmers to increase yields with only minor modifications in current farming systems.

Approximately 25 per cent of resources will be allocated to On-Farm research.

On-Farm research will be conducted with three or four farmers in communities near each research station. Typical sites for research are shown in Figure 3. These sites correspond to the existing farming areas of the SRB. Each has different soil and water resource characteristics.

Activities related to On-Farm research will start as soon as the Contractor team is in place. Planting and growing crops may not start until the second year. Activities will be concentrated on a single site (probably the levee site) near each station until significant progress is made before starting on another site. Because of fundamental differences among the sites, program characteristics will be modified for each.

Steps to be taken in implementing On-Farm research include the following:

(1) Visit nearby farming communities.

(2) Select communities to be worked in, and in consultation with community leaders and farmer committees, select farm families to be cooperators (see Appendix I). Criteria to be used include leadership, willingness to cooperate, ethnic group, caste, sex and age

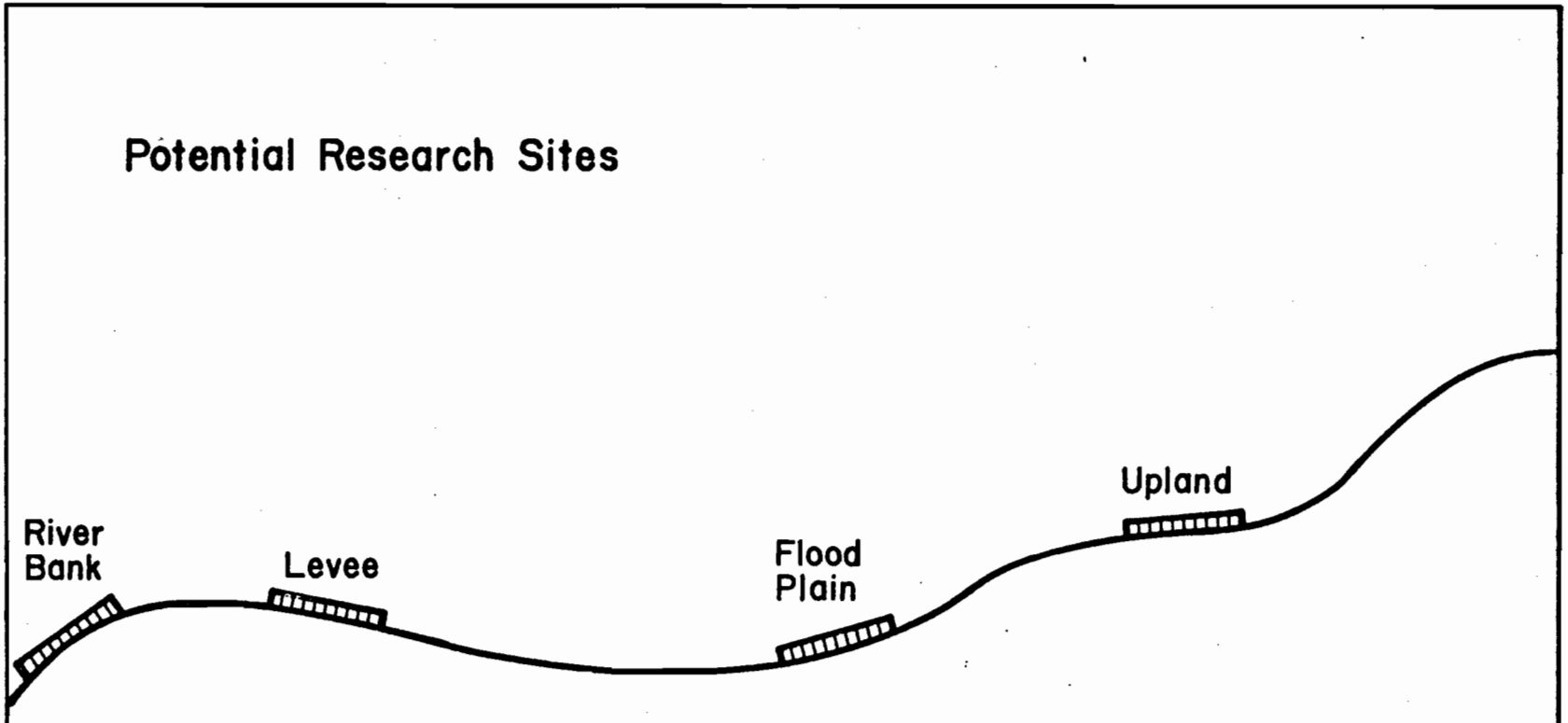

Figure 3 Typical Sites for ON-FARM Research

composition of family; representativeness of site characteristics, and ease of access. An "average" farm family will be sought, not one which belongs to an "elite" group. Local government officials also will be involved in the selection process.

(3.) Make agreements with farmers on use of their land (up to 50 percent), outline procedures to be followed, and explain how the harvest will be guaranteed and their extra labor compensated. Explain what research results are expected, and that they are not always positive.

(4.) Start training research center technicians and laborers who will be involved with On-Farm research. This will be a continuing process.

(5.) Select and define actual field area on the farms to be used. Collect and analyze soil samples; install rain gauge in each field.

(6.) Have farmers work the test area in their normal way except as specifically changed by the research plan.

(7.) Establish a system of record keeping and start collecting data on the farm operation through discussions with the farmers, observation, and measurement fo physical, social, and economic parameters.

(8.) Construct a well or modify a surface water source using local labor and equipment. Install hand or animal-powered pumping equipment, and construct a distribution system to supply supplemental or full irrigation to the test area.

(9.) Select no more than two crops to be tested within the existing pattern of crop mixtures and rotation. Use cultivars the farmers select from those already used, and cultivars developed in previous local research.

(10.) Conduct studies of the households and farming systems, including present farming knowledge and practices, labor use, budgets, and energy flow.

(11.) Identify production-limiting factors and develop a research plan involving minor modifications in the farming system.

(a.) Cultivation and processing practices which might be changed include:

- water supply and management, land leveling, tillage and seedbed preparation, planting, spacing, weed and pest control (including domestic animal control), use of manure, commercial fertilizer, or a green manure crop, mulching, use of windbreaks, harvesting, threshing, grinding, and food preparation. Simple, locally available or reproduceable, low-cost and low-maintenance equipment and animal traction may be used as appropriate. Use results of Applied Research.

(b.) Integration of livestock - small farm animals feedlots.

(12.) Supply all needed new inputs but document carefully their use and costs. Compensate farmer for extra labor input.

(13.) Assist the farmer fully through several crop seasons, or a complete rotation cycle if used.

(14.) Document results carefully with data and photographs. Make comparisons with farmers' own fields at various stages. Conduct economic and energy analysis.

(15.) Give harvested crops to farmers after sampling. Make up any difference as guaranteed.

(16.) Demonstrate results to research personnel, extension agents, and other farmers as approrpiate from time to time through "field days". Explain again that researdh does not always produce positive results.

b.) Applied Research

The purpose of Applied Research is to test or adapt promising research results under conditions which simulate as closely as possible the conditions of local farmers while still being under constant monitoring and control of scientists at a research station. It will serve as a control to measure success of On-Farm research and will help identify and lessen or resolve the constraints and problems of that program. It will use the results of all other types of research as appropriate.

Approximately 30 per cent of resources will be allocated to Applied Research.

Applied Research will be conducted only at the research centers.

Applied Research will be started as soon as possible after the Contractor team is in place.

Steps to be taken in implementing Applied Research include the following:

(1.) Review previous agricultural research in the SRB and evaluate for applicability.

(2.) Obtain commitment from station directors for sites to be used (about 15 ha will be required for all types of crop research at each station).

(3.) Prepare site and facilities as necessary--land leveling, irrigation and drainage ditches, fencing. Collect and analyze soil samples.

(4.) Initiate research to accompany the On-Farm research using the same crops, varieties, and rotation. (If rotation is to be included, allocate part of research parcel to each crop in the sequence, in initial year.) Simulate conditions facing local farmers as closely as possible but with greater number of variables and greater range of variation than in On-Farm research.

(5.) Start training technicians and laborers for field research.

(6.) Initiate other research leading to yield increases for local farmers based on previous SRB research or research done elsewhere in a similar environment. Simulate locar farmers' conditions.

(7.) Start a data collection system and keep accurate records of all activities.

(8.) Prepare progress and other reports from time to time. Prepare an annual research plan. Discuss with committees of local farm families.

(9.) Disseminate information to farmers, extension agents, national government and OMVS officials and other researchers through field days, seminars, reports and workshops.

c.) Community and Regional Research

The purpose of Community and Regional Research is to develop baseline information for the other types of research proposed for AR II, for future project evaluation, and for monitoring environmental trends at the research center locations. Details will be added to the information in the Status Report. Understanding of existing farming systems will be increased so that other types of research will be appropriate to the social, economic, political, and environmental conditions of small communities and the SRB as a whole.

Approximately 15 per cent of resources will be allocated to Community and Regional Research.

Community and Regional Research will be conducted primarily at the research centers and neighboring communities, but also at other locations in the SRB as may be necessary to obtain supporting data.

Committees of farm families will be developed from existing socio-political structure in each community selected for On-Farm research. These committees will be the main point of contact with the Contractor team.

Community and Regional Research will be initiated as soon as the Contractor team is in place.

Steps to be taken in implementing Community and Regional Research include the following:

(1.) Initiate Community and Regional Research in the vicinity of each station, including the following variables for which adequate information does not exist:

(a.) population distribution, ethnic and caste composition;

(b.) the effects of migration and interactions with agricultural development;

(c.) family size and composition;

(d.) land use and tenure;

(e.) problems of farmers--as perceived by the farmers, as perceived by the Contractor team;

(f.) family budgets;

(g.) labor organization, especially roles of women and children;

(h.) food production cycles;

(i.) farming systems;

(j.) marketing;

(k.) development projects and problems.

(2.) Establish the following for environmental monitoring at the three research centers:

(a.) weather stations;

(b.) ground water level observation wells;

(c.) ground and surface water quality monitoring program;

(d.) standard soil erosion test plots;

(e.) record-keeping systems for all of the above.

d.) Supporting Research

The purpose of Supporting Research is to assist development agencies such as SAED, SONADER, OACV, OVSTM, and OPI/API in defining and solving problems that arise in establishing and operating small-perimeter irrigation projects in the SRB, particularly problems that are not being studied under other research projects or types of research within this program.

Approximately 15 percent of resources will be allocated to Supporting Research.

Supporting Research usually will be conducted at the location of the development project but may be conducted at the research centers if necessary.

Supporting Research will be started after the first year when a problem which "fits" overall project capabilities and seems to be something with high potential for success is identified.

Steps to be taken in implementing Supporting Research include the following:

(1.) Establish contact with development agencies and tell them we are willing to assist them with their problems, if appropriate, beginning in the second project year.

(2.) Visit development sites to get ideas for areas of research.

(3.) Request permission to attend planning and administrative meetings of development agencies being held in the area.

(4.) Receive requests for assistance in defining and solving problems.

(5.) Evaluate requests and when appropriate prepare a research plan.

(6.) Conduct research at site of development project or at station.

e.) Innovative Research

The purpose of Innovative Research is to search for and evaluate technologies which have the potential to increase yields, but which involve high risk of failure if tried on farms. Consideration will be given to technologies which have not been tested in the SRB but may have been used elsewhere. Use of such technology would involve significant changes in local farming practices.

Approximately 10 per cent of resources will be allocated to Innovative Research.

Because of the high risk potential, Innovative Research will be conducted exclusively at the research centers except where an unusual situation would make use of a cooperating farmer's field advantageous.

Innovative Research will be started in the third project year.

Steps to be taken in implementing Innovative Research include the following:

(1) Evaluate the limiting factors and problems which have not been resolved through other research.

(2) Select high priority problems.

(3) Survey work done elsewhere to see what solutions to similar problems have been found.

(4) Contact VITA, Peace Corps, GATE and other similar agencies as potential cooperators.

(5) Prepare and submit research proposal.

(6) Consider the following and other technologies: hand and animal-powered pumps, threshing and grinding equipment, animal traction equipment, solar and wind-powered equipment, thornbush and other native fencing, well construction methods.

(7) Conduct research and evaluate results.

(8) Prepare reports.

(9) Disseminate information to farmers, extension agents, government officials and research personnel.

f) Fundamental Research

The purpose of Fundamental Research is to obtain information about plants and their behavior in the SRB environment. Related basic information also will be sought on water resources, soil resources and other environmental factors. While results of this research would not have immediate application, areas of research will be approved only if they are related to agriculture in the SRB.

Approximately 5 per cent of the resources will be allocated to Fundamental Research.

Fundamental Research will be conducted only at the research centers.

Fundamental Research will be initiated in the third project year, after fields have been standardized following leveling procedures.

Steps to be taken in implementing Fundamental Research include the following:

(1.) Identify an interesting and relevant problem. Topics might include: plant breeding, plant physiology, soil genesis and physical and chemical properties, new crops, evapotranspiration, NPK and micronutrient balance, economic modeling, or indigenous systems of plant and soil classification.

(2.) Review the literature.

(3.) Prepare and submit a research proposal.

(4.) Conduct research.

2. Technical Assistance and Counterpart Needs

An eight-person field team is proposed. The approach to meeting personnel requirements includes the following elements:

(a) Recruit worldwide and conside ex-Peace Corps volunteers for field positions.

(b) Provide funds to insure French-speaking capability of Contractor team members.

(c) Supply technical backstopping in various disciplines as may be necessary from Contractor institutions on short-term basis in the SRB.

(d) Select for counterparts relatively inexperienced recent graduates of local universities and train them for professional role in agricultural research.

(e) Have project administration in Dakar for effective involvement of OMVS administrators.

(f) Have Contractor team members and counterparts and their families live at stations where assigned.

1.) Contractor Team Scientists

The size and composition of the agricultural research program determines the kind and number of research scientists to be employed. In Table 4 we recommend the scientists that should be assigned at each of the research stations and also the administrative and backstopping personnel needed at project headquarters in Dakar and in the U.S. during Phase II.

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Table 4

Research Team

Personnel Needs

Administrative Headquarters in Dakar

Long Term
Chief of Party
Administrative Assistant
2 bilingual secretaries

Short Term
Civil Engineer) To supervise construction work
Architect) at the three centers.

FANAYE, SENEGAL:

Agronomist (Specialist in Agricultural Production Techniques Research, Plant scientist).

Agricultural Economist (directs economic aspects of on-farm, support, and community research at all 3 centers).

KAEDI, MAURITANIE:

Agronomist (Plant scientist, horticulturist).

Agricultural Engineer (Study and installation of irrigation systems in all 3 stations, set up maintenance program for equipment and buildings).

SAME, MALI:

Agronomist, plant scientist, with emphasis on sorghum, millet, wheat as cereals on dryland and irrigated land).

Sociologist (directs study of social aspects of on-farm, support and community research in all).

This team will be supported by A U.S. based University. This University will furnish short-term specialists to all three centers as needed. These specialists

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will be recruited from among the OMVS Member States when possible.

Extension Specialist
Agro-meteorologist
Zootechnician
Specialist in Extension Techniques
Specialist in Forestry
Horticulturist
Irrigation Engineer
Plant disease specialist
Veterinarian
Women's Promotion Specialist

Others as required.

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2.) Counterpart Scientists

There are few qualified counterpart scientists available in the three member states. Graduates of local universities (bachelor degrees or lower level) are increasing in number, however, and can be employed as counterpart trainees. Details of their training are given in the following section.

The OMVS Coordinator of Research and the Contractor Chief of Party also will work closely. Their responsibilities are discussed in greater detail in Section

Temporary counterparts of appropriate disciplines will be sought among local scientists to assist short-term specialists in carrying out their assignments.

3. Training

Training will be provided for various individuals or groups associated with the project. Our approach includes the following elements:

a.) Provide training opportunities for all local personnel from administrators to farmers.

b.) Use combination of academic (U.S.) and on-the-job training to prepare counterparts for professional role.

c.) Send research assistants to francophone countries for practical training.

d.) Use full local training capabilities for support personnel.

e.) Conduct seminars, workshops, and field days and use them as appropriate for training purposes.

A summary of training is given in Table 5 ; additional descriptive information follows.

Table 5 Training Summary

	Target Group	Table	Description: Formal	Description: Informal
1.	Administrators	Management/ Administration	--	Study/observation tour* On-the-job experience
2.	Accountants	Accounting/ Administration	2 yrs special training, 3rd country	On-the-job
3.	Professionals			
	Counterpart Trainees	Research, Technical	MS or PhD in US, short courses	On-the-job, Seminars
	Extension Agents	Production, extension methods	--	Field days, Seminars
4.	Research Assistants	Research methods	Special academic (3rd country) Short courses	On-the-job
5.	Support personnel			
	Field Assistants	Field procedures	National training centers	On-the-job
	Mechanics	Pump, tractor and equipment maintenance and repair	Short courses	On-the-job
	Maintenance personnel	Buildings, utilities and infrastructure maintenance	Short courses	On-the-job
6.	Farmers/ families	Agricultural technology, food and nutrition	--	Field days, and through cooperative On-Farm research

*Already accomplished in Phase I

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a) Management Training

Most of the research activities that have been pursued in the SRB have been conducted without involving officials of OMVS national directors of agricultural research in planning the project, implementation, and analysis of the results. Therefore, only a limited amount of expertise in managing agricultural research was acquired by OMVS and national officials.

Phase I of the project included on-the-job experiences for the three national research directors, the Director of Planning and Coordination and the Coordinator of Agricultural Research of OMVS, and the directors of the three agricultural research centers. Five of the eight or their representatives were given technical and administrative orientation in the western United States. A report of this Leader Study-Tour conducted by the Contractor is on file in the project office.

The Contractor Chief of Party will have as a principal counterpart the OMVS official in charge of research. There will be no formal training for this official, but on-the-job experience in research administration will be provided through the close, collaborative working relationship between these two individuals. Regular conferences and briefings will be held. At the end of the six years the OMVS counterpart will be prepared to continue the management of OMVS agricultural research. Similar relationships will be established and maintained with the three station directors.

The administrative assistant/accountant will have to trainee counterparts who will go for two years training in a francophone country, e.g. to ENEA in Dakar, or ENSEA in Rabat, Morocco. They also will be given on-the-job training.

b) Research Training

In order to establish within OMVS an ongoing capability to carry out appropriate agricultural research, the project will train candidates from Mali, Mauritania and Senegal to serve as professional counterparts and to continue the program after the ends. There will be research training at three levels, and recruitment and training will be staggered through the six years of the project to make recruiting qualified candidates easier, and limit the numbers at each station at any one time. (See Table 6 for scheduling details.)

The counterpart trainees will be recruited at the highest level possible (B.S minimum) and will work for one to two years under the direct day-to-day supervision of the Contractor. They will be involved with all phases of the research from planning through analysis of results and report preparation. They will assist with all six types of research.

They will then spend two years at a Contractor institution learning English and studying for an M.S. or Ph.D. degree. Research required for

Table 6 Schedule of Training for Groups of Counterpart Trainees and Assistants

Project Year	1	2	3	4	5	6
At Stations (in-service)						
Counterpart-Trainees	A B	B C	C D	A* D	A* B*	A* B* C*
Research Assistants (conducteurs)	A B	B C	C D	A* D	A* B*	A* B* C*
Field Assistants (moniteurs)	A B	B C	A* C	A* B*	A* B* C*	A* B* C*
At Other Institutions						
Counterpart-Trainees (academic, U.S.--2 yrs)		A	A B	B C	C D	D
Research Assistants (advanced, 3rd country--2 yrs)		A	A B	B C	C D	D
Field Assistants (local, practical--1 yr)		A	B	C	--	--

*Formally trained personnel back at stations.

Each group has 3 people.

completion of the degree will be carried out when they return to the research stations, and they will be given adequate time and resources to do this. The CID scientist under whom they work will be a member of their thesis committee. The degree will be granted only after completion of two years of practical experience at the station under expert supervision following their classroom work.

Research Assistants (conducteurs or ingenieurs de travaux). A total of 12 research assistants will be recruited in the SRB area and trained through on-the-job training and at an institute in a francophone third country.

Field Assistants (moniteurs). A total of these will also be recruited in the SRB area and trained for one year at a local school, either the agricultural training center, ENFVA in Kaedi, or the center, CAA in Samé, both of which are being supported by USAID.

c) Other Training

Other aspects of the training program intended to improve research capability and strengthen the research-development link include:

(1) Local seminars and workshops will be held bimonthly at each station. (All Contractor team and counterparts will participate). Several sessions will be devoted to each crop and/or farming system. Operation of small-scale irrigation projects will be discussed.

(2) Frequent visits to the other stations will be made by the experiment station researchers and assistants to exchange information.

(3) Semi-annual or annual regional and national seminars will be held. Personnel from other research projects (FAO, GERDAT, ORSTOM, SONADER, OVSTM, OACV, OPI/API) will be invited to participate.

(4) Printed pamphlets and "extension" material (pictures and pictorial sketches of simple recommended implements and techniques) will be provided for assistants.

(5) International and regional symposia and meetings will be attended as appropriate.

The research program will provide opportunities for other local people to increase their knowledge and skills vis-a-vis irrigated farming.

(1) The vocational agriculture schools in Kaedi and Samé will be given opportunities to take advantage of the activities at the research stations. The research stations may serve as the practical field laboratories for the training centers, in which all aspects of irrigated agriculture, including irrigation, drainage, land preparation, operation and maintenance of the various types of equipment used in the farming operation can be observed, studied, and practiced. The study courses at the training centers thereby will be improved to turn out people who are better prepared to perform an extension role in the expanding irrigated agriculture of the SRB.

(2) Cooperating farmers in the On-Farm Research activities will be trained in the techniques of irrigated agriculture. The

labor force on the research stations will come from the ranks of farmers within the zones of influence of the stations. The farmers will have an opportunity to work with irrigated agriculture and become acquainted with it prior to actually assuming the role of irrigated land operators. Work assignments will be structured to permit research station workers to farm their own fields by offering part-time positions, leaves of absence, and job sharing.

Construction and Facilities Development

A major effort at the beginning of Phase II will be the physical development of the three stations so as to permit full implementation of the research. Research implementation utilizing existing facilities will begin before the start of construction.

Our approach to construction and facilities development includes the following elements:

a) Use existing facilities as possible, remodel if necessary to provide adequate laboratory and office space.

b) Construct what is needed in addition to make the stations effective.

c) Use modular design for maximum flexibility as the program develops.

d) Adapt construction to local environment.

e) Coordinate with construction being done by other donors on other projects.

f) Initiate and emphasize building and facilities maintenance programs.

g) Prepare field research plots carefully to insure adequate control and standardization of results.

h) Provide attractive personal housing and amenities for CID team and counterparts and their families.

As the first University staff begins its work and as the institutional structures for operating the stations begin to develop, this will provide valuable feedback for ongoing physical development. An important part of staffing the stations is providing a physical, social and institutional environment capable of attracting qualified staff, both the team and local counterparts. When the University team is phased out, it is important that the stations remain an attractive assignment within the research organization of each OMVS member state.

Design and construction of houses for the families of counterpart-trainees and Contractor's scientists will begin early in the project period. Residences for Contractor team families will be equipped with furniture and basic utensils because shipping in and out such items is too time-consuming, costly and generally unsatisfactory. While construction is underway, housing will be rented to meet the needs of the first scientists to be brought in.

Field research areas will be leveled and provided with irrigation and drainage facilities. After leveling, the soil requires preconditioning prior to its use for precisely controlled research plots. This preconditioning consists of one or two crops of forage or legumes to be plowed under as green manure to improve soil physical characteristics, water permeability and retention and to remove some of the initial variability resulting from leveling and field layout operations.

Specific construction to be done and facilities to be provided at each station are listed below:

Fanaye, Senegal:

4 houses for researchers
4 houses for research assistants
1 office for researchers
1 office for assistants and library

(The World Bank is proposing to build other necessary infrastructure in Fanaye for their project with ISRA.)

Kaedi, Rindiao, and Belinabe, Mauritania:

. Kaedi (headquarters site):

2 houses
2 guest bungalow units

(There is an FAO guest house at Kaedi, but its use for Contractor team and families on temporary stays will be difficult.)

. Rindiao and Belinabe (experiment station):

4 offices and support space
machine shop and garage
spare parts storage (a small section needs to be dustproof)
electric power generation station
water supply system
waste disposal system
separate storage sheds for crops and pesticides and chemicals
cool room for fruit storage
equipment and vehicle storage shed
repair flood protection dike.

Samé, Mali:

2 houses for Contractor team,
3 houses for counterpart-trainees and station director
. repair of existing buildings for use as guest house, infirmary, storage,
. office building for 6 offices and support,
. soils and plants laboratory (attached to office buildings)
. agriculture equipment and spare parts shed (a small section needs to be dustproof),
. shed for crops and fertilizer and chemical storage in separate areas,
. recreational facilities,
. electric power generation station
. water supply system
. waste disposal system
. 15 ha furrow irrigation field.

5. Equipment

There is some equipment at the stations in various degrees of operability. Our approach to meeting the needs for additional equipment includes the following elements:

a) Use available equipment if possible. Rehabilitate where necessary.

b) Relate equipment purchases carefully to program needs, and time them accordingly.

c) Vary sophistication of agricultural machinery, equipment, and tools according to program needs, with emphasis on low cost, low maintenance and local availability.

d) Select purchases sources according to characteristics of equipment needed.

e) Place emphasis on and allocate resources for an effective equipment maintenance program.

Equipment to be purchased immediately for the three stations is based on the research program and requests for equipment made during discussions with station directors, the list contained in the OMVS request, and any additions or modifications of these lists made by the CID design team. This equipment is adequate to initiate the research program at each station. Funds are allocated for meeting later equipment needs. All costs in the equipment lists were current costs except as noted, quoted by equipment dealers in Dakar, Senegal in June 1980.

The Fanaye center is allocated more agricultural equipment because the center is new, and the equipment previously furnished to this area by USAID in 1976 should remain at the Guede station and CUMA to support activities there.

Fanaye:

Agricultural machinery and tools:

tractors--1-20 HP, 1-5 HP (walking type) and attachments disc plow, cultivator, plot thresher, equipment trailer pumping equipment miscellaneous "appropriate technology" equipment.

Laboratory equipment:

ovens, scales, glassware and supplies

Office equipment:

typewriters, small copy machine.

Miscellaneous:

diesel-electric generators (2) 50 KW

Kaedi:

Agricultural machinery tools:

1-5 HP walking tractor and attachments, plot thresher, equipment trailer pumping equipment, miscellaneous "appropriate technology" equipment, hand tools.

Laboratory equipment:

oven, scales, glassware and supplies

Office equipment:

typewriters, small copy machine

Miscellaneous:

diesel electric generators (2) 50 KW

Samé:

Agricultural machinery and tools:

1-5 HP walking tractor and attachments, plot thresher, equipment trailer, pumping equipment, miscellaneous "appropriate technology" equipment, hand tools.

Laboratory equipment:

oven, scales, glassware and supplies

Office equipment:

typewriters, small copy machine

Miscellaneous:

diesel-electric generators (2) 100 KW

General Project Use (not assigned to stations):

Vehicles:

6 pick-up trucks (4 wheel drive)
1 sedan
12 motorbikes

Office equipment:

electric typewriters
desk calculator
hand calculators
large copy machine

B. Administration/Management Analysis

A critical part of the research program is its administrative organization. Since research administration is a new role for OMVS, some change will be made to create the necessary administrative environment. Our approach to administration includes the following elements:

1) Set up a simple administrative structure with clear authority and responsibility.

2) Insure overall program accountability through required written and oral reports for each research project.

3) Establish a fiscal accounting system and train local personnel in its use.

4) Integrate research activities at each station, with other stations, and with other programs through cooperative efforts and personal interactions.

5) Build an evaluation system into administration so that project objectives and methods can be changed as dictated by results and experience to ensure that the overall purpose is being addressed.

6) Place adequate emphasis and resources on maintenance programs and on training personnel for them.

Agricultural research requires a degree of freedom, a flexibility for the individual scientists to plan, design and conduct their research work and flexibility to respond to new information and/or changes in external factors. At the same time there must be accountability, coordination and integration of their work, so that individual research activities are directed toward the overall program goals.

There are four administrative levels for this project. (See figure 7) The first level of administration is the OMVS Interstate Research and Development Committee (CIERDA) which is essentially a technical policy-making body with overall responsability for the research program for the Council of Ministers. We note the lack of representation of farmers and feel that the committee's effectiveness would increase if representatives of this group were included.

On the second level are the OMVS coordinator of agricultural research and the Contractor Chief of Party who approve proposals, allocate funds for projects, monitor the overall program to insure its integration internally and with other national and international research.

On the third level is the research center. The center is under the direct management of the center's director. Based on the activities and policy guidelines approved by the CIERDA, the director works with the Chief of Party to assure that these objectives are carried out. However, all materials, equipment, vehicles, and buildings constructed under this project remain the responsibility of OMVS and the University-contractor until the end of the project.

The fourth level of this project is made up of the local and team researchers. These people will conduct the work of the project. Two elements of the project at this level are 1) that each researcher have a home base at on of the research stations and 2) that each research have the freedom to work on a short-term basis both at the other research stations and in the field as research demands.

There will be advisors from other donors. It must be understood that the Contractor Chief of Party only deals with that part of the research at the stations that is funded by USAID. Other donors will be providing funds as well. It is our intent that the USAID program be closely integrated with the work of other donors. This will require statesmanship by all the advisors.

1. Individual Projects

The project system is an effective means of administering research programs and will be used to meet the desired goal of conducting high quality research. Individual projects involving the various types of research will be proposed by Contractor team members and counterparts

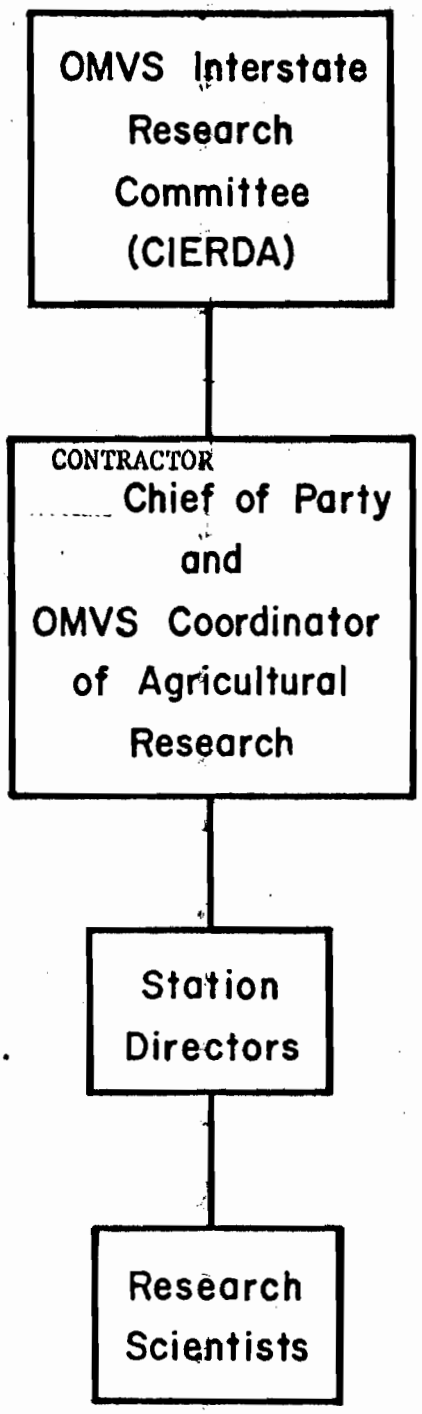

Figure 7 Administrative Levels

scientists. Plans for research will be prepared specifying the reasons for doing it, the present knowledge base upon which it is founded, the objectives expected to be accomplished, the general procedures by which the objectives are to be pursued, a listing of the scientists and technical personnel responsible for the work, the facilities to be used, the length of time needed, and the funds required. The station directors will be informed of proposals, but the Contractor Research Administrator (Chief of Party) and OMVS Coordinator of Agricultural Research will approve the projects. It will be their mutual responsibilty to insure that the approved projects are relevant and that as a total package they meet overall program requirements. They will designate a leader for each project.

2) Reports

The results of research will be reported periodically for administrative evaluation and dissemination to interested users. Annual research reports will be required. The project leader will summarize the results from each on-going experiment and write up a brief report explaining the results. Copies will go to the OMVS Director of Agricultural Research, the Contractor Chief of Party, and the appropriate station director. The reports from the research scientists in the field will be reviewed jointly and will become the basis for making fund allocations and program management decisions. An overall annual research report will be prepared by the Contractor Chief of Party and the OMVS Research Director.

Quarterly progress (activity) reports will be submitted by all research scientists in the same fashion. Scientists on short term assignments will prepare reports giving their findings and recommendations.

The Senegal River Basin Status Report, a compilation of general information on the SRB started during Phase I, will be updated as information becomes available. The Status Report will continue to provide background information which will be useful in designing and conducting research.

3) Disbursement of Funds

Disbursement mechanisms for project funds are discussed in Section V Implementation plan .

4) Maintenance

Lack of maintenance of research and support facilities was a major problem with previous research projects. Special maintenance training will be provided to station personnel, and administrators will visit the centers regularly to observe maintenance procedures. Systems of preventive maintenance will be established by the Contractor team in cooperation with the Station Directors. Short Term assistance will be provided if necessary.

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5. Integration of Activities

Integration of activities within and among the three stations is important if overall objectives are to be achieved. Regular research team meetings will be held to improve integration. Certain of the team members will be involved with research activities at all three stations. Research seminars will be held semi-annually or annually at one of the stations on a rotating basis.

To insure appropriateness of research, it also must be integrated within the local communities. This will be accomplished through the presentation of results to committees of local farmers organized by the project and through field days held at least semi-annually at the stations and at on-farm test sites. Representatives of development agencies and other national and international research projects will be invited to participate in the seminars and field days.

C. Financial Analysis

This section provides an analysis of some of the remaining financial aspects of the proposed project, including a financial plan and costing of projects inputs. Recurrent costs following the end of AID financing are discussed, as are the effects of having the additional resources on OMVS. Justification for a susbtantial foreign source procurement is given.

Cost effectiveness of the research program is discussed in Section IV.E. Economic Analysis, and the institutional capability of OMVS is examined in Section IV.B, Administrative Analysis.

1. Financial Plan

The original PP covered only Phase I finances. This amendment adds Phase II financial information.

a. AID-Contributions The AID contribution of $13 million is detailed in Table 8, Costs. It includes components of technical assistance, operation and maintenance, training, construction, equipment, and miscellaneous. Also detailed there are the costs to be covered by local currency (Title III) funds.

b. OMVS/Members States In addition to the counterpart Staff at the research centers and project administration in Dakar, the Member States will provide the equivalent of about $500,000 in kind toward construction and improvements, including the value of new land to be made ready. They also will provide approximately $400,000 in support personnel of various levels at the three stations and at the OMVS secretariat.

OMVS and its Member States will provide for the project the support personnel listed in Tabl 9.

c. Other Donor Assistance The OMVS receives annually from other bilateral and multilateral donors support fort agricultural research and related training in the Senegal River Basin. In addition member states individually receive support for agricultural research, a part of which is carried out in or is relevant to the SRB. Relevant projects are discussed in Section V.C. Implementation Plan, and Appendix VI, Other Donor Programs in the SRB. We estimate the annual contribution to agricultural to research from these donors as $200,000. Summary cost estimates and the financial plan are given in Tables 10 and 11.

2. Recurrent Costs

Current and past operations of the research centers reveal a fairly typical problem for Sahelian governments , i.e., an inability to provide sufficient funds to keep the facilities operating and maintained properly. There

Table 8

OMVS Agronomic Research II

AID and OMVS Members-States Contributions

By Fiscal Year

Fiscal Year	A.I.D. FX	A.I.D. LC	O.M.V.S.*	Other Donors	Total
1982	2.424	-	900	200	3.524
1983	2.526	450	400	200	3.576
1984	2.597	450	400	200	3.647
1985	1.646	192	400	200	2.438
1986	1.883	-	400	200	2.483
1987	1.812	-	400	200	2.412
	12.890	1.090	2.900	1.200	18.080

* Salaries = contributions in kind

Table 9 Project Support Personnel

	Location			
	Dakar	Fanaye	Kaedi	Samé
Accountant	2	-	-	-
Secretary	2	1	1	1
Administrative clerk	1	-	-	-
Drivers	2	1	1	1
Research Assistant	-	4	4	4
Field Assistant	-	3	3	3
Mechanic	-	2	2	2
Carpenter	-	1	1	1
Grounds maintenance personnel	-	2	2	2
Agricultural labor	-	4	4	4
Guards	-	2	2	2

Table 10

SUMMARY OF ESTIMATED COSTS per fiscal year
(1000's of US$)

	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	Subtotal
Personnel	979	979	1093	1093	1195	1195	6535
Training	32	175	175	175	175	140	874
Local Operating	283	283	283	283	283	283	1700
of which:							
. OMVS/USAID	(283)	(132)	(132)	(132)	(283)	(283)	(1245)
. Title III (Senegal)	(-)	(152)	(152)	(152)	(-)	(-)	(456)
Construction facilities Development	930	1395	1395	187	130	94	4131
of which:							
. OMVS/USAID	(930)	(1097)	(1097)	(146)	(130)	(94)	(3494)
. Title III (Senegal)	(-)	(297)	(297)	(40)	(-)	(-)	(634)
Equipment	200	143	100	100	100	100	743
Total USAID/OMVS	2424	2526	2597	1646	1883	1812	12891
Total Title III (Senegal)	-	450	450	192	--	--	1090
Grand Total	2424	2975	3046	1838	1883	1812	13983

N.B. Sums may not be exact due to rounding.

Table 11 BREAKDOWN OF PROJECT ELEMENTS
By Fiscal Year ($ 000)

University Contract Team

POSTE	No.	Person-Months	Estimated Expenses FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	SubTotal
Chief of Party	1	72	131,000	131,000	147,000	147,000	160,000	160,000	876,500
Administrative Assistant	1	72	86,000	86,000	96,000	96,000	105,000	105,000	575,000
Research Scientists									
. Long Term: Senegal	2	144	172,000	172,000	192,000	192,000	210,000	210,000	1150,000
Mali	2	144	210,000	210,000	234,000	234,000	256,000	256,000	1400,000
Mauritania	2	144	225,000	225,000	250,000	250,000	275,000	275,000	1500,000
. Short Term:		63	113,000	113,000	126,000	126,000	138,000	138,000	756,000
Project Director (US)		72	36,000	36,000	40,000	40,000	44,000	44,000	240,000
Technical Backstopping		36	5,600	5,600	6,300	6,300	6,900	6,900	37,500
Subtotal			978,600	978,600	1093,000	1093,000	1195,000	1195,000	6535,000
TRAINING:									
Counterpart trainees (MS/PhD in US, Salaries not included)	14	24	21,000	112,000	112,000	112,000	112,000	90,000	560,000
Research assistants (Francophone countries)	14	24	5,400	31,000	31,000	31,000	31,000	25,000	154,000
Field assistants (local)	14	24	2,000	12,000	12,000	12,000	12,000	9,000	60,000
Other			3,500	20,000	20,000	20,000	20,000	16,000	100,000
Subtotal			31,900	175,000	175,000	175,000	175,000	140,000	874,000

is nothing unique about this deficiency, and the CID design team has no novel solutions to the problem. The team has established that the research is a vital necessity for rural development in the SRB and that substantial amounts of assistance--human, capital, and technical--must be injected over a long period before the research results will pay off for the agriculture sector. But the investment is necessary.

Since 1976, when the FAO project terminated and the few FAO personnel remaining were not supported by UN regional funds, operations at the centers have gradually declined to the point where only a minimum research effort is taking place. Some experiments are continuing, under the direction of the remaining FAO personnel, but the member states were not able to provide the extra seasonal laborers who must be hired at certain times of the year to clear the fields and plant. Only because of the AID support during the past few years have the centers been able to continue.

It is common for AID to support local costs during the early years of a new project. The problem comes when external assistance is withdrawn and host governments are obliged to maintain the centers with their own resources. It is clear that such outside support will be necessary for the life of this project.

AID typically exacts counterpart contributions in funds or in kind to assure the commitment of the host governments. In this case, while budgetary support will continue to come from both donor assistance and from member states' own allocations, the OMVS and host governments will continue to provide, in increasing amounts, staff, candidates for training, and the land on which to carry out the research. Finally, AID will insist that grant agreements specify the amounts and kinds of support which OMVS and its member states will provide as counterpart to the AID contribution. The process of negotiating this matter with OMVS will ensure a regular review of their budget contribution and its adequacy.

Estimated recurrent costs after the AID financing is ended are given in Table 18, page 58.

3. Effect of Additional Resources on OMVS

A small amount of the overall project input (money) will be given directly to OMVS for disbursement to the member states to cover local operating costs. The OMVS staff is adequate in numbers to manage these resources, but new management procedures are required and will be implemented. Training will be provided for OMVS accounting personnel to enable them to set up the necessary information and control system.

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Table 12

O.M.V.S. AGRONOMIC RESEARCH II

MAURITANIA

1 $US = 50 OUGUIYA

PROJECT INPUT	$ US ('000)	OUGUIYA ('000)
Technical Assistance	2.328	116.400
Training	291	14.550
Local Operating Costs	567	28.350
Construction	1.022	51.100
Equipment	248	12.400
Total	4.456	222.800

Table 13

O.M.V.S. AGRONOMIC RESEARCH II

SENEGAL

1 $US = 250 CFA

PROJECT INPUT	$ US ('000)	CFA (millions)
Technical Assistance	1.978	494,5
Training	291	72,75
Local Operating Costs	567	141,75
Construction	880	220
Equipment	248	620
Total	3.964	991

Table 14

O.M.V.S. AGRONOMIC RESEARCH II

MALI

1 $US = 500 F.M.

PROJECT INPUT	$US ('000)	Francs Maliens (million)
Technical Assistance (Personnel)	2.228	1.114
Training	291	145,5
Local Operating Costs	567	283,5
Construction	2.225	1.112,5
Equipment	248	124
Total	5.559	2.779,5

LOCAL OPERATING COSTS - TABLE 15

	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	Total
A. GENERAL ADMINISTRATIVE SUPPORT (granted directly to OMVS but accountable to Contractor COP + USAID/ OMVS Dakar)	100,000	100,000	100,000	100,000	100,000	100,000	600,000
of which:							
. USAID/OMVS	100,000	44,167	44,167	44,167	100,000	100,000	432,500
Title III (Sénégal)	-	55,833	55,833	55,833	-	-	167,500
B. RESEARCH SUPPORT of Stations							
1. LABOR	66,667	66,667	66,667	66,667	66,667	66,667	400,000
of which							
. USAID/OMVS	66,667	27,833	27,833	27,833	66,667	66,667	283,500
. Title III (Sénégal)	-	38,833	38,833	38,833	-	-	116,500
2. EQUIPMENT MAINTENANCE & REPAIR OFFICE LAB & INFIRMARY SUPPLY	66,667	66,667	66,667	66,667	66,667	66,667	400,000
of which:							
. USAID/OMVS	66,667	27,833	27,833	27,833	66,667	66,667	283,500
. Title III (Sénégal)	-	38,833	38,833	38,833	-	-	116,500
C. LOCAL TRAVEL	33,333	33,333	33,333	33,333	33,333	33,333	200,000
OF WHICH:							
. USAID/OMVS	33,333	15,000	15,000	15,000	33,333	33,333	145,000
. Title III (Sénégal)	-	18,333	18,333	18,333	-	-	50,000

LOCAL OPERATING COSTS (cont'd) - TABLE 15

	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	
D. TEMPORARY LODGING FOR COUNTERPARTS	16,667	16,667	16,667	16,667	16,667	16,667	100,000
of which:							
. USAID/OMVS	16,667	16,667	16,667	16,667	16,667	16,667	100,000
. Title III (Senegal)	-	-	-	-	-	-	-
E. SUBTOTAL	~~183,333~~ 283,333	283,333	283,333	283,333	283,333	283,333	1,700,000
of which							
. USAID/OMVS	283,333	131,500	131,500	131,500	283,333	283,333	1,244,500
. Title III (Senegal)	-	151,833	151,833	151,833	-	-	455,500

TABLE 16 - CONSTRUCTION FACILITIES DEVELOPMENT COSTS

LOCATION	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	SUBTOTAL
1. FANAYE (includes Richard Toll) Title III funded (Senegal)	198,000	297,000	297,000	40,000	27,000	20,000	880,000
2. KAEDI (includes Rindiao + Bélinabé) (USAID/OMVS funded)	230,000	345,000	345,000	46,000	32,000	23,000	1022,000
3. SAME (USAID/OMVS funded)	501,000	752,000	752,000	100,000	70,000	50,000	2225,000
4. SUBTOTAL	930,000	1395,000	1395,000	187,000	130,000	94,000	4131,000
EQUIPMENT COSTS							
1. US Procured							
a. Vehicles	34,000	24,000	17,000	17,000	17,000	17,000	125,000
b. Agricultural machinery	67,000	48,000	34,000	34,000	34,000	34,000	250,000
c. Field & Laboratory equipment	40,000	29,000	20,000	20,000	20,000	20,000	150,000
d. Supplies	5,000	3,500	2,400	2,400	2,400	2,400	18,000
2. Foreign Exchange Procured							
a. Agricultural machinery	27,000	19,000	13,000	13,000	13,000	13,000	100,000
3. Locally Procured							
a. Building materials Maintenance supplies research supplies	27,000	19,000	13,000	13,000	13,000	13,000	100,000
4. Subtotal	200,000	142,500	100,000	100,000	100,000	100,000	743,000
TOTAL	2,424,000	2,975,000	3,046,000	1,838,000	1,883,000	1,812,000	13983,000

N.B. Sums may not be exact due to rounding.

Table 17 Details of Estimated Construction Costs (projected to October 1981)

		No. Units	Total Costs ($US)	
A. FANAYE & RICHARD TOLL				
1. Civil Works (Richard-Toll)				
a. Housing for researchers	Fanaye	4	250,000	
b. Housing for assistance	Fanaye	4	181,000	
c. Office buildings	Fanaye	2	195,000	
				626,000
d. Contingencies (15%)				94,000
Total Estimated Cost for Civil Works				720,000
2. Furniture, Equipment & Spare parts				
a. Furniture for Housing			110,000	
b. Climatological Station			8,000	
c. Spare Parts for Bulidings			30,000	
Total				148,000
3. Agriculture Land Development				
a. Hand dug Wells (for on-farm research sites)			10,000	
b. Contingencies (20%)			2,000	
				12,000
Total Costs for Fanaye & Richard Toll				880,000

Table 17 (Cont'd)

	No. Units	Costs ($US)	
B. KAEDI & BELINABE			
1. Civil Works - Kaedi			
a. Housing	2	120,000	
b. Bungalow Units	2	100,000	
c. Standby 50 kw generator w/shelter		30,000	250,000
d. Engineering & Architectural Services			25,000
e. Impréyus (15%)			41,000
TOTAL.....			316,000
2. Civil Works - Belinabe			
a. Office	1	80,000	
b. Machine Shop & Spare Parts Storage	1	60,000	
c. Vehicle Shed	1	50,000	
d. Hangar	1	40,000	230,000
e. Fuel Storage Tanks			3,000
f. Engineering & Architectural Services (10%)			23,000
g. Contingencies			40,000
TOTAL			296,000
3. Furniture, Equipment & Parts - Kaedi & Belinabe			
a. Furniture for Housing		70,500	
b. Office Equipment & Furniture		28,500	99,000
c. Climatological Station			8,000
d. Spare Parts for Buildings			39,500
e. Spare Parts for Uitilies			49,500
TOTAL			196,000

Table 17 (Cont'd)

	No. Units		Costs ($US)
B. KAEDI & BELINABE (Cont'd)			
4. Agricultural Land Development - Belinabe			
a. Research Field Preparation	15 ha	120,000	
b. Dike Repair	400 m	32,000	
c. Hand dug wells	4	10,000	162,000
d. Engineering Services (10%)			16,000
e. Contingencies (20%)			36,000
TOTAL			214,000
5. TOTAL COST FOR KAEDI & BELINABE			1,022,000

Table 17 (Cont'd)

		N° Units	Total Costs (US$)		
C.	SAME				
1.	Civil Works				
a.	Housing	5	400,000		
b.		1	150,000		
c.	Office	1	36,000		
d.	Laboratory	1	40,000		
e.	General Hangar	1	20,000	646,000	
f.	Storage Area Rehab.		8,500		
g.	Guest House Rehab.		40,000		
h.	Infirmery Rehab.		30,000		
i.	Machine Shop Rehab		22,500		
j.	Spare Parts Rehab.		15,000	116,000	
					762,000
k.	Fuel Storage Tanks		10,000		
l.	Electric Power System		50,000		
m.	Water Supply System		250,000		
n.	Air Conditioning for Office & Laboratory		25,000		
o.	Waste disposal System		85,000		
p.	Recreational Facilties		25,000		
q.	Road Improvement		50,000		
					495,000
r.	Site Preparation & Landscaping (10%)				126,000
s.	Engineering & Architectural Services (10%)				140,000
t.	Contingencies (20%)				305,000
	Total for Civil Works - Samé		.....		1,828,000
2.	Furniture, Equipment & Spare Parts				
a.	Furniture for Housing		149,550		
b.	Furniture & Equipment for office, lab. & Infirm.		86,450	236,000	

Table 17 (Cont'd)

	No. Units	Total Costs (US$)	
C. SAME (Cont'd)			
c. Spare parts for buildings	60,250		
d. Spare parts for utilities	96,750		
		157,000	
e. Climatological Station		8,000	
			401,000
3. TOTAL FOR SAME			2,229,000

Table 18 Annual Recurrent Costs of OMVS Agricultural Research (3 stations, in 1981 $)

	Number	1000US $
Personnel		
Coordinator	1	25
Scientists (formerly Counterpart-Trainees)	12	216
Research Assistants	12	72
Field Assistants	9	36
Accountants	2	20
Secretaries	5	25
Administrative Clerk	1	5
Mechanics	6	36
Carpenters	3	18
Drivers	5	15
Grounds Maintenance Personnel	6	15
Agricultural Labor	12	24
Guards	6	12
		519
Fringe Benefits	25%	130
Sub Total		649
Supplies, Operation and Maintenance		
Office, Laboratory and Field Supplies		60
Fuel and Lubricants		480
Utilities		75
Equipment Maintenance		60
Building and Housing Maintenance		75
Travel		75
Conferences, Seminars, and Short Courses		15
Sub Total		840
Administration (10%)		155
Total Annual Recurrent Cost		1,644

D. Social Analysis

Although the primary impact of this activity is institutional, the goal of AR II is to improve the standard of living the small-scale farmers in the SRB, who are the ultimate beneficiaries. The establishment of a research capability and subsequent production improvement of crop varieties, cultural practices and agricultural production systems in the SRB will have favorable impact on all farmers in the basin. Successful agriculture depends upon the constant flow of information from research centers on crop varieties, farming practices, mechanization, application of inputs, and extension methods.

To insure that benefits of AR II are available to the small-scale subsistence farm families which constitute the majority of the SRB population, it is necessary to consider both the existing socioeconomic structure and the possible effects of agricultural development. In Appendix III, Social Soundness Analysis, the problem of equal access in regard to ethnic group, caste, land tenure, and household organization is discussed in detail.

To achieve as great a degree of equity among existing socioeconomic groups as possible, AR II focuses on research whose results will be technically, economically and socially amenable to combining with existing farming system in the SRB. To insure these results, the research program proposes to begin with the farmers' present knowledge and practices and work with them in developing improvements.

Irrigation will plan an increasingly important role in the development of agriculture in the SRB. Our analysis of the experience with irrigation to date (see Appendix III.D.) suggests that small-scale irrigation promotes the long-term equitable benefit of development more than large-scale irrigation, at least in its present format, and AR II therefore focuses on applicability to small-scale situations in research involving irrigation.

Special attention is devoted to women, since development has so often overlooked their important roles in agricultural production and in the domestic economy, which are intimately related to it. Their important roles often have been overlooked in the development of irrigation projects in the SRB.

E. Economic Feasibility

1. Cost Effectiveness

The usual procedure in evaluating long-term investments is to compare the flow of benefits over a relevant time period with the associated costs through a discounting procedure. As with most research projects, this technique cannot be meaningfully applied to AR II. Neither the long-run costs nor the benefits that might be forthcoming can be estimated with the requisite precision. The potential benefits of agricultural research, and in particular applied research at the national level, are discussed in Appendix I. Benefits and costs at the farm level will be examined below.

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This section will examine the cost effectiveness of the proposed program; that is, the degree to which it makes efficient use of the scarce resources that will be committed to the project.

a) AR II will use the extensive knowledge of local farmers in planning research at the three stations. Before controlled experimentation begins, CID team personnel will familiarize themselves with farming systems in the area. Initial research will be in direct response to problems perceived by farmers and will build on the best of their existing practices.

The exchange between farmers and researchers on the farm will allow for quicker testing under typical production conditions. By this constant evaluation of the farmers' management capabilities and farm-level constraints, the program will not waste time developing inappropriate techniques or inputs. Constant feedback from cooperating farmers who belong to the OMVS development plan's target population will allow for a self-correcting program that should result in readily transferable technologies.

b) The scientists at the stations will be used more efficiently in the proposed project than in the traditional approach. They will use on-farm trials of crops and methods to supplement the more controlled on-station research. In addition, the use of plots of the four major land types will give a wider scope to the scientists' work than would the classical approach and will allow them to focus on directly productive lines of study.

c) Counterpart trainees will be sent to the U.S. for graduate-level training. In order to best prepare the candidates for their academic work, the host country researchers will be required to work for two years with a CID team researcher prior to departure. Following completion of their course work, two years of research experience will be required. This approach maximizes the usefulness of academic training for appropriate research. However, even if they leave the research stations upon fulfilling their requirement, the countries will still benefit from their training. Training at the research assistant and field assistant levels also will rely heavily on in-service training by project personnel at the stations.

d) The trainign program will take advantage of previous AID and other donors investments in such schools as Hassan II Institute Agronomique et Veterinaire in Morocco for training of technicians, and the ENFVA and CAA schools at Kaédi and Samé for training field assistants.

e) The research program draws upon the results of research done over the past 50 years in the SRB and in other stations in the OMVS member countries. This research has been sponsored by FAC, WARDA, ORSTROM, UNDP/FAO, AID, and others. Pertinent studies have included the testing of rice, corn, and wheat under irrigation, double- and triple-cropping, and pedology and other topics (Appendix I). These results will provide the starting point for AR II, especially for ON-FARM and APPLIED research.

f) The program avoids duplication of infrastructure and personnel. The research program is designed around the existing and planned infrastructure in the stations in Fanaye/Guede, Kaedi, and Samé (Appendix I).

The research program will provide researchers with skills that are complementary to those of the experts already on the stations, and will call for cooperation among all researchers in the implementation of the research programs. (See Appendix I for details on team composition and the interaction among the researchers.)

Many bilateral and multilateral donors are providing development assistance in the SRB. Most of their activities have some relationship to our proposed agricultural research program. We examined the donor-funded activities to determine the possibilities for cooperation and/or coordination of efforts. We assume this will be a mutual benefit.

The kinds of coordination and cooperation possible were categorized as:

(1) avoidance of duplication;

(2) exchange of ideas and information about their programs and about ours;

(3) interaction of scientists;

(4) training for project personnel (we will assist in training their personnel; they will assist in training ours);

(5) joint use of research facilities (buildings, land, and equipment);

(6) provision of assistance to each other in scientific or technical specialty.

The status of possible cooperative effort is reported as:

(1) recognized (examination of documents, third-party discussions);

(2) observed in field by Contractor design team;

(3) discussed by CID design team with

(a) project planner(s)

(b) scientist(s) and other project personnel

(c) project administrators;

(4) agreed upon.

2. Farm-Level Analysis

The ultimate success of agricultural research is measured by the effect it has at the household level on the methods, and on quantities and consumption of production. At present, 85 per cent of the population in the SRB are members of subsistence farm families. The subsistence farm produces for its own consumption, with any surplus stored against poor years or sold and bartered in local markets for other essential commodities.

However, even this level of production has been decreasing over the last 20 years due in part to drought, which affects flood recession agriculture through low levels of flooding, and rainfed agriculture through inadequate and poorly distributed rainfall. The drought has increased the large-scale migration of males out of the SRB, especially from the Soninké population in the upper valley (Boutillier 1980, Bradley et al. 1977). This has reduced the effective labor force in the SRB but, because these emigrants send wages home, cash income in the region has actually increased.

Low yields, a shortage of labor, and the capacity to import foodstuffs have prevented the local farmers from benefitting from the increased purchasing power of the region and have contributed to an ever-increasing dependence of the region upon the exterior (Bradley et al. 1977).

3. ON-FARM Research System

The comprehensive research system to be used by the project, is an attempt to increase yields and production without creating unacceptable levels of risks. The approach is that of farming systems research, practiced increasingly successfully over recent years. After identifying bottlenecks in present farming systems, tools

and techniques will be developed and introduced onto the farm plots, where further modifications will be made based upon the farmers' experiences.

Results of the research will reach a large population by virtue of building upon the traditional agricultural system. The use of wells as sources of permanent and supplemental irrigation will be encouraged. This allows for easy, immediate extension of irrigated farming to the uplands, presently neglected in farming research. At present, irrigation projects are concentrated on the levees, which are subject to traditional land use regulation and are limited to 30 to 5,000 ha each in the SRB (Weigel 1980). Use of the uplands is less restricted by land tenure traditions than is the case in other land types. In flood-free areas there will be the advantage that protective dikes, presently a great expense on small-scale development schemes, will not be necessary. The ability of the farmers to accept only those elements which they perceive as advantageous to them will lower the risk of adopting innovations and will allow the farmers to tailor improvements to respond to the constraints under which they are presently operating.

Le made estimates of the labor requirements of the system using animal-powered water lifting devices proposed for development by AR II and compared them with those under small-scale pump irrigation at Bakel (Le 1980). The labor requirements of the farmer are only 29 per cent of that of the pump-irrigated plots. In fact, a farmer could cultivate 3 ha using the ON-FARM system with less labor than on a plot with a motorized pump. Total labor requirements for 3 ha would be only 86 per cent of those for 1 ha using methods presently employed at Bakel.

The present small-scale irrigation schemes often allow only specific crops (usually rice), at a fixed price that is often considered inadequate by the farmers. The farmers are often forced to produce rice to pay off debt they have incurred. The ON-FARM research system will allow for greater flexibility in cropping patterns. The farmers will be able to choose a mix of cash and food crops according to their own evaluation of the economic environment.

4. Animal Traction

Johnston (1978) refers to the use of animal draft power as "the most promising means of modifying existing farm systems." The research

program will test plows, seeders, and other animal-drawn equipment as well as animal-powered pumps.

In using oxen instead of engines as the source of power for raising water, the farmer is less tied to external, expensive inputs such as fuel, machine parts, and knowledge of complex machinery. Additionally, whereas the engine depreciates rapidly over a period of three to five years, "the costs of rearing and maintaining animals are largely internal" (Johnston 1978). The oxen appreciate in value over the time the farmer uses them (until they die, or are sold), and the farmer is able to feed them crop residues available locally. However, if every farmer has oxen, the crop residues may not be adequate. If properly handled, manure can be a valuable addition to the soil. Franzel (1979) estimates the appreciation of oxen at 28,000 CFAF/year in Senegal. The use of an internally maintained technology allows for greater independence of the farmer. In minimizing reliance upon external inputs, the farmers lessen their risk of incurring debts.

Animal traction, coupled with machines specifically developed for use in various soil types, may reduce overall demand for labor. "The use of livestock for draft power will not only ease seasonal bottlenecks but permit fuller year-round utilization of the available labor force in productive activities because the patterns of labor demand tend to be more complementary than competitive" (Johnston 1978). We have concern about feed for the animals and point out the need for investigation of feed sources.

5. Multiplication Effects

There are over 1.5 million people in the SRB. Over a million of them are involved in subsistence farming. These million people are those who can potentially benefit from the proposed research of AR II.

Demonstration effect: The ON-FARM plots will provide an opportunity for the farmers to see the results of adopting various tools and techniques to their own systems of farming. As the system will be developed so that it can be adopted in part or as a whole package, the farmers can calculate risks and judge the innovations accordingly. Positive response by the farmers can lead to the spread of the techniques

considered successful by other farmers, and can create a demand for the tools developed. The tools will be simple ones that the local artisans can fabricate on demand. Though limited, the spontaneous nature of such adoption of tools and techniques can do much to prepare other farms for the work of the extension agencies.

Extension effect: The final implementation of the results of the research in this program will not be limited by reliance upon the demonstration effect among the farmers near the test plots. The results will be taken up by the extension agencies within the SRB and will also be an important foundation for the proposed OMVS/USAID integrated rural development project. Though extension has been difficult in the SRB, the development agencies are gaining experience and flexibility in their approaches to extension. An article in Le Soleil (May 31, 1980) discussed the weakness inherent in former strategies of small irrigation project development and outlined a new approach on the part of SAED, in which farmer organizations would be responsible for expressing the needs of the farmers:

> Here, the training programs will be worked out in cooperation with the farmer organizations instead of being imposed. Agents in direct contact with the farmers will complement and be capable of listening to them and proposing solutions that will be adapted to the problems of the rural world. In effect they will be agricultural advisors. There will exist at the farmers' level a technician elected by the members of the cooperative or the group, the same as the president or the treasurer.

This sort of commitment will provide an improved vehicle for the utilization of the results of the research program. The project will work with the development agencies to ensure adequate understanding of the nature, advantages, and limitations of innovations developed by AR II.

Ultimately, the returns to farmers will rely upon the increased marketing efficiency of the region to ensure that there will be a high enough effective demand to provide incentives to the farmers. The increased incomes of the families in the SRB will stimulate demand for goods and services within the region and increase the flexibility of the production system as demand for vegetables and other products rises--an event which often follows a general rise in income.

As the quantity and variety of foods consumed increases, a general improvement of health and productivity of the SRB population can be expected.

With proper incentives, production in the SRB can be used to reduce the heavy burden that the imported food, especially rice, places upon reserves of foreign exchange. From 1961 to 1975, rice imports averaged 10 per cent of the value of annual export earnings. Food imports were 25.5 per cent of total imports into Senegal for the period 1973-1977. The concentrations of investments in the SRB has been justified in that "rates of return would be acceptable on a national basis when income distribution weights are given to the benefits streams"(World Bank 1979: Vol. 1).

The AR II program is aimed at giving small farmers control over their productive resources, and thus supports such an investment strategy.

F. Environmental Analysis

At the small scale of the proposed agricultural research project, it is unlikely that environmental impacts of the project will be significant. However, if technology developed under the project is adopted widely, there are several potential adverse effects which should be noted and monitored.

1. More extensive use of surface and ground water for irrigation could lead to declining water levels and deterioration of water quality (increased salinity).

2. Each dug well that is installed presents another opportunity for pollution/contamination and accompanying water-borne diseases such as malaria, schistosomiasis, and guinea worm.

3. Mismanagement of agricultural chemicals could result in pollution or runoff to the river and the shallow water table in areas adjacent to the river. This could result in local health problems, algae blooms, fish kills, and other effects.

4. Deep plowing could lead to increasing the erosion potential of soil on the research stations or at ON-FARM research sites. If adopted extensively, other areas could be effected.

5. Increased use of animal traction will put increasing pressure on local grazing resources, exacerbating existing problesm of vegetation depletion.

6. Establishment of many more small irrigation projects will further compound the land use problem by elimination of grazing sites and including brush and trees.

The project will support research that will help to better identify and mitigate these potential adverse environmental efforts of agricultural development in the SRB.

V. Implementation Plan

The proposed schedule of activities with responsible parties for the first 2 years only is given below. The schedule will be revised regularly as dictated by operating experience.

A. General Activities

Action	Responsible	Date
Project Paper approved	AID	August 1978
Grant Agreement signed	AID/OMVS	September 1978
G.A. Amendment N° 1 signed	AID/OMVS	October 1978
Contract with CID for Phase I signed	AID/CID	May 1, 1979
CID design team starts work	CID	July 1979
One-month observation/study tour conducted	CID	July 1980
Field design studies completed	CID	December 1980
AID issues 611 (a) certification	USAID	
PP Amendment for Phase II submitted	CID	March 1981
Final Report Phase I submitted	CID	May 1981
Approve Project Paper Amendment	USAID/AID	August 1981
Sign Project Agreement	USAID/OMVS	October 1981
Negotiate contract for Phase II	AID/Contractor	November 1981
Recruit for team	Contractor	November 1981
Counterpart trainee selection	OMVS	November-December 1981
Order Commodities	Contractor	February-November 1981
Orientation for team	Contractor	February 1981
Arrival in country of team, Chief of Party and administrative assistant	Contractor	February 1982
Counterpart trainee assignment to stations	OMVS	June 1982
Initiate research	Contractors/OMVS	March 1981
Consulting farmer committees	Contractors/SAED SONADER/ORSTOM	April 1982
First semi-annual research seminars	Contractor	October 1982
First field days	Contractor	December 1982
Initial group of counterpart trainees departs for training in U.S.	Contractor	December 1982

Action	Responsible	Date
Second group departs		December 1983
Third group departs		December 1984
First group returns		December 1984
Reports submitted		
progress (activity)		Quaterly
annual research		
individual projects		Annually
summary		Annually
Final Report		1987

B. Details of Construction Implementation Schedule

The construction at the centers is estimated to take 8 months.

The following calendar of activities is projected:

X	= date of approval of the project Negotiation with and selection of architecture-engineering (A-E) firms for design of the construction at the research stations.
X + 1.5 months:	Signing of contract with A-E firm for master plans and preliminary cost estimates.
X + 3.0 months:	Completion of master plans, schematic building design and preliminary cost estimates.
X = 3.5 months:	Approval by Contractor OMVS/AID, and signing of contract for design development drawings and refined estimates of project costs (avant-project).
X + 5.5 months:	Completion of avant-project.
X + 6.0 months:	Approval of avant-project by Contractor/OMVS/AID, start of the detailed construction drawings.
X + 8.0 months:	Issuing of invitations to local and/or international companies for prequalification. The format for and the method of prequalification would be approved by Contrator/OMVS/AID prior to the invitation.

x = 10.0 months:	Completion of detailed construction drawings, technical specifications, materials quantities, and final project cost estimates. Prepartion of tender documents. Evaluation and ranking of prequalified contractors.
X + 10.5 months:	Approval of detailed drawings by Contractor/OMVS/AID. Call for bids.
X + 12.0 months:	Bids due.
X + 12.5 months:	Negotiation and signing of construction contract.
X + 14.0 months:	Latest date for biginning of construction.
X + 32.0 months:	Completion of construction.

With proper planning, advance preparation and a speedy decision making process the completion time could be reduced by about 6 months. If preliminary work can be started earlier, i.e., before Fiscal Year 1982, then certain of the construction related activities can be started and finished prior to the onset of the rainy season thereby avoiding possible delays and saving time and funds.

Contractor will have an architect and civil engineer to act as a liaison between the architect and engineer firm and Contract/OMVS/AID for the first 32 months of the project. After about 26 months, the station director of each station should effect the transition from construction to operation, and establish the inventory system. The Contractor architect and engineer, and later the station directors will prepare quarterly reports on the physical progress, the financial accounting and the constraints or problems encountered.

C. Relationship to Other Donor Research

Improvement of the agricultural sector is the key element in the development program for the SRB. Plans call for the Valley to become much more productive agriculturally, and many projects are in operation or proposed toward that end.

Cooperation among donors is important in increasing the efficiency of utilization of resources including funds and personnel and thereby in increasing the chances of success of overall development programs in the SRB. The Contractor Chief of Party and other team members will seek to catalyze a continuing, strong cooperative effort with and among other relevant donor projects and the individual scientists associated with them.

1. Donor-Funded Development Activities

Development activities are centered around proposed changes in the river regime or at least take cognizance of them and operate accordingly (Appendix II for details of changes). Most development activities are donor funded. Several European countries, notably France, and Canada, Saudi Arabia and the U.S., are involved in bilateral development assistance. The World Bank, UNDP/FAO and the CGIAR institutions are among the multi-lateral agencies active in the SRB.

Several of the donor-funded projects include an agricultural research component, and a few are providing training relevant to the needs of this project. These donor activities, summarized in Table 19, will be of benefit to our work, and we have already discussed potentials for cooperation with them. Letters of agreement will be negotiated with cooperators after the Contractor team is in place. Additional details of these projects are given in the Economic Analysis, Appendix II and Appendix, Section VI. Aspects of the overall cooperative effort are given in the following sections.

2. Administrative Relationships

A major benefit of cooperation with other donors will be in avoiding duplication of effort, thus making best use of limited funds. Sharing of construction costs at Fanaye (with the World Bank) and at Kaedi (with FAC) has already been verbally agreed on in discussions with Contractor team members, although questions of timing remain. Joint use of research facilities has been discussed and will strengthen our program and theirs. Specific cooperative efforts in training support personnel will be possible but have not been discussed.

3. Scientific Relationships

Individual scientists will benefit from cooperation with colleagues. They will be able to exchange information and ideas about their research through informal and formal contacts (e.g., seminars).

Because of its limited size, the proposed Contractor team will not include personnel with several important special skills. While the Contractor universities are prepared to provide specialists in such areas, it also will be possible to take advantage of specialists who are in the SRB with other projects. Similarly, Contractor team member will be able to help other scientists with their problems.

4. Role of CIERDA in Coordination

The influence of CIERDA extends well beyond this project to all the agricultural development activities in the SRB. By keeping its members informed and involved in AR II, the CID Chief of Party will assist

Table 19 Relevant Donor-Funded Research

Donor	Project Description	Locations
Belgium	Crop research	Fanaye, Richard Toll
England	Crop research	Fanaye, Richard Toll
France (FAC)	Crop research, Construction	Fanaye, Richard Toll Kaedi, Sotubua (Mali)
(IRAT)	Crop research (horticulture)	SRB in Senegal
US (AID)	Crop research	Senegal (w/ISRA)
CILSS	Crop research (pest control)	Fanaye, Richard Toll
FAO/UNDP	Crop research	Guede, Fanaye, Saint Louis, Kaedi, Samé
IBRD	Crops and farming systems research	Senegal (w/ISRA)
IMPHOS	Phosphate trials	Fanaye, Rindiao
IRRI/ICRISAT/CMMYT	Variety trials	Samé
WARDA	Rice production	Fanaye, Kaedi, Samé other SRB locations

(See also Economic Analysis, Appendix II and Appendix, Section VI)

it in becoming a more effective coordinator of the overall development effort. CIERDA members will be invited and encouraged to participate in project field days and seminars.

D. Foreign Source Procurement

The project will use $200,000 to procure equipment and vehicles from non-U.S sources. Normally, strong arguments in support of U.S procurement for a major project in which the U.S. is the principal donor would be made. In this case, however, there are strong points in favor of signification non-U.S. procurement. Past USAID experience in the SRB, knowledge of the local scene, the capabilities of local dealers, and the constraints under which the three centers operate (which are highlighted in other section of this Project Paper amendment) persuade the CID design team that imposition of Code 000 procurement requirements on all equipment purchases for this project would lead to severe difficulties later on, when unforeseen spare parts requirements arise or when no one familiar with American machinery can be found within the region to service broken-down equipment. For these reasons, we strongly recommend that procurement of agricultural and irrigation machinery through local dealers be authorized where foreign-source procurement is indicated in Appendix II. D.

E. Institutional Contract

The financial management of this project will be vested primarily in the institutional contract. This institutional contract will include the following principal responsabilities:

(1.) hiring and fielding the technical assistance personnel;

(2.) arranging with other educational institutions for the training of personnel at all levels of the research organization;

(3.) procurement of all U.S. manufactured equipment following standard AID procedures;

(4.) procurement of equipment of third country origin;

(5.) supervision, management, and disbursements for the on-site construction;

(6.) disbursements to OMVS and the research stations to cover certain local costs;

(7.) disbursement of local currencies to project personnel for salaries and miscellaneous project expenditure.

1. Disbursement of U. S. Dollars

Costs for technical personnel, U.S. and third country training, U.S. origin machinery and equipment, and administrative and support expenses in the U.S. will be disbursed from AID/W to the Contractor's Executive Offices in Tucson on a cost reimbursement basis following standard AID/W procedures (see Figures 20 and 21). The Contractor will allocate funds to its participating member universities according to its standard operating procedures. Most local costs will be disbursed in CFA to the Contractor Chief of Party by USAID/OMVS.

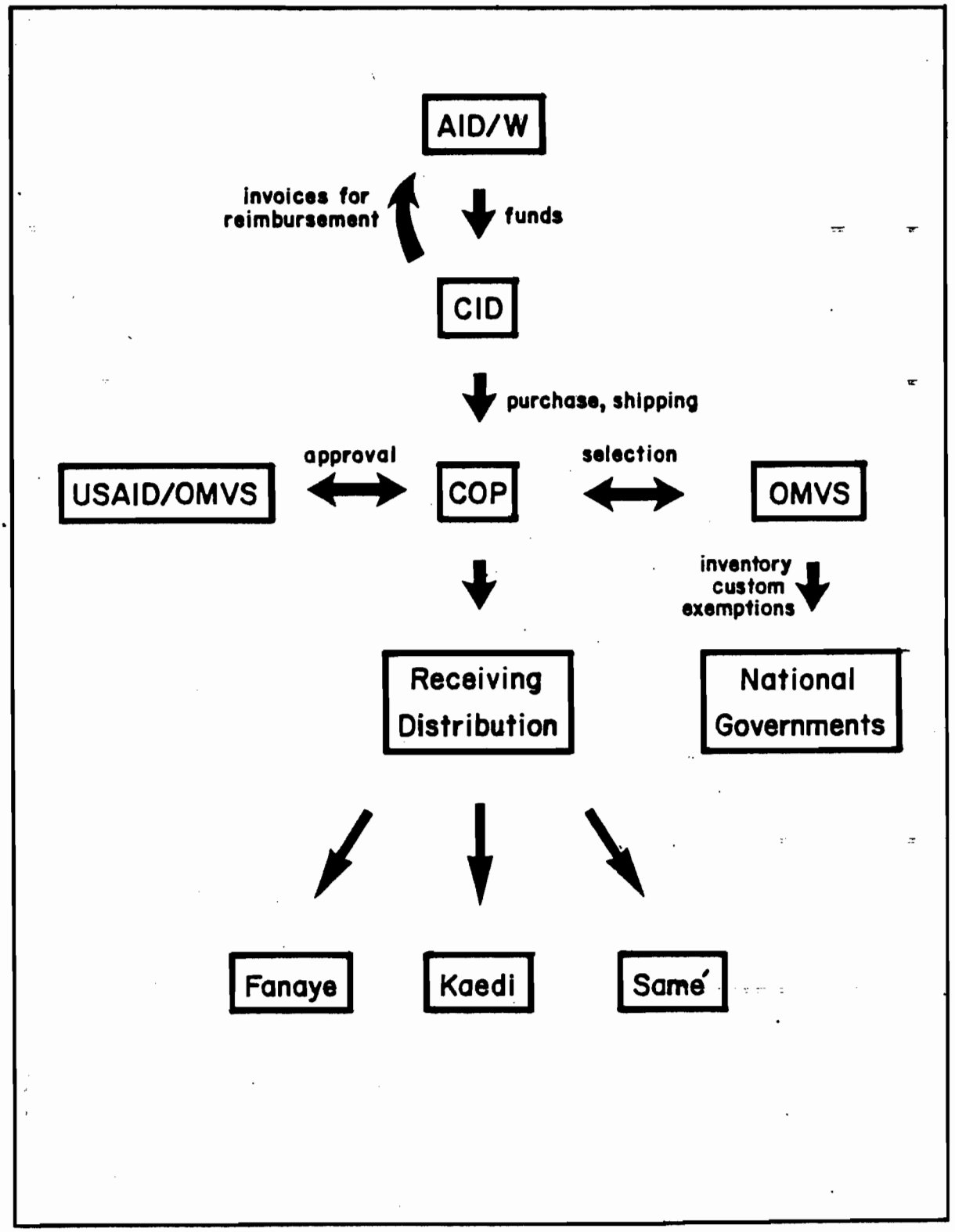

Figure 20 Procurement of U.S. equipment and vehicles

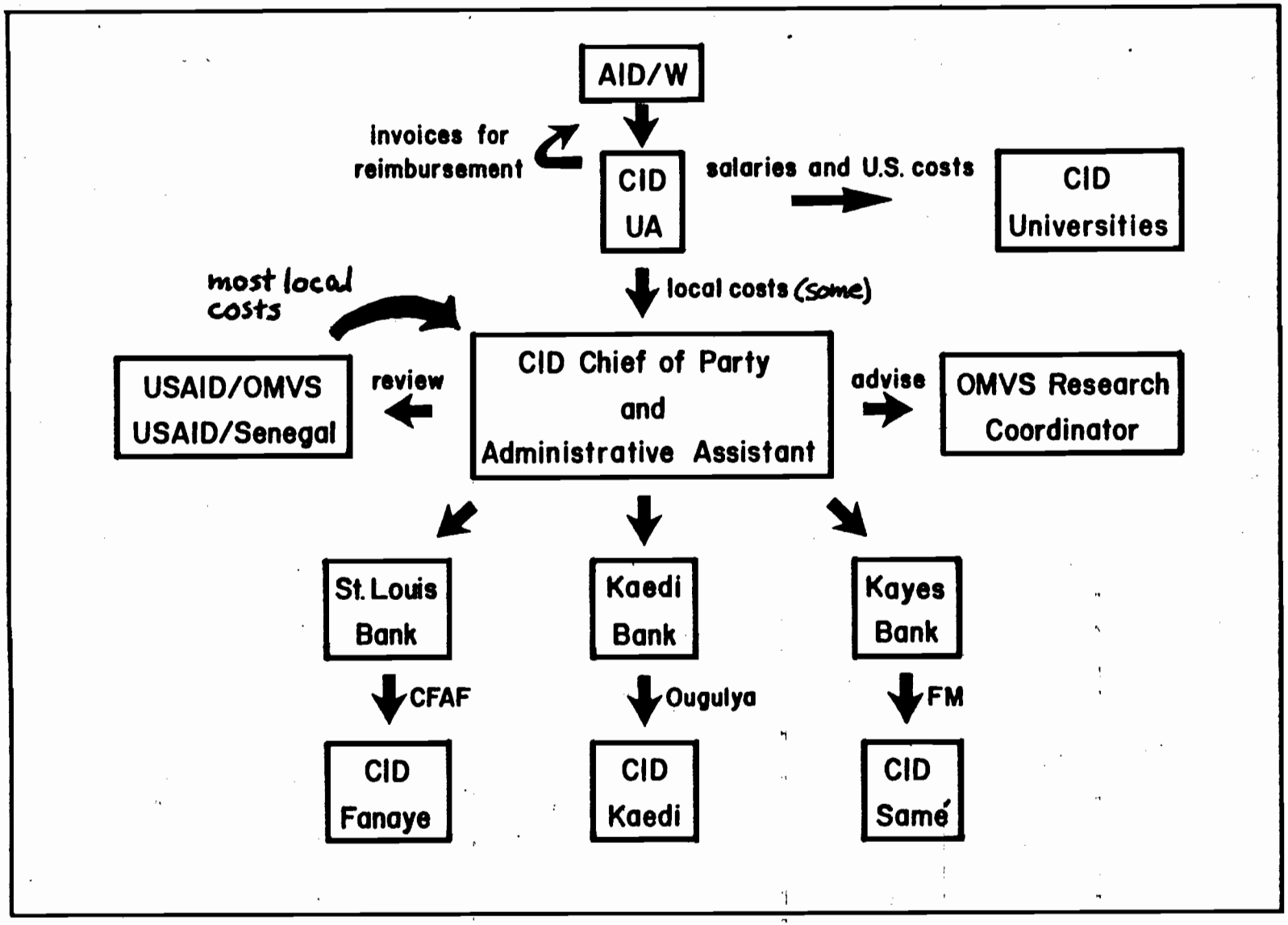

Figure 21: Flow of funds for project local costs and CID team salaries

2. Disbursement of Local Currencies

The disbursement of local currencies to the research stations is more complex than normal, because each of the OMVS states has its own currency --Malian Franc, Mauritanian Ouguiya, and the CFAF for Senegal. The CFAF is the only internationally negotiable currency. Past experience has shown that CFAF disbursed out of Dakar usually found its way into the black market for currencies; therefore, in order to avoid this problem, local currency disbursements will be handled primarily by the Chief of Party's office in Dakar through bona fide banks in St. Louis, Kaedi, and Kayes.

In the case of project related local funds (i.e., parts of salaries in local currency, labor costs, maintenance of project equipment, etc.), the Chief of Party may disburse dollars or CFAF directly to the regional banks for use by the project members (Figure 21).

In the case of general local support costs to the stations, a different method will be used. During the first three years of the project, each station director will submit a budget or invoices to the OMVS Agronomic Research Coordinator who in turn will review them and then submit them to the Chief of Party's office for payment. Payment will be made directly by the Chief of Party's office to the respective local banks near each research station. From the third to the sixth year of project implementation and after an effective accounting system has been established in OMVS, the Chief of Party's office will review the stations' budgets and invoices and disburse funds directly to the OMVS. The OMVS will then disburse the money through the already established procedures in the local banks for use by the research stations (see Figures 22 and 23).
In all cases, deposits and withdrawals recorded by the local banks will serve as verification of properly disbursed funds for periodic audits of the individual station finances.

3. Purchase of Local or Third Country Farm Equipment and Tools

Local farm equipment or machines from such countries as India or Morocco will be purchased directly through the project office in Dakar. Figure 24 represents this procedure.

4. Disbursement for Local Construction Costs

Management of construction on each of the three research stations is expected to be rather complex because of the difficulties arising from supervising and verifying work done by three construction firms in relatively isolated areas. It is therefore necessary that construction funds be disbursed from the field in the most timely fashion to keep the construction on schedule once it has started. Construction will be divided into distinct building activities/phases, and firms will draw on the funds as each activity is undertaken.

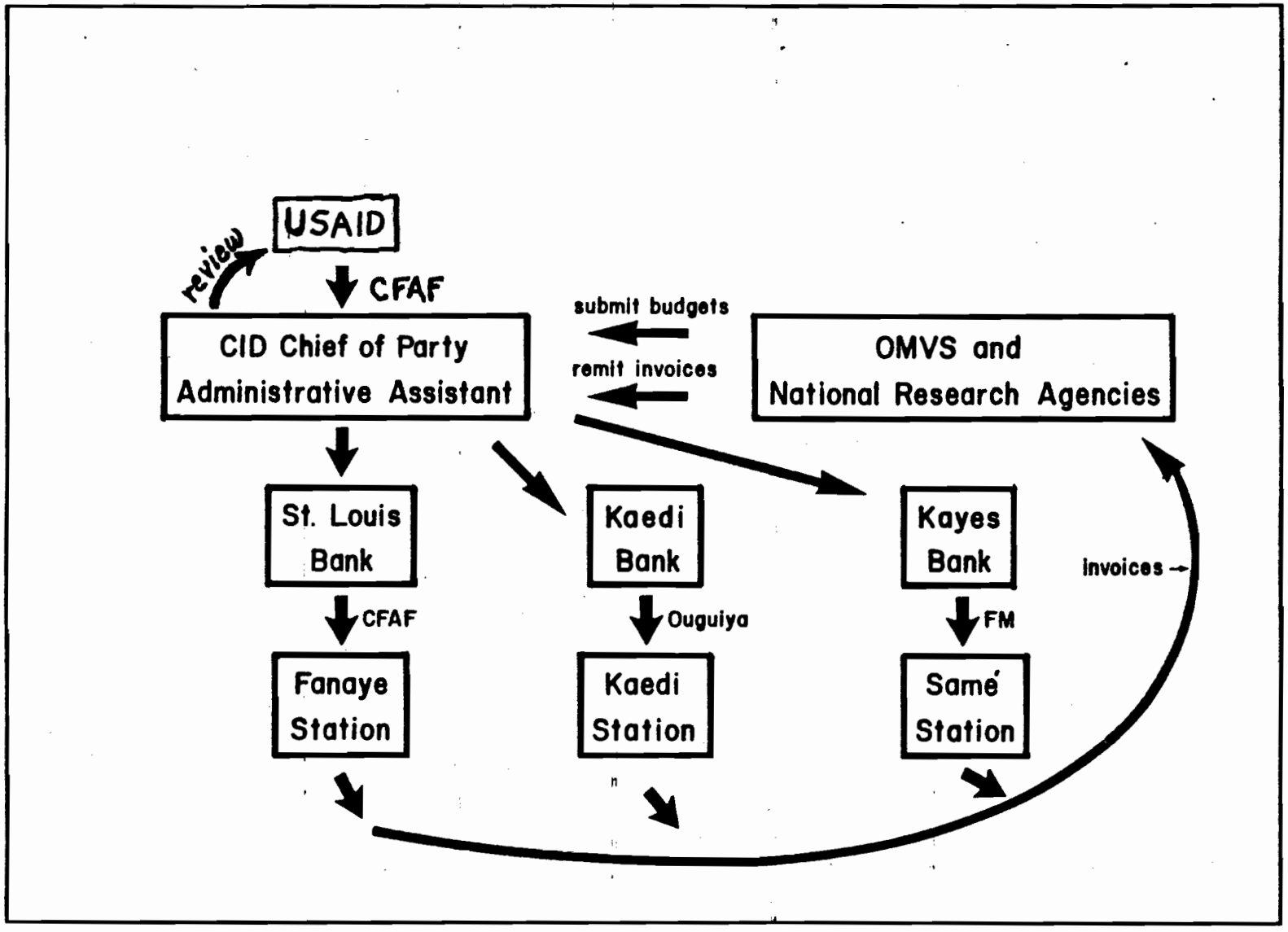

Figure 22. General local administrative support for stations: for first to third years.

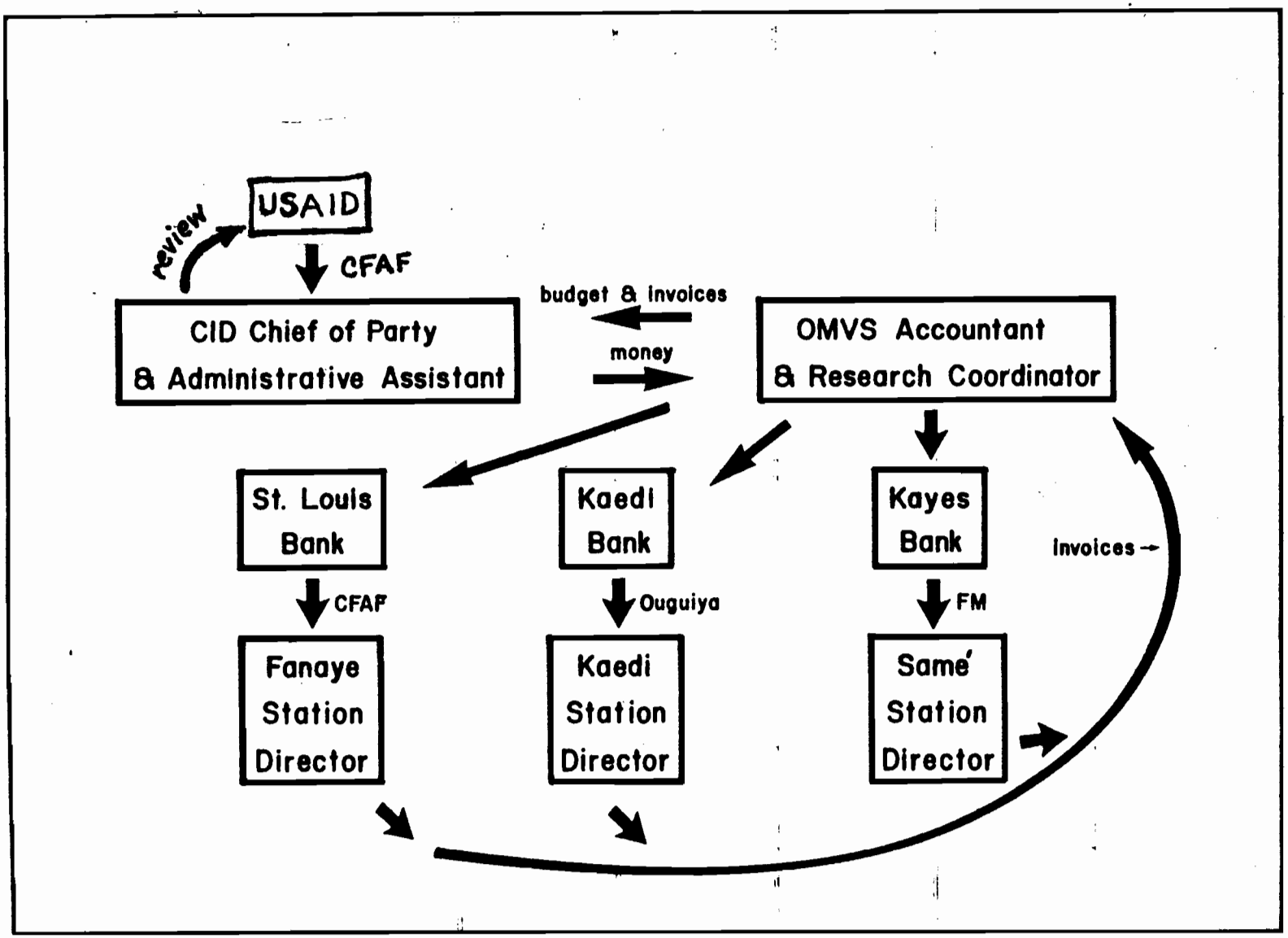

Figure 23 General local administrative support for stations: for third to sixth years.

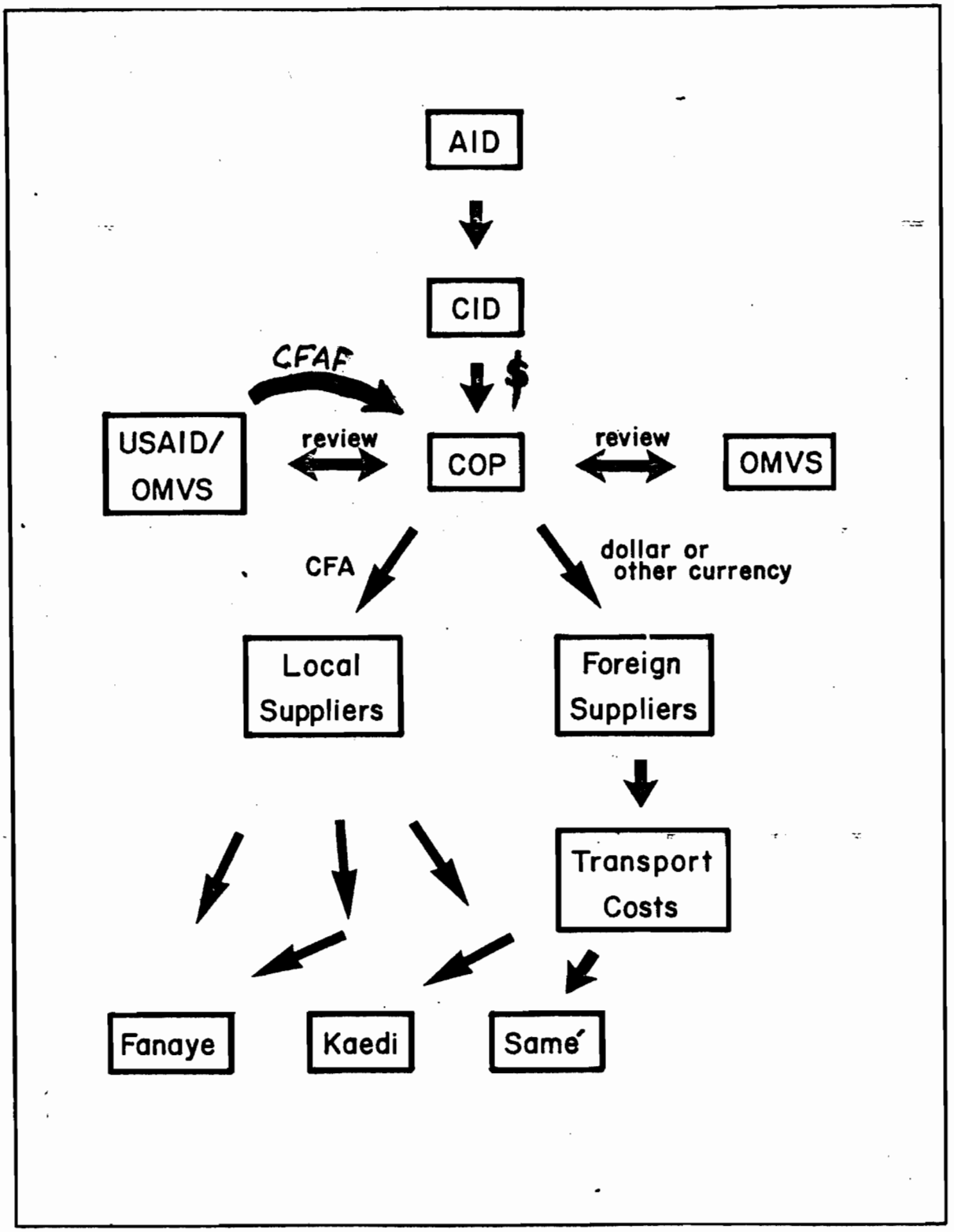

Figure 24 Local and foreign exchange purchase of farm equipment and tools.

If the institutional contract includes primary responsibility for all construction, then funds should be disbursed through the project office in Dakar to the architectural/engineering firms in charge of construction as indicated in Figure 25.

F. Audit

It is recommended that the project be audited every six months by a private auditing firm contracted systematically under the project or by AID's Regional Controller's Office. It is also strongly advised that a final audit be effectuated of all the project's goals, in all 3 stations and OMVS, every 2 years.

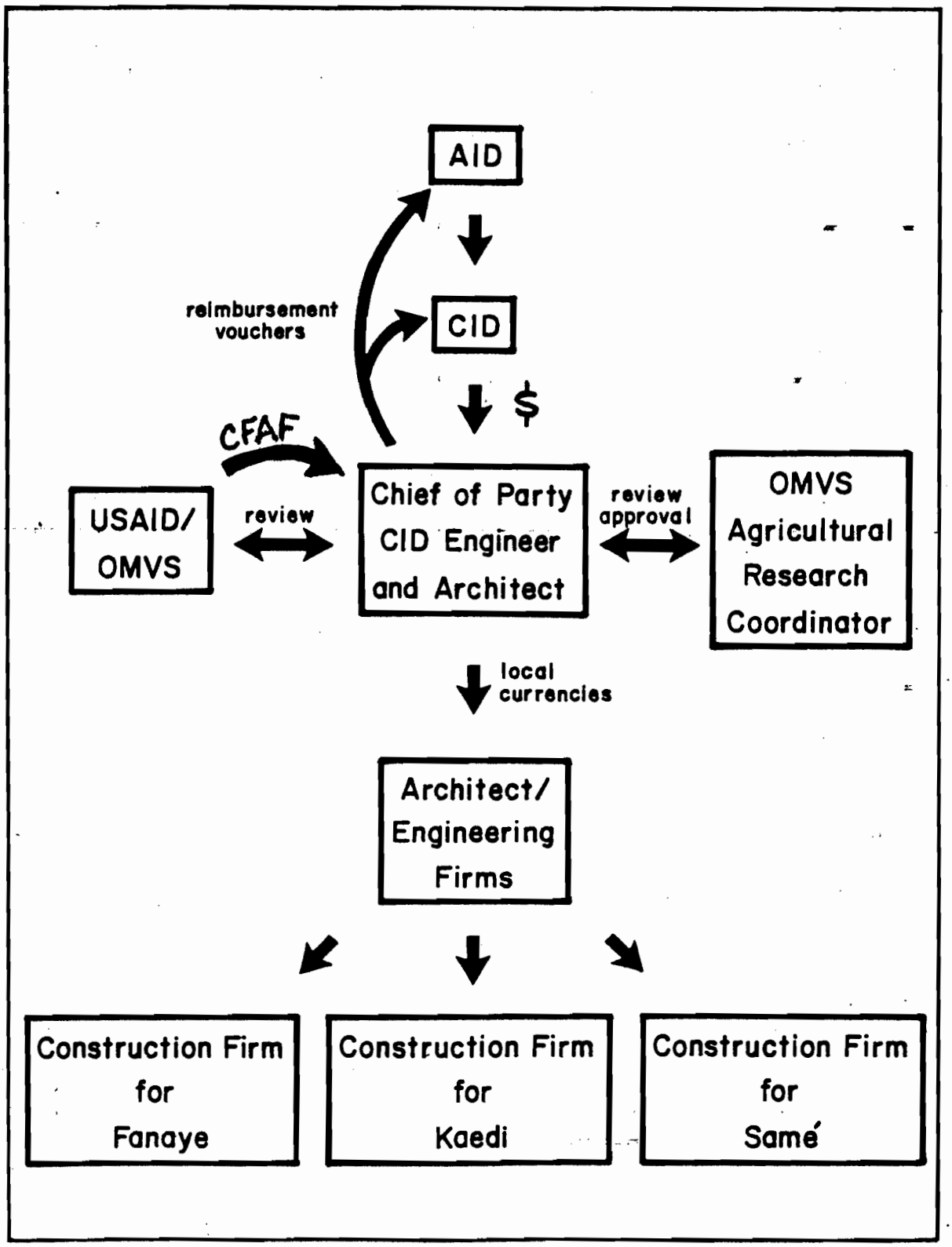

Figure 25 Local costs (construction)

93/94

VI. Evaluation Plan

The project will be regularly evaluated by the Contractor and by AID on a continuing basis. Project accomplishments will be compared with projections made in the Logical Framework (Annex A) and with contract specifications. In Volume II, Technical Appendices, the assumptions upon which the research design has been based are examined. The assumptions are justified on the basis of present knowledge, but it is emphasized that these assumptions will also serve as test hypotheses to be examined in the course of research.

All aspects of AR II, construction, training, and research, are meant to be flexible so that the project can be modified in response to increasing familiarity with the SRB situation and results of research specifically.

In keeping with the provisions of the Collaborative Assistance mode, OMVS and member state officials will participate with AID and Contractor representatives in making a major evaluation every two years. See Section V, Implementation Plan. Work plans will be revised accordingly.

The Status Report referred to earlier will provide some of the baseline data required for evaluation. Other baseline information will be obtained in conducting the research.

Individual research projects will be evaluated by project administrators on the basis of their stated objectives, which will have been designed to contribute to the overall purpose and goal of AR II. Project completion reports or annual research reports will provide the bases for the evaluation. Peer reviewers from national and international agencies, especially those involved in research and development in the SRB, will be asked to assist in research evaluations.

SECTION 15 PROJECT DESIGN SUMMARY LOGICAL FRAMEWORK

Life of Project
From FY__ to FY__
Total US Funding_____
Date Prepared

Project Title and Number: OMVS Agronomic Research II Project 628-0605

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Goal: To realize the integrated development of the Senegal River Basin.	Measures of Goal Achievement (A.2) -Increased political and economic support by member states as integrated development scheme progresses. -Strengthening and expansion of OMVS functions and expertise. -Increased national level financial and human resource allocations to OMVS as regional development organization. -OMVS capable of developing regional policies. -Other donor projects being planned or in practice.	(A.3) -Proceedings and actual resolutions and decisions made by the OMVS Council of Ministers and Heads of State.	Assumptions for achieving goal targets (A.4) -Regional approach to Senegal River Basin development is a complex, long-term proposition. -Member-states will increase political and economic commitment for integration with regard to use of river's waters rather than act in "disintegrating" manner. -Steady increase of outside financial and technical aid to OMVS keeps pace with development momentum created initially. -Mali, Senegal and Mauritania will coordinate national activities within the region and provide conditions conductive to operation of OMVS.

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
			-Necessary policies and legislative measures are enacted and implemented nationally and regionally.
Sub-Sector Goal: To increase agricultural production in the Senegal River Basin.	-Greater hectarage under cultivation. -Higher yield per hectare basic cereals. -Extensive irrigation infrastructure in place in basin. -Decreasing imports (grain) requirements. -Reduction of out-migration.		-That research-production link is a long-term proposition. -That agronomic research results are applied to future agricultural development programs by member-states and donors.

OMVS AGRONOMIC RESEARCH PROJECT

PROJECT PURPOSE

PROJECT PURPOSE	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
The project purpose is to search for ways to increase the efficiency of utilization of land, labor and other inputs, particularly water in existing agricultural production systems. These improvements will assist farmers in taking advantage of the water resources of the SRB through small scale irrigation projects which are part of regional development plans.	- Farmers in immediate area of research stations voluntarily using on-farm research methods. - Methods are voluntarily imitated by farm neighbors.	- Observation of on-farm research in action. - Use of results by national development agencies.	- Results of scientific studies carried out during past 30-40 yrs. is of quality ready for applied research. - Farmers in station areas can be convinced to try on-farm research. - Approach condoned by all parties involved —OMVS, AID, station directors. - Adoption of existing varieties & technologies is possible in SRB

OMVS AGRONOMIC RESEARCH PROJECT

O U T P U T S	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
To develop a sustained capability among OMVS states to conduct adaptive research in the SRB.	- Continued research after life of project. - Other donors doing adaptive research. - More trained nationals at research stations. - Countries contributing to functioning of research stations. - Research stations feeding information and results into development agencies and donor efforts. - Continued dissemination of research results.	- Publication. - Official government records. Donor records.	- States able to generate enough agriculture revenues to contribute to research. - Donors take on some costs in the interim and train capability into research organizations. - Regional vs. national priorities are sorted out.

O U T P U T S	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
Research Outputs: Additional knowledge will be gained about: - existing farming systems and how to make them more efficient over the long term through increased production and economic return per unit of land, water, labor (energy), and other inputs; - characteristics of the physical environment; - water quantity, quality; - soil physical and chemical characteristics; - climate and weather; - crop ecology; - methods to improve soil fertility and increase its resistance to erosion; - procedures to stabilize and improve the environment, thereby avoiding desertification, depletion, and degradation; - social-political-economic factors affecting agriculture in the SRB.	records and reports of team	periodic project evaluation comparing initial baseline data gathered by team members vs. changes observable by team in two year intervals;	positive agronomic and social options will emerge

OUTPUTS	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
Human Resource Outputs: Human resources will be developed in the following ways: - A small group of farmers in selected communities will become better trained in new techniques and more motivated, innovative, receptive, and involved in development activities. They will become more productive and have surplus production to barter or sell. This will permit them to increase food consumption, leading to better nutrition and health.	- increased food consumption of subject farmers - higher yields - more cash or bartering		that there is a viable alternative to other methods of mechanized, intensive, irrigated agriculture in SRB.
- Counterparts will become trained, motivated researchers and administrators. They will gain more understanding of farmers' needs and of the need to involve the farmers in the research process; they will be well grounded with knowledge of farming systems in the SRB. - Research assistants and field assistants also will be trained. - CID team members will gain a greater understanding of SRB problems.	- certificates of study - number with U.S. degrees - counterparts holding research related posts in other institutions.		counterparts of prescribed levels of education and English proficiency are available and willing to accept work-study conditions.

O U T P U T S	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
Physical Resource Outputs: - Participating farmers will have improved farm units yielding crops of higher quality and greater quantity. Their farming systems will become increasingly efficient, providing them with more income and opportunities for re-investment. - Viable agricultural research stations will be established and operating at three locations in the SRB.	- plant facilities in place - improved farm, in general	observation	- construction standards can be met by existing construction firms
Institutional Resource Outputs: OMVS: - A regional research management system will be established and integrated with national research and development agencies. Member States: - National research agencies will have improved capability for appropriate agricultural research, more facilities, and researchers. - National development agencies will have greater in-	- regional management system in place - regional research decisions and flow of funds	observation	- states do not view growing regional orientation as threat to national sovereignty but see their interest in OMVS.

OUTPUTS	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	ASSUMPTIONS
volvement in the research program leading to more, successful, development projects in the SRB. CID: - Member institutions which participate will have greater expertise in regional technical and social aspects. USAID: - Staff will have greater appreciation of how agricultural research can contribute to SRB development.			
Social Research Outputs: - Communities involved in the research will have increased capability for involvement in developing activities, ultimately leading the countries of the SRB to greater food self-sufficiency and improved nutrition and health of their populations. - Communities which participate will gain a measure of control over their own destiny through involvement in a successful development activity. - Overall economic development in the region ultimately will be boosted.	Formation of local committees planning own on-farm research program near research stations.	Observation reports.	Involvement in research related to development will lead farmers to development.

PROJECT INPUTS	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
A. AID Technical Assistance -Chief of Party research administrator -Fiscal control officer -Seven on-station scientists -Short-term expertise	-Expatriates in place carrying out job plans by end of 2nd year.	CID roster of expatriates.	-Able to recruit worldwide. -Availability of expatriates tollocate in Kaedi, Fanaye, Same. -Acceptability of MS level or third country national.
Equipment (see details pg.) -Small farm innovative tools -Innovative low-energy pumps -On-station pickups and machinery. -Ag machinery	-Equipment in place by end of second year. -$-- expended on equipment.	AID procurement documents. Observation.	-Adequate communication between suppliers and destination.
Construction, on station -Housing -Ag equipment sheds and garages. -Offices -Dike repair -On-farm research wells	-Construction on station completed by second year. -$-- expended on construction.	Bid documents. Observation. Architectural plans. Construction --	-Competent local contractors are available when CID ready. -Bids are within reasonable limits to estimates.
Training -On-station counterpart training bound for US Masters program. -On-station "conducteur" trained in third country ag institute. -On-station "moniteurP trained in country, Kaedi.	Throughout life of projects, there will be prescribed numbers on-station and in training destinations (see for training details page).		-Availability of counterparts at prescribed levels. of academic training.

SECTOR INPUTS	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Local Costs Support Stations operating costs	Local cost budgets and invoices.	Books and Accounts records	-Adequate fiscal controls. are imposed within OMVS form accountability.
B. OMVS Countries			-OMVS states are financially solvent to make contributions through salaries.
-Salaries of counterparts -Salaries of conducteur and moniteur -Local operating costs	-Adequate number on station receiving salaries.	Observation. Pay stubs.	
C. Other Donors			
-Counterpart housing -Part-time use of labs -Part-time use of expatriates.	Housing, labs in place by second year of AID project operation.	Donor documents, Letters of agreement.	-Agreement can be reached between OMVS and AID and other donors based on oral commitments up to date.
D. Farmers' Communities			
-Trial on-farm plots. -Draft animals.		Observation.	-Outstanding land tenure problems can be resolved for trial farms. -Farmers willing to take risk. -Draft animals trainable.

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5C(2) - PROJECT CHECKLIST

Listed below are statutory criteria applicable generally to projects with FAA funds and project criteria applicable to individual fund sources: Development Assistance (with a subcategory for criteria applicable only to loans); and Economic Support Fund.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP TO DATE?
HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PRODUCT?

A. GENERAL CRITERIA FOR PROJECT

1. FY 79 App. Act Unnumbered; FAA Sec. 653 (b); Sec. 634A. (a) Describe how Committees on Appropriations of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that figure)?	This project has been presented to Congress through the advice of program change process.
2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial, and other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?	YES
3. FAA Sec. 611(a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?	No legislative action required
4. FAA Sec. 611(b); FY 79 App. Act Sec. 101. If for water or water-related land resource construction, has project met the standards and criteria as per the Principles and Standards for Planning Water and Related Land Resources dated October 25, 1973?	YES
5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?	YES. This certification is attached as Annex
6. FAA Sec. 209. Is project susceptible of execution as part of regional or multilateral project? If so why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.	YES, OMVS is a regional organization

A.

7. FAA Sec. 601(a). Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.

The project purpose is to undertake research to improve the technical efficiency of agricultural research in the Senegal River Basin.

8. FAA Sec. 601(b). Information and conclusion on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).

This is a research project that will be implemented by a U.S. University.

9. FAA Sec. 612(b); Sec. 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized to meet the cost of contractual and other services.

OMVS is contributing to extent possible to cover certain local costs.

10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?

U.S. does not own any excess foreign currency.

11. FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?

12. FY 79 App. Act Sec. 608. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar, or competing commodity?

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

a. FAA Sec. 102(b); 111; 113; 281a. Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained

Agronomic research results, when provided to rural farmers, will involve them in the economic development process in the area. Farmer committees will be organized to facilitate their involvement.

basis, using the appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries?

b. FAA Sec. 103, 103A, 104, 105, 106, 107. Is assistance being made available: (include only applicable paragraph which corresponds to source of funds used. If more than one fund source is used for project, include relevant paragraph for each fund source.) N/A

(1) [103] for agriculture, rural development or nutrition; if so, extent to which activity is specifically designed to increase productivity and income of rural poor; [103A] if for agricultural research, is full account taken of needs of small farmers;

(2) [104] for population planning under sec. 104(b) or health under sec. 104(c); if so, extent to which activity emphasizes low-cost, integrated delivery systems for health, nutrition and family planning for the poorest people, with particular attention to the needs of mothers and young children, using paramedical and auxiliary medical personnel, clinics and health posts, commercial distribution systems and other modes of community research.

(3) [105] for education, public administration, or human resources development; if so, extent to which activity strengthens nonformal education, makes formal education more relevant, especially for rural families and urban poor, or strengthens management capability of institutions enabling the poor to participate in development;

(4) [106] for technical assistance, energy, research, reconstruction, and selected development problems; if so, extent activity is:

(i) technical cooperation and development, especially with U.S. private and voluntary, or regional and international development, organizations;

(ii) to help alleviate energy problems;

(iii) research into, and evaluation of, economic development processes and techniques;

(iv) reconstruction after natural or manmade disaster;

B.1.b.(4).

(v) for special development problem, and to enable proper utilization of earlier U.S. infrastructure, etc., assistance;

(vi) for programs of urban development, especially small labor-intensive enterprises, marketing systems, and financial or other institutions to help urban poor participate in economic and social development.

c. [107] Is appropriate effort placed on use of appropriate technology?

Project research will help develop all best appropriate technologies.

d. FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or has the latter cost-sharing requirement been waived for a "relatively least-developed" country)?

This is a multi-donor project to a regional organization under Section 121 and thus the 25% requirement is not applicable

e. FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to the Congress been made, and efforts for other financing, or is the recipient country "relatively least developed"?

N/A

f. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participation in governmental and political processes essential to self-government.

This project will provide essential agronomic research results which will assist the member state in meeting their food needs.

g. FAA Sec. 122(b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase or productive capacities and self-sustaining economic growth?

OMVS will provide African manpower to complement the U.S. University researchers.

2. Development Assistance Project Criteria (Loans Only)

N/A

a. FAA Sec. 122(b). Information and conclusion on capacity of the country to repay the loan, including reasonableness of repayment prospects.

b. FAA Sec. 620(d). If assistance is for any productive enterprise which will compete in the U.S. with U.S. enterprise, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?

B.

3. Project Criteria Solely for Economic Support Fund — N/A

a. FAA Sec. 531(a). Will this assistance support promote economic or political stability? To the extent possible, does it reflect the policy directions of section 102?

b. FAA Sec. 533. Will assistance under this chapter be used for military, or paramilitary activities?

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B - 7

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5C(3) - STANDARD ITEM CHECKLIST

Listed below are statutory items which normally will be covered routinely in those provisions of an assistance agreement dealing with its implementation, or covered in the agreement by imposing limits on certain uses of funds.

These items are arranged under the general headings of (A) Procurement, (B) Construction, and (C) Other Restrictions.

A. Procurement

1. FAA Sec. 602. Are there arrangements to permit U.S. small business to participate equitably in the furnishing of goods and services financed?	YES, the USAID/Senegal Project Support Office will see that US. small businesses are considered as procurement sources.
2. FAA Sec. 604(a). Will all commodity procurement financed be from the U.S. except as otherwise determined by the President or under delegation from him?	YES
3. FAA Sec. 604(d). If the cooperating country discriminates against U.S. marine insurance companies, will agreement require that marine insurance be placed in the United States on commodities financed?	YES
4. FAA Sec. 604(e). If offshore procurement of agricultural commodity or product is to be financed, is there provision against such procurement when the domestic price of such commodity is less than parity?	N.A
5. FAA Sec. 608(a). Will U.S. Government excess personal property be utilized wherever practicable in lieu of the procurement of new items?	YES
6. FAA Sec. 603. (a) Compliance with requirement in section 901(b) of the Merchant Marine Act of 1936, as amended, that at least 50 per centum of the gross tonnage of commodities (computed separately for dry bulk carriers, dry cargo liners, and tankers) financed shall be transported on privately owned U.S.-flag commercial vessels to the extent that such vessels are available at fair and reasonable rates.	YES
7. FAA Sec. 621. If technical assistance is financed, will such assistance be furnished to the fullest extent practicable as goods and professional and other services from private enterprise on a contract basis? If the	Title XII collaborative contract is the selected mode of implementation.

A.7.

facilities of other Federal agencies will be utilized, are they paritcularly suitable, not competitive with private enterprise, and made available without undue interference with domestic programs?

8. International Air Transport. Fair Competitive Practices Act, 1974. If air transportation of persons or property is financed on grant basis, will provision be made that U.S.-flag carriers will be utilized to the extent such service is available? — YES

9. FY 79 App. Act Sec. 105. Does the contract for procurement contain a provision authorizing the termination of such contract for the convenience of the United States?

B. Construction

1. FAA Sec. 601(d). If a capital (e.g., construction) project, are engineering and professional services of U.S. firms and their affiliates to be used to the maximum extent consistent with the national interest? — N/A

2. FAA Sec. 611(c). If contracts for construction are to be financed, will they be let on a competitive basis to maximum extent practicable? — YES

3. FAA Sec. 620(k). If for construction of productive enterprise, will aggregate value of assistance to be furnished by the United States not exceed $100 million? — N/A

C. Other Restrictions

1. FAA Sec. 122 (e). If development loan, is interest rate at least 2% per annum during grace period and at least 3% per annum thereafter? — N.A

2. FAA Sec. 301(d). If fund is established solely by U.S. contributions and administered by an international organization, does Comptroller General have audit rights? — N.A

3. FAA Sec. 620(h). Do arrangements preclude promoting or assisting the foriegn aid projects or activities of Communist-bloc countries, contrary to the best interests of the United States? — YES

4. FAA Sec. 636(i). Is financing not permitted to be used, without waiver, for purchase, long-term lease, or exchange of motor vehicle manufactured outside the United States, or guaranty of such transaction? — YES, A.I.D. regulations on vehicle procurement will be applied.

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C.

5. Will arrangements preclude use of financing:

a. FAA Sec. 104(f). To pay for performance of abortions or to motivate or coerce persons to practice abortions, to pay for performance of involuntary sterilization, or to coerce or provide financial incentive to any person to undergo sterilization? YES

b. FAA Sec. 620(g). To compensate owners for expropriated nationalized property? YES

c. FAA Sec. 660. To finance police training or other law enforcement assistance, except for narcotics programs? YES

d. FAA Sec. 662. For CIA activities? YES

e. FY 79 App. Act Sec. 104. To pay pensions, etc., for military personnel? YES

f. FY 79 App. Act Sec. 106. To pay U.N. assessments? YES

g. FY 79 App. Act Sec. 107. To carry out provisions of FAA sections 209(d) and 251(h)? (Transfer of FAA funds to multilateral organizations for lending.) YES

h. FY 79 App. Act Sec. 112. To finance the export of nuclear equipment, fuel, or technology or to train foreign nations in nuclear fields? YES

i. FY 79 App. Act Sec. 601. To be used for publicity on propaganda purposes within United States not authorized by the Congress? YES

ORGANISATION POUR LA MISE EN VALEUR DU FLEUVE SENEGAL

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N° 00030 OMVS HC

Dakar, le 21 AOUT 1981

onus file

Le Haut Commissaire

(7)

Objet : Demande d'aide - Projet de Recherche Agricole (625-0205).

Monsieur le Directeur,

ACTION
PDO
INFO
DIR
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MO
FMM
OMVS
Reg Con
EFM
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FFP
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Ex Sec
Disp
MIV
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Chron

Comme vous le savez déjà, le Haut-Commissariat de l'OMVS et ses Etats membres ont financé pendant de nombreuses années un programme régional de recherche agricole dans le bassin du fleuve Sénégal. Les agences internationales telles que le Programme des Nations Unies pour le Développement et l'Organisation pour l'Alimentation et l'Agriculture (PNUD/FAO) y ont participé depuis les années 60. De 1970 à 1976, la FAO a pris une part très active dans la direction de ce programme de recherche agricole effectué dans les centres de Fanaye au Sénégal, Samé au Mali et Kaédi en Mauritanie.

A la demande de l'OMVS, appuyée en cela par le PNUD/FAO, l'USAID a fourni aux trois centres, l'outillage, l'assistance technique et a pris en charge les frais de fonctionnement de 1975 à 1978. Cette assistance de l'AID a permis aux centres de continuer à fonctionner et à poursuivre les essais surle terrain bien que l'assistance de la FAO/PNUD ait pris fin.

Les Etats membres de l'OMVS soucieux de rentabiliser le programme d'infrastructure régionale dont l'une des principales justifications reste le développement du secteur agricole avaient demandé au Haut-Commissariat de l'OMVS de mettre sur pied un programme de recherche Agricole. Ce programme devait permettre de développer les possibilités d'une recherche continue dans le bassin du fleuve Sénégal tout en accroissant la production et en améliorant le revenu des paysans. Ce programme fut présenté et adopté lors de la réunion du Club du Sahel à Ottawa, Canada en Mai 1977. Par la suite, l'USAID a été sollicitée pour une assistance dans l'élaboration de ce programme de recherche Un programme de recherche a donc été étudié et a fait l'objet d'analyse et de recommandations lors des rencontres avec les Etats membres, l'OVSTM, la SONADER, l'ISRA et les membres du CIERDA.

USAID/SENEGAL
Date received AUG 25 1981
Registry Nber 1312
Date Action Taken
Action Taken
Signature :

./.

Monsieur David SHEAR
Directeur de l'USAID/Sénégal

D A K A R

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Afin de mettre en place cet important programme de recherche agricole, je vous serais reconnaissant de bien vouloir appuyer auprès de l'AID/Washington l'octroi de son financement.

Ce programme constitue pour l'OMVS un élément essentiel dans la stratégie d'ensemble du programme de développement dont le but est d'atteindre l'autosuffisance alimentaire de la sous-région.

Veuillez agréer, Monsieur le Directeur, l'expression de ma considération distinguée.

Mokhtar Ould HAIBA

Haut Commissaire

Organisation pour la Mise en Valeur du Fleuve Sénégal

ANNEX D.

UNITED STATES GOVERNMENT

memorandum

DATE: 06/25/81

REPLY TO ATTN OF: Barnabas Mosley, PDO/ENG

SUBJECT: OMVS - Agricultural Research 625-0605
611 (A) Requirement.

TO: David Shear, Director 6/29

I have examined the subject background material, technical aspects, and preliminary cost estimates for the proposed construction of subject project. Additionally, I have inspected the sites at Sama, Mali and Fanaye, Senegal and found the conditions to be exactly as described by the engineer working with the project design team. Based on the above, I have determined that the preliminary plans and specifications for the construction are adequate and that a reasonable estimate of the cost to U.S. Assistance has been made.

ANNEX. D.

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MISSION DIRECTOR'S 611(e) CERTIFICATION

I. PROJECT DATA:

A. Country	: O.M.V.S.
B. Project	: OMVS Agricultural Research (625-0605)
C. Funding	: $ 12.89 million
D. Life of Project	: 6 years.

II. JUSTIFICATION:

This project provides support to the Senegal River Basin Development Organization (OMVS) for a regional agricultural research program in the Senegal River Basin involving Senegal, Mauritania and Mali. The overall program is built around a set of comprehensive agricultural research activities focused on small-scale farming systems in community settings. The support for the first phase of this project and the continuing commitment of Senegal, Mauritania and Mali to agricultural development and to applying new agricultural technology indicate that this support will continue. The OMVS and Member States have successfully fulfilled support agreements for other AID-financed projects and have expressed strong commitment for this project during the collaborative design effort.

III. CERTIFICATION:

As the principal officer of the Agency for International Development in Senegal, I affirm that, in my judgement, the OMVS and Member States have both the financial capability and the human resources to effectively maintain and utilize the goods and services being provided by the OMVS Agricultural Research Project (625-0605).

David Shear,
Director,
USAID/Senegal

Signature David Shear

Date 8/26/81

ANNEX E.

SCOPE OF WORK FOR TECHNICAL ASSISTANCE

Descriptions of the responsibilities of all CID personnel in both field and backstopping positions are given in this section along with necessary qualifications. A set of general responsibilities and qualifications is given first; these apply to all field personnel except the Administrative Officer. Specific responsibilities and qualifications then are listed for each individual position.

1 General Responsibilities and Qualifications

- Become familiar with the project area including existing farming systems and all relevant research and development activities there.
- Review all literature available in CID library (Dakar) and appropriate documents and publications in the OMVS Documentation Center (St. Louis).
- Cooperate with other team members as necessary to meet project objectives (outputs).
- Prepare "scopes of work" for short-term staff as they may be necessary.
- Work with local counterparts in planning, implementing, and evaluating research programs.
- Participate in OMVS/SRB research seminars.
- Participate in regular and special team meetings.
- Establish permanent systems of data collection, storage, and retrieval for long-term analyses.
- Establish and maintain contact with other research and training activities in the SRB that could contribute to accomplishing project objectives.
- Assist other CID team members in conducting in-service training courses, special short courses, and extension programs for counterpart professionals and mid-level technicians.
- Train research and field assistants in methods of data collection, coding, and initial analysis of data.
- Help identify promising candidates for further training.
- Prepare quarterly progress and end-of-tour reports.

General Qualifications

- Ability to communicate well in written and spoken French (R2, S2 minimum).
- Experience in development assistance programs desirable.
- Experience in West Africa desirable.
- Ability to work closely with counterparts and to conduct training programs of various levels.

2 Chief of Party/Research Administrator (Dakar)

- Carry out all general responsibilities (Section 19.1).
- Prepare guidelines for programming, planning, and implementing all research activities.
- Initiate, coordinate, and supervise the various research projects in conjunction with the OMVS Coordinator of Agricultural Research and the station directors.
- Assist station directors in organizing and carrying out maintenance programs.
- Assist and encourage CID team scientists in research planning and experimental design.
- Establish contact and working relationships with national development agencies.
- Assist OMVS Director of Planning and Coordination to direct all project research toward accomplishment of OMVS research goals, and keep the Director informed of progress.
- Serve as liaison between OMVS administrators, USAID representatives, and field research personnel.
- Assist in planning, coordinating, and conducting all training programs.
- Attend CIERDA meetings and seek to inform and involve its members in AR II.
- Keep abreast of other donor activities in the SRB and attempt to foster a cooperative spirit among them.
- Determine need for and responsibilities of short-term personnel. Coordinate their visits through and with CID team members. Assist team members in preparing "scopes of work" for each short-term assignment.

- Visit research stations regularly.
- Coordinate the preparation of quarterly progress and annual scientific reports.
- Prepare overall progress and research reports.
- Assist team members in resolving personal problems.

Qualifications

- Meet general qualifications (Section 19.1).
- Ph.D. in agricultural science, or MS and equivalent experience.
- Experience in planning and administration of agricultural research.
- Experience with farming systems approach desirable.
- Experience as Chief of Party in development assistance project desirable.

3 Administrative Officer (Dakar)

- Assist with the allocation of research funds for the three research stations and for scientists at each location.
- Determine the characteristics of local accounting systems, and set up a bookkeeping system compatible with existing systems.
- Keep records of expenditures by project and by station.
- Assist in setting up and administering procurement systems to minimize time and effort in purchasing and receiving research supplies and equipment.
- Establish and maintain a project library and other project files.
- Provide logistic support services for meeting personal and family needs of CID team members.

Qualifications

- Meet general qualifications (Section 19.1).
- BS in accounting or equivalent experience.
- Experience in research administration desirable.

4 Plant Scientist (Fanaye)

- Carry out all general responsibilities (Section 19.1).
- Plan, design, and conduct ON-FARM, APPLIED, and SUPPORTING research as defined in PP amendment.
- Assist in planning, designing, and conducting COMMUNITY AND REGIONAL research as defined in PP amendment.

- Plan, design, and conduct INNOVATIVE and FUNDAMENTAL research as defined in PP amendment (after 2nd project year).
- Prepare research project reports.

Qualifications

- Meet general qualifications (Section 19.1).
- MS in Plant Science or BS and equivalent experience.
- Experience in research project design and implementation.
- Experience with farming systems research desirable.

5 Social Scientist (Samé)

- Carry out all general responsibilities (Section 19.1).
- Coordinate the design and execution of a survey of the communities in the area in which each station is located, as part of COMMUNITY AND REGIONAL research.
- Coordinate the selection of communities and farmers to participate in ON-FARM, SUPPORTIVE, and other research.
- Work with all other scientists at the stations in making their research sensitive to the characteristics of the people and responsive to their needs.
- Help in coordinating the different research station projects in the same community or on the same farm.
- Help to organize farmer committees in communities where ON-FARM research is being carried out.
- Investigate community social structure and leadership patterns among farm families in relation to decisions affecting changes in farming system.
- Analyze patterns of migration and identify possible effects upon these patterns of the proposed development plans.
- Identify cultural and behavioral resources and constraints for the adoption of various technological systems including farmers' ideas about present problems and possible solutions.
- Cooperate with agricultural economist in the analysis of household and community labor and marketing patterns as they affect and are affected by changes in farming systems, giving attention to the separate roles of men, women, and children.

- Coordinate efforts in and supervise technicians working on farming systems.
- Explain the research station and its proposed program to the local officials and farmers and encourage them to give their opinions about how the station could best serve the need of improving agriculture in the area.
- Assist the agricultural economist in studying money and energy flow of representative farm households, communities, and irrigation projects to compare the returns to the farmers under alternative methods of production.
- Conduct research on agricultural practices as they relate to present problems and possible solutions. Specific topics should be worked out with all of the other station scientists. This should include beliefs as well as behaviors.
- Prepare research project reports.

Qualifications

- Meet general qualifications (Section 19.1).
- MS in Social Science or BS/BA and equivalent experience.
- Experience in farming systems research desirable.
- Experience in designing and implementing social research programs.

6 Plant Scientist (Kaedi)

- Carry out general responsibilities (Section 19.1).
- Plan, design, and conduct ON-FARM, APPLIED, and SUPPORTING research as defined in PP amendment relevant to Kaedi area, with emphasis on horticultural crops.
- Assist in planning, designing, and conducting COMMUNITY AND REGIONAL research as defined in PP amendment.
- Plan, design, and conduct INNOVATIVE and FUNDAMENTAL research as defined in PP amendment (after 2nd project year).
- Prepare research project reports.

Qualifications

- Meet general qualifications (Section 19.1).
- MS in Plant Science or BS and equivalent experience, emphasis on horticultural crops.
- Experience in design and implementation of research projects.

7 Agricultural Engineer (Kaedi)

- Carry out all general responsibilities (Section 19.1).

- Assist in design and installation of irrigation and drainage facilities at the three stations.

- Plan and implement maintenance programs for equipment and facilities at the three stations.

- Assist in locating and constructing wells for ON-FARM and INNOVATIVE research.

- Coordinate APPLIED and INNOVATIVE research on appropriate technology with other scientists, including the design, development,

and local production of small-scale pumps, farm tools, and food processing equipment.

- Carry out research in water requirements as related to crops, soils, and environment.
- Assist other scientists in determining the soil-water characteristics in the SRB as related to infiltration, percolation, drainage, and possibility of salt problems developing.
- Evaluate technical and economic feasibility of ground water utilization for irrigation and other purposes in the SRB.
- Supervise collection of climatological data.
- Prepare research project reports.

Qualifications

- Meet general qualifications (Section 19.1).
- BS in Agricultural Engineering or equivalent experience.
- Experience with appropriate technology in development context desirable.
- Extension or similar experience desirable.

8 Plant Scientist (Samé)

- Carry out all general responsibilities (Section 19.1).
- Plan, design, and conduct ON-FARM, APPLIED, and SUPPORTING research as defined in PP amendment, relevant to Samé area.
- Assist in planning, designing, and conducting COMMUNITY AND REGIONAL research as defined in PP amendment.
- Plan, design, and conduct INNOVATIVE and FUNDAMENTAL research as defined in PP amendment (after 2nd project year).
- Prepare research project reports.

Qualifications

- Meet general qualifications (Section 19.1).
- MS in Plant Science or BS and equivalent experience.
- Experience in research project design and implementation.

9 Agricultural Economist (Fanaye)

- Carry out all general responsibilities (Section 19.1).
- Assist in planning, designing, and conducting ON-FARM, APPLIED, SUPPORTING, and INNOVATIVE research as defined in PP amendment.

Conduct economic analyses of production technologies being developed. Assist other CID team members in limiting factors analysis.

- Plan, design, and conduct COMMUNITY AND REGIONAL research as defined in the PP amendment. Organize and conduct farming systems research. Cooperate with social scientist in the analysis of household and community labor and marketing patterns as they affect or are affected by changes in farming systems, giving attention to the separate roles of women, men, and children. Study money and energy flow of representative farm households, communities, and irrigation projects to compare the returns to the farmers under alternative methods of production. Collect and organize available regional economic data, including previous economic analyses. Analyze market systems in the SRB for the major crops.
- Prepare research project reports

Qualifications

- Meet general qualifications (Section 19.1).
- MS in Agricultural Economics or BS and equivalent experience.
- Familiarity with farming systems research desirable.
- Experience with use of computer in analyzing farming systems and other agricultural and marketing data.

10 Project Director (US)

- Provide overall administrative and technical leadership for the project.
- Recruit and orient CID team members and replacements.
- Recruit personnel for short-term assignments.
- Prepare miscellaneous routine and special project reports. Prepare final report.
- Provide liaison between field team and AID/Washington.
- Assist CID Chief of Party in organizing and implementing the field activities.

Qualifications

- Experience in agricultural research administration.
- Experience in agricultural development.

- Ph.D. or MS and equivalent experience in appropriate discipline.
- Ability to communicate in reading and spoken French desirable.

11 Agricultural Scientist (US)

- Provide technical backstopping for field team members.
- Serve on short-term field assignments as appropriate.
- Assist in selecting ordered equipment and supplies.

Qualifications

- Ph.D. or MS and equivalent experience in appropriate discipline.
- Experience in agricultural development desirable.
- Experience in West Africa desirable.

12 Short-Term Personnel

- Carry out "scope of work" as prepared by field team.

Qualifications

- Those necessary to carry out assigned "scope of work" in SRB.

ANNEX. F.

CATEGORICAL EXCLUSION FROM ENVIRONMENTAL PROCEDURES

A. Country	: OMVS
B. Project	: Agricultural Research (625-0605)
C. Funding	: $ 12.89 million
D. Life of Project	: 6 years

PROJECT DESCRIPTION:

The project provides support to the Senegal River Basin Development Organization (OMVS) for a regional agricultural research program in the Senegal River Basin involving Senegal, Mauritania and Mali. The project purpose is to search for ways to increase the efficiency of utilization of land, labor and other inputs, particularly water, in existing agricultural systems. The program is built around a set of comprehensive agricultural reserach activities focused on small-scale farming systems in community settings.

CLASS OF ACTION:

The project is within the class of action of categorical exclusions under A.I.D. Environmental Procedures 216.2 (c) (2) (ii) for projects involving "controlled experimentation exclusively for the purpose of research and field evaluation which are confined to small areas and carefully monitored".

DETERMINATION:

David Shear,
Director,
USAID/Senegal

Approved David Shear

Disapproved _____

Date 8/26/81

CONCURRENCE:

Africa Bureau
Environmental
Officer

Approved _____

Disapproved _____

Date _____

ANNEX G.

JUSTIFICATION FOR PROCUREMENT WAIVER

I.	A. Cooperating Country	: OMVS
	B. Authorizing Document	: Project Agreement to be executed
	C. Project	: OMVS Agricultural Research (625-0606)
	D. Nature of funding	: Grant
	E. Nature of goods	: Agricultural Equipment and vehicles
	F. Approximate value	: $ 200,000
	G. Likely source	: France
	H. Waivers previously granted	: None
	I. Presently Authorized Sources	: Code 00 and Cooperating Country.

II. DISCUSSION

The subject project will provide technical assistance, training, facilities development, equipment and operating support to help develop the agricultural research capacity of Senegal, Mauritania and Mali in the Senegal River Basin. The program involves a comprehensive set of agricultural research activities that are focused on small-scale farming systems in community settings. These research activities will be undertaken at three research stations in the Senegal River Basin: Fanaye, Senegal; Kaedi, Mauritania; and Samé, Mali. All three locations are in remote areas where travel is difficult and equipment parts and maintenance lacking.

U.S. manufactured vehicles and agricultural equipment (i.e tractors, motor tillers, pumpsets, etc.) are extremely rare in the Senegal River Basin. A major problem with U.S. manufactured equipment has been after-sales service (warranty work, spare parts, maintenance servicing, etc). Several surveys of the situation have been undertaken by the REDSO/WA engineer and by USAID's Senegal, Mauritania and Mali and some project activities (i.e. SAED Training Project - 685-0218) are addressing these problems, but despite this and some other recent changes, including the opening of a GMC dealership in Dakar, equipment servicing remains a major problem in the area. No American manufacturers are represented in the SRB and there are no garages in the Richard Toll/Fanaye, Kaedi, or Kayes areas that have any experience, tools, or parts for the maintenance and repair of American-made vehicles.

The only spare parts available, even for the European cars on which the garages work exclusively, are for minor tune-ups, cooling and brake system repairs. Spare parts for major repairs and overhauls are ordered from Dakar as needed.

Spare parts would have to be ordered with the equipment and vehicles, if U.S. manufactured equipment and vehicles were purchased. This in itself presents no problem. The problem is presented first in having to establish a new spare parts stock system and to have it policed to avoid having parts disappear quickly and second, procurement of the major repair items for which spare parts were not foreseen and ordered. Any spare part which is not in stock can be air freighted into Dakar within two months provided the paperwork channel is functioning and the

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purchase orders do not get lost in the system. The requirement for import licenses and customs clearance can extend this time to six months.

An ancillary but equally serious problems is the requirement that repair manuals and spare part catalogs be in French, or that a bilingual mechanic be found and provided to the garage. To date, no American manufacture has been willing to publish service and maintenance manuals in French.

The USAID/Dakar motor pool has standardized on Jeep for field vehicles. It is estimated that this American-made vehicle purchased with a coordinated package of spare parts and maintained under the direct supervision of an American mechanic on the USAID staff, can have a satisfactory service life of at least two years. Without an American mechanic to supervise maintenance and repair and the capability to order required spares through the Embassy pouch system, it is virtually certain that the vehicles would be out of service in six months.

On the other hand, Peugeot, the largest dealer of light vehicles in the area, imports approximately 20% of all the light vehicles in use in Senegal. Their shop in Dakar is large and complete with numerous mechanics and a large supply of spare parts. Parts can be ordered easily from Dakar and major overhauls can be undertaken in local commercial shops in St-Louis, Kaedi and Kayes.

Other European suppliers have smaller facilities in the OMVS countries. The Renault dealer has a shop in Dakar which was recently remodeled. It was low on spares due to its recent relocation but there was no indication of vehicles sitting in the shop waiting for parts. Landrover is supported by a large facility in Dakar and can be maintained and repaired.

The conclusion of the surveys undertaken was that there is no U.S. manufacturer in Dakar at the present time who is capable of providing normal after-sales support and service nor proper warranty support. Of the European manufacturers, Peugeot, Renault, and Landrover are three companies who have strong support facilities and are capable of supporting vehicles with normal after-sales service.

III. RECOMMENDATION:

For the above reasons, it is recommended that a change in the authorized Geographic Code 000 (U.S. only) to Geographic Code 935 (Special Free World) be approved to permit the procurement of agricultural equipment and vehicles not to exceed two hundred thousand dollars ($ 200,000) and that the authorizing officer certify that the interests of the United States are best served by permitting the procurement of goods from Code 935 countries, and that procurement from the sources recommended is necessary to the attainment of US foreign policy objectives and objectives of the foreign assistance program.

PROJECT PAPER APPENDICES

OMVS AGRICULTURE RESEARCH PROJECT

625 - 0605

(VOLUME II)

USAID/SENEGAL
B.P. 49
Dakar, Senegal

August, 1981

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

O. M. V. S.

AGRICULTURE RESEARCH PROJECT

625-0605

VOLUME II - TECHNICAL APPENDICES

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I. Technical Analysis

Technical aspects of the overall research program are examined from the standpoint of the existing farming systems and the justification for, feasibility of, and impacts from the proposed approach. Assumptions are made on the basis of what we know and thus also are, in effect, "test" hypotheses. If they prove invalid, the research program can and will be changed (see Section VI.)

A. Agricultural Analysis

In this section the existing farming systems are described. Assumptions we have made in designing the programs are listed, and the feasibility is discussed. Details of the previous crop research which forms part of the base for this continued effort are given.

The agricultural research program will have impacts on the social and physical environments. These impacts are discussed in the Social Soundness Analysis (Append.III) and Environmental Analysis (Append. V).

1. Farming Systems (based on Gannet et al., Inc. 1979; Contractor 1978; and team observations)

Economic aspects of farming systems are discussed in Append. II.B and II.C. and social aspects in Section IV below. In the present section agronomic and environmental factors are considered.

Farming systems incorporate several basic strategies, differentiated on the basis of water supply for crop production, season of cultivation, and location with respect to the river and its flood plain. See Table 26 and figure 26 for summary information; details are given below. Individual farm families commonly use more than one method. Their allocation of resources depends on rainfall and flooding, labor supply, and availability of each type of land to make their decision regarding concentration of effort.

a) Rainfed Agriculture: Wherever rainfall is adequate in the SRB, crops are grown on water supplied by rain which falls from July to October (rainy season varies with location in the SRB). Upland soils and natural levees infrequently subjected to flooding are typically used for rainfed agriculture. Sorghum and millet are the principal crops produced there. Other crops of importance are cowpeas and a local cucurbit. Yields per unit of land are low and highly variable. Mixed cropping, crop rotation, and use of cultivars with different characteristics are common practices. Hoes of various types and sharpened sticks are the only tools used, and use of animal traction and purchased inputs are rare. Occasionally, manure is applied before planting. Field sizes are typically less than 5 hectares, although there are a few large landholders especially in Mauritania. In years of good harvest (i.e., good rainfall), labor may be diverted from other farming systems.

Table 26. Farming Systems in the SRB

Water Supply	Cropping Season	Location (Soil Type)	Crops
Rainfed	Hot, wet season (July-October)	Upland and natural levees--sandy to loam soils	Millet, sorghum, cucurbit, beans
Flood recession	Cold, dry season (October-March)	Floodplain, clay loam to silty clay loam soils	Millet, sorghum
		Steep riverbank, sandy soils	Vegetables, beans, corn, sweet potatoes, green millet
Irrigated	Cold, dry season (October-March)	Loam/clay loam	Rice, sugarcane, tomatoes, other vegetables
	Hot, dry season (March-June)	Sandy/loam	
	Hot, wet season (July-October)		

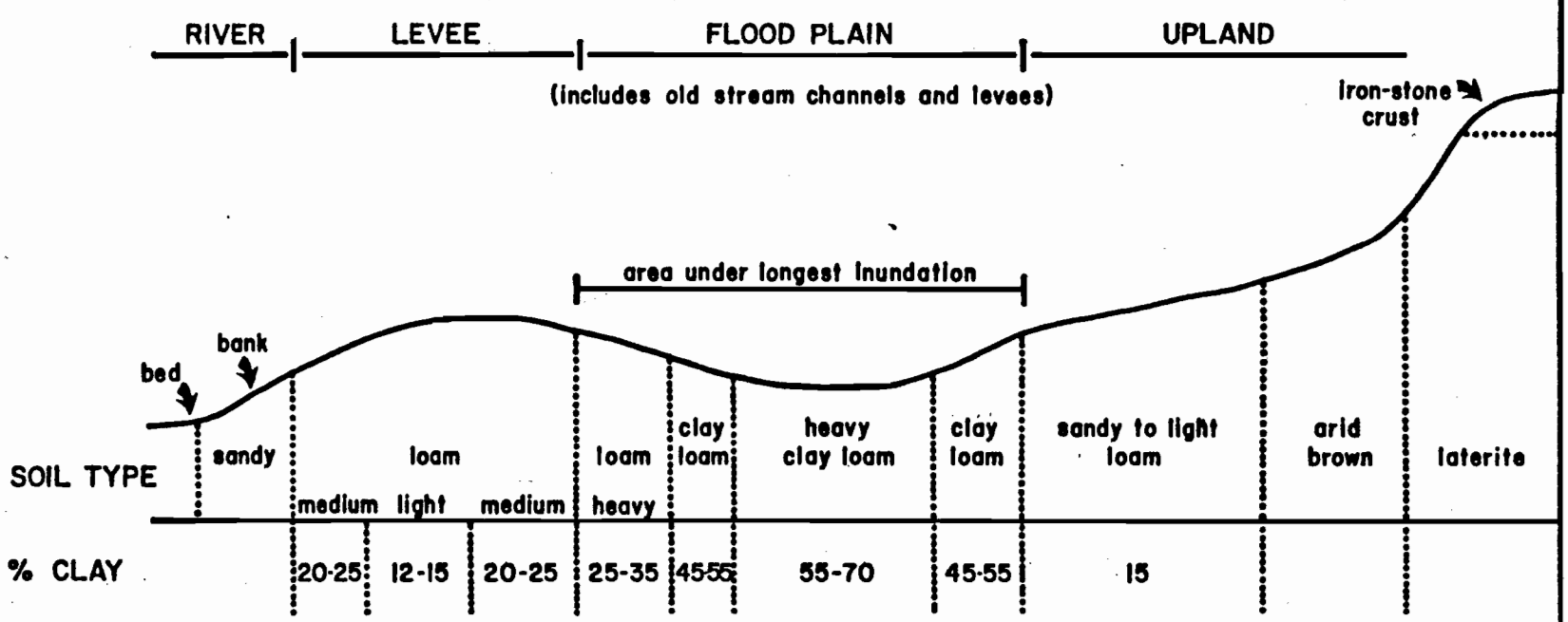

Figure 26. Simplified Typical Profile of River and Flood Plain. Adapted from CID 1978

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b) Flood Recession Agriculture: When the river overflows its banks in response to summer rains, the water inundates the flood plain and saturates the soil. As the flood waters subside, the farmers sow their seeds in the moist soil. This system is highly dependent on variables over which the farmers have no control. The growth of crops is determined by the amount of water retained in the soil. In a low-river-flow, low-rainfall year, which has typified many of the growing seasons in the 1970's, as few as 15,000 ha. in the entire valley have been used for this type of agriculture. In a year of average to high river flow and rainfall, more than 140,000 ha. have been cultivated. To obtain reasonable yields, the farmers must plant at just the right time: if they sow too soon, the seeds may rot in the saturated soil; if they plant too late, the soil moisture may be too diminished to support crop growth. Finally, even in good years, the yield is only a fraction of the possible yield of irrigated crops. For example, the farmer rarely obtains more than 500 kg. of millet per hectare from flood plain fields. Sorghum is also grown on the floodplain, with corn, beans, sweet potatoes, and vegetables raised in the river bank fields. Field size is generally limited to a few hectares; many are measured in terms of 1000's of square meters.

Cultivation is more intensive in flood recession agriculture than under rainfed conditions, because of the more favorable moisture regime, and the annual renewal of soil fertility by the flood waters. Most farmers in the SRB favor the flood recession farming system. In fact, in good years they have abandoned irrigated areas in favor of flood recession agriculture.

c) Irrigated Agriculture: Irrigation is the controlled application of water for crop production. In the SRB irrigation is carried out both at the village level and at the commercial level. Rice, sugar cane, and tomatoes are common irrigated crops.

d) Small-Scale Irrigation: Small-scale irrigation is carried out on lands that range in size from 10 to 25 ha. and which are referred to locally as "perimeters." They are usually located close to a village and a surface water source (either a flowing stream or marigot), and are worked by farmers from that village. Location of the small irrigation projects is based on consideration of such factors as (a) proximity of village to the water source; (b) relatively light soil, which makes the land easier to work with simple implements and is conducive to culture of a wide range of crops; (c) relatively flat topography, which reduces land leveling required; and (d) elevated land, which reduces the labor of building flood protection dikes and allows for natural drainage toward the river.

The small irrigation projects generally consist of (a) an engine-driven pump installation with intake and discharge hoses or pipes; (b) a network of canals to bring water to the plots; (c) a network of surface drains; (d) small water-retention dikes; and (e) partially leveled plots, usually less than 1 ha. Approximately 1,100 ha. are now devoted to be a means to facilitate the farmers' making the transition between traditional agriculture and larger-scale irrigated agriculture.

Land preparation commonly is done by the development agencies. Planting, weeding, harvesting, and threshing are done by hand. Weeding is reported as the major constraint to increasing the area farmed per worker. Insecticides and fungicides are used on a limited scale, especially on rice and vegetables.

e) Medium and Large-scale Irrigation: These projects (also referred to as "perimeters" usually range in size from a few hundred to several thousand ha. The infrastructure and equipment used for irrigation and drainage include: (a) general dike work to protect gainst river flooding, commonly paralleled by a main access roadway; (b) an irrigation network including canals of all sizes, ranging from primary to tertiary and field distribution channels, with structures for controlling water levels and distributing flows; (c) one or more pumping stations, which often serve the dual purpose of supplying irrigation water and eliminating drainage water; (d) a drainage network; and (e) roads along the irrigation and drainage routes. In 1979, about 27,000 ha. were devoted to medium and large irrigation projects (OMVS 1980b).

A fairly sophisticated agricultural technology is attempted, with extensive use of tractors and machinery as well as fertilizers and chemical pest and weed control.

2. Assumptions

The following assumptions were made regarding the proposed agricultural research program:

General

- farmers will accept our approach and be willing to cooperate.
- Equitable ways can be found to compensate farmers for their personal involvement in On-Farm research.
- Development agencies will participate in this cooperative effort, particularly in Supporting Research.
- Initial focus on individual farmers with considerable attention given to problems of development agencies will lead to increased local capability to design, construct, and operate small irrigation projects.

Plants

- Productivity of crops being grown on individual farms can be increased through our agricultural research approach.
- There is some potential for introduction of exotic crops to farmers.

Soils

- Most soils are suitable for irrigation and/or more intensive farming systems if properly managed.
- Adequate drainage can be provided to prevent excess soil moisture and salinity build-up under irrigation.

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Water

- Water of adequate quality, and quantity, for irrigation will be available on a long-term basis.

3. Feasibility

The proposed research program is feasible for the following reasons:

Soils

- Salinity, drainage, and erosion conditions will be monitored closely so remedial action can be taken if necessary.
- Existing irrigation projects (large- and small-scale) show that soils are generally irrigable, given adequate and appropriate methods. Productivity of research station soils has been maintained under irrigation.

Water

- Ground water is generally available and usable. There is no trend of declining water levels near the river.
- "Problem" water (e.g., at Samé) can be analyzed before use.
- Dug wells are found in the area.
- Examples of simple animal and human-powered pumping equipment which can be fabricated, operated, and maintained locally are plentiful.
- Pumping equipment (pumps, engines) are already in use in area. Maintenance will be added.

Energy

- Fossil fuel use at stations will not affect greatly the existing supply and distribution system.

Plants

- Research starts with existing crops and crop mixtures and introduces new technology slowly.
- Problems which arise from On-Farm research can be studies under more easily controlled conditions at stations.
- Research shows increased yields have been obtained on experiment stations; selected varieties are available for further testing.
- "Experimental units" already in operation have demonstrated possibility of improved technology.
- Proposed research will not perturb the existing farming system greatly in terms of crops or cultivation practiced used.

Summary of Previous and Ongoing Crop Research:

Recently there has been a tendency away from basic research or that oriented at academic thesis toward more applied research, and new agreements under the name Recherche d'accompagnement (accompanying research) have been initiated. Also, new outreach stations were established such as Point d'Appui Pour Experimentation Multilocale (PAPEM) (Support Point for Multilocation Experiments). Many years of accumulated research results are summarized very briefly in this analysis. For further details the reader is referred to the original reports and paper cited. Table 27 summarizes the state of the available field crop results up to November-December, 1980.

. Fanaye and Guede, Senegal

Wheat (Triticum aestivum)

FAO-supported variety research began in 1969. By 1977-78, Mexipak had been selected as the best wheat bread (Moscal 1979, 1980b). Over 950 cultivars were tested, including 368 from CIMMYT. Work with other cultivars was conducted independently at Guede. Since 1975 there has also been extensive work on cultivation practices.

The selection process was first conducted in 0.4 to 1.2 - m^2 plots, was later continued on 10-100 m2 randomized blocks, and then moved into 1.2 ha. field plots for the most promising cultivars. Some cultivars were tested in pre-extension plots with SAED and other agricultural development agencies. Furthermore, Mexipak was produced under controlled conditions on 50 ha. in the Guede region and 24 ha. in Mali (Timbuktou) by farmers in small plots and yielded 2.5 T/ha. in both locations (Moscal 1980b). The results from these long-term experiments are considered reliable and can be used as the basis for our On-Farm research.

Sorghum (Sorghum spp.)

Eighty introduced composite and hybrid cultivars, as well as 22 local cultivars, were tested over a six-year period at Guede and Fanaye by UNDP/FAO scientists with the help of ICRISAT (Moscal 1979, 1980a, 1980b). The trials covered the three seasons of the SRB.

The highest yielding cultivars were found to be P-8416 BT x P-7822 (5.12 T/ha), P-830T x 5915 (5.10 T/ha), and P-8325T x P7812 (5.05 T/ha). Due to the absence of seed production services, farmers use their own production for seed and the composite cultivars, although lower yielding, are more practical than hybrids and remain good for six or seven growing seasons. The yields of the dry-hot season were much lower than those of the dry-cold season.

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Table 27. Summary of Field Crop Research

Crop	Fanaye/Guede	Kaedi	Samé
Wheat	950 cultivars tested Mexipak tested on wide scale	3 cultivars selected	identified promising cultivars
sorghum	153 cultivars tested 6 selected	(not much attention) 2 cultivars selected, 2 others being tested	4 cultivars identified
corn	140 cultivars tested 3 selected	4 cultivars being tested	4 promising cultivars identified
millet	(little work in SRB) standard cultivation practices, "early" and "late" cultivars selected	2 cultivars tested under rainfed conditions	5 cultivars are best adapted
soybeans	(some work done) 5 promising cultivars	limited work	--
cowpeas	(little work) 2 cultivars selected in other areas	limited work	--

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ISRA (1980) tested 17 cultivars from the SRB along with others from different areas of Senegal. The best yielded from 0.69 to 1.31 T/ha. In another series 34 hybrids were tested. The yields were from 1.2 T to 1.6 T/ha in the dry-hot season. Like FAO, ISRA recommended that sorghum not be grown in the dry-hot season in the SRB. Sorghum trials conducted in the dry-cold season yielded an average of 5.15 T/ha with an 8.5% coefficient of variation and significant differences in favor of the "2450" cultivar among the six best cultivars of the 34 tested (ISRA 1980). Other newly recommended cultivars are 75-14 (5.68 T/ha), 612 x 75-14, and Sombassoki (a local cultivar). These results are ready to be tested in our "On-Farm" as well as "Applied" research.

Corn (Zea mays)

Over 140 cultivars of different origins have been tested since 1974 in all three seasons of the SRB. The most promising cultivars were found to be: Penjalinan (yield = 5 T/ha in rainy and dry-cold season), Early Thai (5.4 T/ha and 4.7 T/ha, Diana (4.3 T/ha and 5.0 T/ha). It can be inferred from these results that the best seasons for growing corn are the dry-cold and rainy seasons.

These results are applicable to our On-Farm research. More work on the cultivation practices needs to be done in the Applied Research program.

Millet (Pennisetum spp.)

Very little work has been done on millet in the Senegal River region. ISRA prepared some standard cultivation practices for experimentation in all regions of Senegal concerning early (Souna) and late (Sonia) millet (Pocthier 1980). The suggested cultivars are Souna III (early and "Sanio de Sefa" (late).

Under rainfed conditions, a spacing of 90 x 90 cm is recommended. Under irrigation, solid seeding (60 x 15 cm) might be the ideal. Most of the work was done in Bambey and the Casamance region (Pocthier 1980).

Some Applied Research to adapt these results to the SRB will have to be conducted on the experimental stations before applying the results to On-Farm research.

Soybeans (Glycine max)

ISRA gives cultural practices for soybeans under rainfed conditions (Pocthier 1980). FAO has conducted several trials under rainfed and irrigated conditions for the last few years in cooperation with INTSOY and ISRA (Moscal 1978c, 1980a).

The best seeding date for soybeans has been found to be 5 to 15 of July. The most promising local cultivar was found to be ISRA 1974. Other local possible cultivars are: ISRA 26/72, ISRA 3173, ISRA 188/74, and ISRA 20/74.

Innoculation with Rhizobem japonicum has significantly increased the yield. Moreover, the application of 46 kg/ha of nitrogen did not increase soybean seed production except for the July 15th seeding. In some cases it reduced the yield.

More work needs to be done, especially on irrigated soybean production and cultivar selection for the SRB before introduction can be contemplated.

Cowpea (Vigna spp.)

Little work has been done on this crop in the SRB. Storage of cowpea seeds is hampered by the "Brucus" bug, which attacks the cotyledons. This reduces germination percentage to about 50 per cent.

The most promising cultivars seem to be KVX 1841-CE (2.76 T/ha) and TVX 1576 x OIE (2.36 T/ha) (Moscal 1979).

Kaedi, Mauritania

Wheat (Triticum aestivum)

In the dry-cold season, the cultivars Mexipak (6 T/ha), Chenab 70 (3 T/ha), and SA-Y2 (3.5 T/ha) have given satisfactory yields in research plots and are recommended for testing in the On-Farm research program.

Sorghum (Sorghum bicolor L. Moenck)

This crop did not receive much attention, and the present cultivars under local conditions yield 0.8 T/ha (Samé 600) and 0.6 to 0.8 T/ha (NIDABIRI). Newly introduced cultivars RT 13 (1.0 T/ha) and SD-10 (0.6-0.8 T/ha) need further study. These cultivars were suggested for growing in the dry-cold season. Aphid attacks tend to limit the growth of RT-13.

Corn (Zea mays)

Limited work has been done at Kaedi. The cultivars currently tested are CPJ de Bawaki (10 T/ha), Early Thai (3 T/ha), and Diana (3 T/ha). The locally grown cultivar is Makr with 0.7 to 0.5 T/ha yield. More applied research is needed in this area, with emphasis on composites which are more easily adopted by farmers.

Millet (Pennisetum spp.)

The cultivars BJ-104 and INCH-105 of ICRISAT yielded from 1 to 1.5 T/ha in research plots. The trials were conducted during the rainy season, which is recommended for millet production.

Cowpeas (Vigna spp.) and Soybeans (Glycine max)

Very limited research was done with these crops.

Vegetable Production

Extensive work has been done in the area of species introduction and adaptation, vegetable production scheduling, and plant protection by CNRADA in cooperation with IRAT, IFAC, IFRA, and GERDAT. Some work has been done in adapted cultivar selection (see Table 28).

A production schedule has been established and is ready for On-Farm research. Plant protection problems have been identified, but not yet solved except for insects and spiders.

Also tested: pepper (14 cultivars), okra (6 cultivars), melon and tomatoes, during dry-hot and dry-cold seasons with limited results (DeBon 1980).

Fruits

The Fruit station at the Rindia section of the Kaedi station was started in 1970 by IRAC and continued by IRFA until 1975, at which time CNRADA took over. The results obtained are summarized in Table 29.

A nursery has been established at Rindia, where fruit species and cultivars which have proven successful in research are being distributed to farmers.

Samé, Mali

Wheat (Triticum aestivum)

Cultivar introduction and selection trials have been conducted in the last few years by FAO/UNDP and the government of Mali (through IER) in cooperation with CIMMYT. Some promising cultivars have been identified and are ready for testing in On-Farm research.

Sorghum (Sorghum spp.)

Cultivar selection trials revealed that the best local variety is "Gabiaba de Nara" (PNUD/OMVS 1967).

Table 28. Summary of Results of Vegetable Production Research, CNRADA (Mauritania)

Crop	Cultivars	Growing Season	Yields	Remarks
Eggplant	Baily, Profic F_1	dry hot	120 T/ha	Main vegetable
	Black Beauty	season	140 T/ha	in this season
	Baron F_1	"	90 T/ha	
Tomatoes	Homac VF	15 Jan-30	64 T/ha	Disease problems
	Small Fry VFN	April		
Melons	Cantaloupe	15 Jan-30		
	C. Ido	April	20.8 T/ha	Local market
	Planter Jumbo		17.0 T/ha	prefers "meaty"
	Charentais		12.6 T/ha	cantaloupes
Watermelon	Benpe		34 T/ha	Local market
	Sugar Ball		27 T/ha	prefers dark
	Sugar Baby		25.5 T/ha	red, sweet
	Sugar Belle		20.4 T/ha	watermelons
Cabbage (of China)	Miscellaneous	Oct. (dry cold)	25-17 T/ha	Harvest cannot be extended beyond April
Onions	Crystal White Wax	Rainy or dry-hot season	38 T/ha	Low humidity dries bulbs
	Yellow Crowns			
	White Crowns		16.4 T/ha	

Table 29. Summary of Research Results on Fruit at Rindiao (Mauritania) (Source: CNRADA 1980)

Crop	Cultivars	Yield (T/ha)	Remarks
Citrus	miscellaneous		Collection, adaptation, seed trials
Lemon	Gallet	9.25	Phytophtera attacks are serious problem
Orange	"Pineapple"	9.5	Long juice fruit
Orange	Valencia	1.4	
Pomelo	Marsh	3.25	Good quality
Tangerine	Cleopatre	1.5	Serious phytophera problem
Tangerine	Troyer	8.0	
Citure Mac-lophyllae		31.8	
Citrange	Carizo	4.5	
Lemon	Rouge	29	
Bitter Orange		20	Multipurpose stock and rootstock
Banana	LePoya	35.40	Cultivar response and adaptation trials
Mango	Amatie	3	Adaptation response and cultivar trial
Mango	Early Passy	15	
	Irwin	13	
Guava	Supreme Ruby	0.72	1972 response trials and 1973 cultivar trials initiated
	Supreme White	0.9	
	Supreme Ruby White	2.6	
	Elizabeth	2.8	

Among the introduced cultivars the most promising were CE 90, 137-62 (Niger), and 96-1217 A (Upper Volta). The yield average was 3.5 T/ha in a cycle of 120 days. Currently more trials are being conducted with ICRISAT providing design and data analysis for sorghum as well as millet.

Millet (Pennisetum spp.)

Selection among the local and introduced cultivars revealed the best adapted ones to be M2D2, NKK, Mg (Mali), Souna II (Senegal), and P3 Kolo (Niger). They all yield about 1.5 T/ha. More recent trials conducted in cooperation with ICRISAT identified new higher yielding cultivars that can be used in On-Farm and Applied Research.

Corn (Zea mays)

The cultivars Segola NDi and Mais de Doro were selected from the local corn cultivars grown in the area. BDS and JDE are the two most promising cultivars introduced from Bambey (Senegal).

Research from Other Areas

There are many examples of research in other arid and semi-arid areas which may be applicable to the SRB.

Work done in southwestern U.S. on water requirements for crops and identification of heat-resistant cultivars may be useful under SRB ecological conditions.

Farming system and animal traction work done in pilot farms in Morocco and in outreach stations or experimental stations as well as with local farmers in other West African countries (Togo, Nigeria, and Ghana) appears to be successful and feasible in those locations. Some of the acquired techniques and methods may be adaptable to SRB conditions.

Small agricultural equipment developed or tested by IRRI, ICRISAT, CIAT, and other organizations or countries (India, Philippines, Thailand), as well as other appropriate technology, can be introduced in our Innovative Research program.

Crop rotation may be tested. The various components of a rotation could be: cereals (sorghum, millet, wheat, corn), vegetables, legumes (cowpeas, soybeans), forage (alfalfa, Stylosanhes grassilis, Desmodium spp.), cash or industrial crops, other crops specific to the area and food habits of the local population.

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B. Technical Assistance and Counterparts

The proposed research program calls for an 8-person Contractor team with 14 counterpart trainees, 63 person-months of technical backstopping, and other administrative and support personnel. Assumptions, justification, feasibility, and impacts of this approach to meeting personnel needs are discussed below.

1. Assumptions

We made the following assumptions with respect to meeting the needs for technical assistance and counterpart personnel:

- The Contractor can recruit qualified candidates for all positions;
- OMVS can recruit and assign 14 qualified counterpart-trainees;
- an effective working relationship can be established with counterparts at all levels;
- temporary housing near stations will be available when Contractor team members arrive (until permanent housing is constructed);
- the counterpart training program will be implemented on schedule.

2. Justification

Our approach to meeting technical assistance and counterpart needs is justified because:

- fully qualified counterparts are generally unavailable in the member states;
- the small Contractor field team does not exceed local absorptive capacity but is large enough to make its presence felt; short term technical backstopping will fill any gap in team expertise;

C. Construction and Facilities Development

To attract and retain qualified Contractor team and national researchers and extension workers, an attractive and comfortable physical environment must be created at the three research stations. At the same time laboratory, shop, storage, and field facilities must be adequate for the research program. These would include as a minimum: good housing, ample office and laboratory space, well prepared field plots, efficient irrigation and drainage systems, basic recreational facilities, easy access to a medical clinic, and safe and reliable domestic water supply, waste disposal, and electric power systems. Facilities are sited so as to integrate the Contractor team and local scientists with the surrounding communities.

The investment in a good physical infrastructure, however, is in itself not sufficient for the success of the project. Inadequate maintenance is a chronic problem. Sufficient spare parts for buildings, equipment, and machinery will be supplied from the beginning of operations. The agricultural Engineer will train people at each station to maintain all physical facilities, equipment, and machinery with the help of national mechanics; he will develop and operate a spare parts inventory and ordering system based on reliability principles. A the same time a maintenance budget for the physical facilities and equipment is provided in the operating budget.

Tight financial control of the construction process is important, and it will be essential to process quickly the purchase, importation, and clearance of tax- and customs-free items. This is particularly true during the construction phase, because any delay in clearing and delivering tax- and duty-free material from customs will give the contractor cause for increasing the contract price.

1. Research Stations

The three research stations where project activities will be concentrated are described in brief below.

Fanaye, Senegal

The Fanaye station is being established (a) as a replacement for the station at Richard Toll which is being displaced by construction for a sugar mill, and (b) as a supplement to the station at Guede, which is unsuitable for expansion. It consists of a gross area of approximately 700 ha., with about seven different types of soil ranging from heavy clay soils to light sandy soils. The current plans of the Senegalese government call for the development of about 60 ha. of the easterly 100 ha. for research purposes. The remainder of the area is proposed to be used for other activities such as demonstration or pilot farms, farmer training, and seed production. Currently about 20 ha. are leveled and have irrigation facilities. Approximately 40 ha. of the planned research area remains to be completed. At present, only 1,500 m. of a needed 4,600 m. flood protection dike have been completed.

There are only three buildings at the station. Housing, storage facilities, and water and power facilities need to be constructed.

Kaedi, Mauritania

The Kaedi center is also in the process of development. Previous research in the area has been done at Wandama and Rindiao. The Wandama station is comprised of about 9 ha. and located some 2 km south of Kaedi; the Rindiao station consists of about 14 ha. located roughly 7 km west of Kaedi. These two areas are inadequate for the planned research program and were established under a temporary short term agreement with local land holders.

The new station, about 100 ha. in size, is located at Belinabe about 6 km west of Kaedi, adjacent to the Rindiao station. Currently, about 25 ha are being leveled and prepared for irrigation. There are few facilities at the station site. The required offices, shop, and maintenance facilities, storage areas, equipment sheds, power and water supply facilities will have to be constructed or installed. Housing will have to be constructed at the headquarters site in Kaedi.

Samé, Mali

The Samé research center is actually made up of two stations: the Kamenkole station, located about 5 km west of Kayes, and the main station located about 3 km west of the village of Samé and about 20 km west of Kayes. The Kamenkole station consists of about 6 ha, two hectares of which are presently in rice trials. The Samé station fields are about 60 ha, the bulk of which has been used for rainfed crops. Eleven ha. have been leveled and developed for irrigated agriculture, with more of the area being planned for development. The plan of the Malian government is to expand the research areas about 200 ha. of leveled land.

Three houses are available at the Samé center. They are in need of repairs and maintenance. There is also a repair shop and maintenance area with one storage room.

2. Buildings to be constructed

The final design of the buildings will be done in cooperation with either local architectural engineering firms or by the Rural Engineering Service. The construction will be done by national and/or international contractors. At this time we can only make suggestions for design of the buildings. We have given due consideration to climatic factors and the need for double roofs, insulation, and cross-ventilation in all buildings to minimize the artificial cooling requirements. In our design the interiors of the office and laboratory buildings have movable partitioning to achieve flexibility in space use with changing requirements. Although laboratories are designated for a specific purpose, they would be sufficiently large to contain room for general laboratory analysis. If possible, construction should be in modular units and phased in such a way to allow the early initiation of the research activity. Use of prefabricated buildings, either of steel or concrete, would perhaps reduce costs and speed up construction, but unless it is part of a local industry, the foreign exchange component

would be high. Construction should preferably begin after the rainy season to prevent difficulties in transportation of materials to the sites in Mali and Mauritania, and to allow site preparation, site development, and enclosure of buildings before the next rainy season.

The number of housing units, research laboratories, and other facilities is designed to meet the specific requirements of this project as set forth by the agricultural research program. After the termination of Phase II, research activities will continue under OMVS and national programs, and perhaps under the aegis of other funding agencies. At that time the overall facilities will be available to other agricultural projects. Thus housing and office facilities vacated by Contractor team members will become available to new researchers. However, since the future participation of the other donor agencies cannot be predicted at this time, it is reasonnable to suggest that complete financing of the Samé station in Mali by this project is justified. The Fanaye station in Senegal is one of the agricultural research centers which the World Bank and other donors are financing under the decentralization plan for agricultural research in Senegal. There should be coordination of effort and sharing of costs for this station.

The Kaedi station in Mauritania is receiving financial aid from FAC for the construction of residential, laboratory, and office buildings. Efforts should be coordinated for design and construction of facilities at this station.

Land at all three stations is provided by the national governments.

All buildings should be separately metered for water and electricity. All occupants of housing units should pay for electricity and water used according to rates based on amortization of equipment and operation and maintenance costs. This would discourage waste. Metering would also help in assessing the actual operating costs of various buildings. Maintenance of the housing units should be done by the station maintenance crew, but costs of spare parts should be charged to the occupants. Spare parts for buildings and utilities maintenance are included in the capital budget at the rate of 5 per cent of buildings costs and 15 per cent of utilities costs, respectively.

Preliminary site plans were made for each research station in accordance with the anticipated needs of the project, and in response to the general conditions of the sites, particularly the climate. Actual site planning will require field work to locate exactly the structures vis-a-vis configuration of the terrain, local flooding and water table, soil conditions, as well as existing structures and vegetation.

It is important to propose appropriate technologies for the buildings required to carry out the research program. Buildings designed to ventilate and cool themselves naturally will require much less energy than will buildings designed without the effects of the climate in mind (Clark and Paylore, 1980). Based on a combination of indigenous building design in West Africa and research that has been done at the University of Arizona, we are proposing site layouts and prototype building designs that can provide models for future development along the Senegal River.

Climate is a very important factor in building design, particularly in area that experiences both hot arid and hot humid atmospheric conditions. All three research center sites experience similar weather patterns: relatively mild and dry winters, a hot dry spring season, and a hot humid season that extends from July through October when the majority of the rainfall occurs. They experience approximately 8 months of dry weather with occasional Harmattan winds off the Sahara desert and 4 months in which hot moist air blows from the southwest quadrant (see figure 30). The effect of the sun on buildings in the lower latitudes is somewhat different than its effect in latitudes farther north. Located at 14.5° (Samé) and 16.5° (Fanaye and Kaedi) north latitude, even the northern facades of buildings will receive significant amounts of insolation, especially during the hot wet months. Yearly temperature extremes fall between 16°C and 42°C, meaning that keeping the building interiors cool is the more urgent problem.

Although various approaches to passive cooling may be defined separately, they work best when combined. The optimal passive cooling system is one which minimizes the need for cooling in the first place. Responsive building designs with proper orientation, optimal window area, good shading and insulation, minimal air infiltration, and appropriate construction materials should be considered before specific passive or active cooling systems are proposed.

3. Agricultural Lands

It is assumed that agricultural land preparation including land leveling, irrigation and drainage network, and installation of piezometers will be done by contractors. However, it would be preferable to have the land preparation done by station personnel in cooperation with action agencies such as SAED in Senegal and SONADER in Mauritania and under the supervision of the Contractor team irrigation and drainage engineer. The cost of land preparation would be lower, but more important, the station personnel would be useful when additional work is undertaken later.

Four hand-dug wells at or near each research center with an animal- or hand-powered pumping sytem will be provided for experiments with supplemental irrigation with ground water. These will be constructed one at a time at each On-Farm research site.

It is planned to provide an irrigation network initially on only 15 ha. at each station. A 1600-m flood protection dike will have to be constructed at Fanaye and a similar dike at Kaedi (Rindiao) will have to be repaired.

A simple climatological station will be provided at each research center consisting of: (1) wind measuring system, (2) U.S. Weather Service type climatological station, (3) U.S. Weather Service class-A evaporation pan, (4) soil temperature and soil moisture measuring devices, and (5) net radiometer.

4. Cost Estimating Procedures

The cost figures have been developed from the best available information on past constructions at the sites and adjusted to October, 1981. The esti-

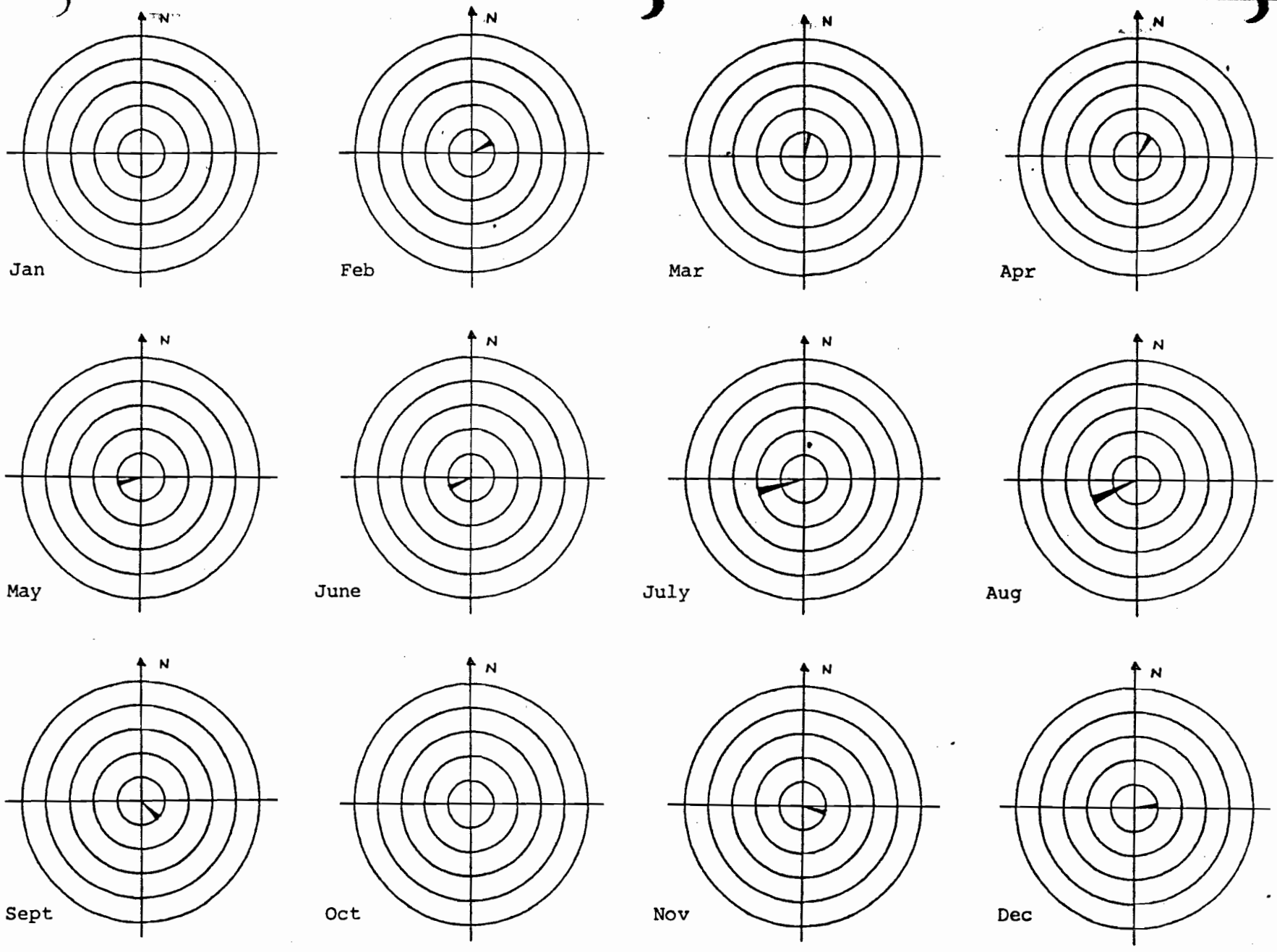

Figure 30 Wind Roses for Matam, Senegal
Monthly average direction and velocity shown in m/sec. Each circle is 1 m/sec.

mated construction costs have been checked with USAID engineering staff in Dakar, Bamako, and Nouakchott, but do not reflect the cost of the barrel vaulted roof construction. No detailed enumeration of office and house furnishings has been attempted. Furnishings for residential buildings, office furniture and equipment, and furniture and scientific equipment for laboratories, were estimated based on experience at the three USAID's.

The cost of renovating existing facilities is taken as 25 per cent of the cost of similar new construction. Construction site development and landscaping costs are assumed to be 10 percent of the cost of civil works.

The architect-engineering fees for building design are taken as 10 per cent of construction cost, because they include topographic survey of the construction site, subsoil investigations and the cost of obtaining the necessary building permits and/or certification of insurance, as well as supervision of construction. The engineering fees for agricultural land development are taken as 10 per cent of construction cost.

In the Fanaye-Richard Toll station area, the World Bank will fund all architectural on engineering fees for OMVS research buildings and houses under its loan to Senegal.

Construction contracts in Senegal, Mali, and Mauritania carry a clause allowing the contract price to be adjusted according to a formula incorporating proportional increases in labor rates; the price of cement, steel, and other construction materials; and fuel for: (a) price and cost increases during the period between the date of submission of bids and the date of the order to begin construction; (b) official governmental increases in labor rates, the price of cement and other construction materials, and fuel. These cost adjustments are applicable even after the signing of the lump sum contract.

The estimates of project costs are exclusive of all taxes and custom duties, and assume that construction will start by February 1982. The preparation of design and bid documents will take 7 months under the best of circumstances. Thus it is not likely that construction can begin by that date; delay may cause a cost increase at the rate of 1 to 2 per cent per month.

It should be pointed out that these estimates will be refined after construction drawings are completed. The final cost will only be known after construction bids are received.

5. Construction Contract

The tender documents should make absolutely clear that all bids are to be submitted with all cost items calculated tax and duty-free; the tax on profit will be the contractor's responsibility. It is accepted practice--if requested by the contractor--to advance to the contractor 15 per cent of the total contract cost within a period of one month after signing of the contract. It is also acceptable to advance to the contractor up to 50 per cent of the cost of construction materials. The total of

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such sums should be approved only upon presentation of appropriate bank guarantees. Monthly payments are made later upon presentation and approval of construction progress reports and accompanying bills. Within 15 days of acceptance of the contract, the contractor deposits a surety bond equal to 5 per cent of the total contract cost, and from subsequent monthly account settlements 10 per cent is deducted as guarantee deposits.

6. Specific Construction Requirements at Research Stations

Description of the actual construction for the three research stations are given in this section.

Fanaye, Senegal

The civil works requirements at Fanaye are:

Four 3-bedroom housing units each about 135 m^2 floor area
Four 1-bedromm houses for research assistants
One office building for researchers
One office building for assistants and a library

The general arrangement of the Fanaye station is shown in Figure 31. The preliminary site layout is given in Figure 32.

Topographical maps of Fanaye exist and may be adequate for agricultural land development. Local architects will have to develop their own site maps for the exact location of the buildings based on local site conditions. The building site is on a firm sand dune, and no foundation difficulties are foreseen.

Ground water of good quality is available from a shallow aquifer in ample quantities for domestic use with a modicum of treatment. Water from the irrigation system can be used for other purposes such as watering lawns, trees, and vegetable gardens. Investigations by World Bank engineers have led to the same conclusions. Water demand for the well system of 25,000 l/day is based on a population projection of 50 permanent and 100 transient people. An elevated storage tank of 75 m^3 should supply the full demand for 3 days as well as sufficient emergency fire demand flow.

The waste disposal system for about 17,000 l/day could most effectively and economically be accomplished by a septic tank system.

The electrical power system would consist of two, 50-KW diesel generators, one of which would be a stand-by unit.

The Fanaye, Senegal, station will benefit from the proposed construction of housing, laboratories, and infrastructure by the World Bank. Because the exact site layout of that development is not known to us at the present time, a small grouping of scientists' houses and a guest house in a universal setting is proposed, with a definite orientation to prevailing winds and sun angles (see Figure 32). The major site organizer is the response to the desiccating winds from the northeast which occur during a majority of the

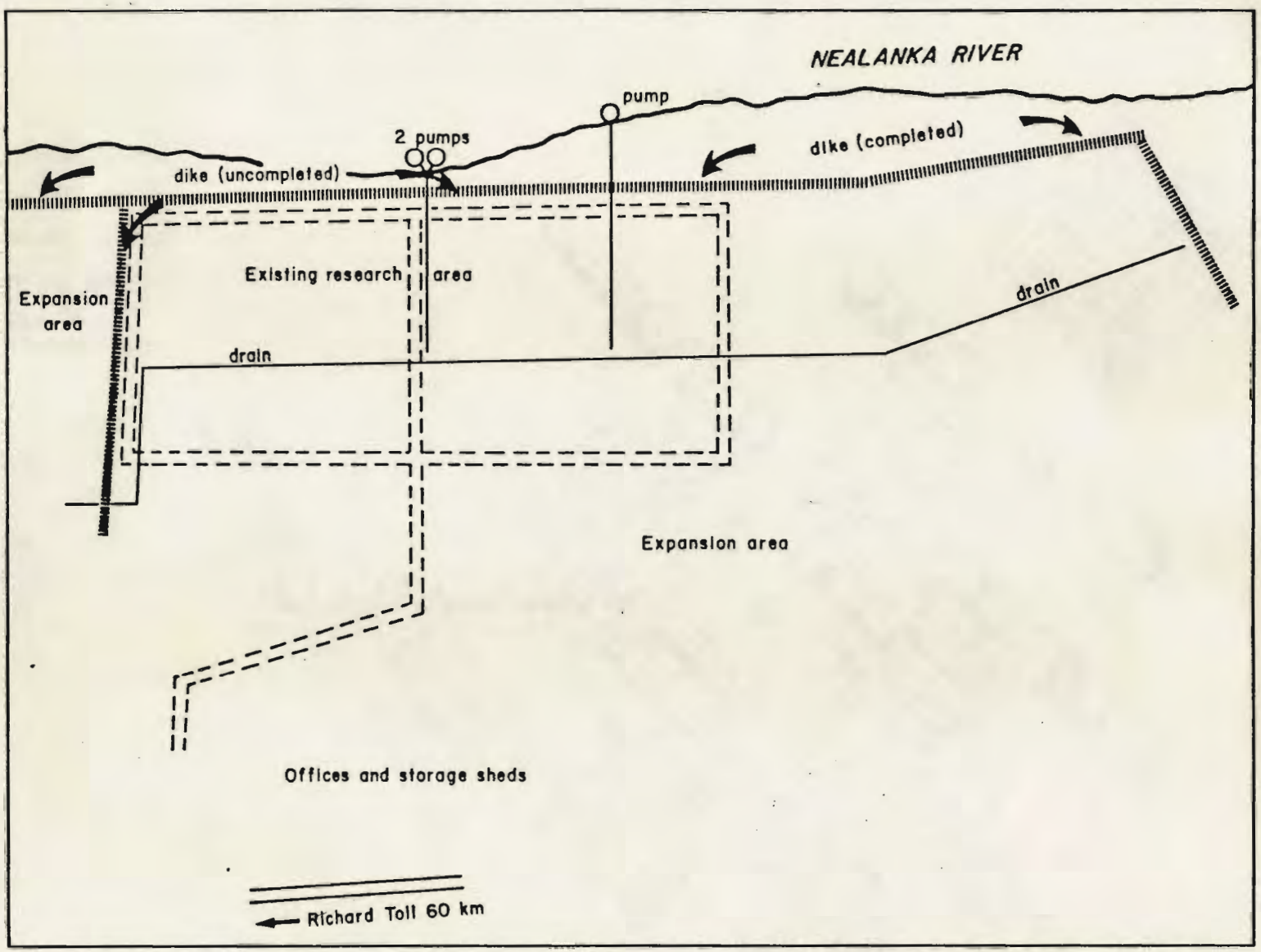
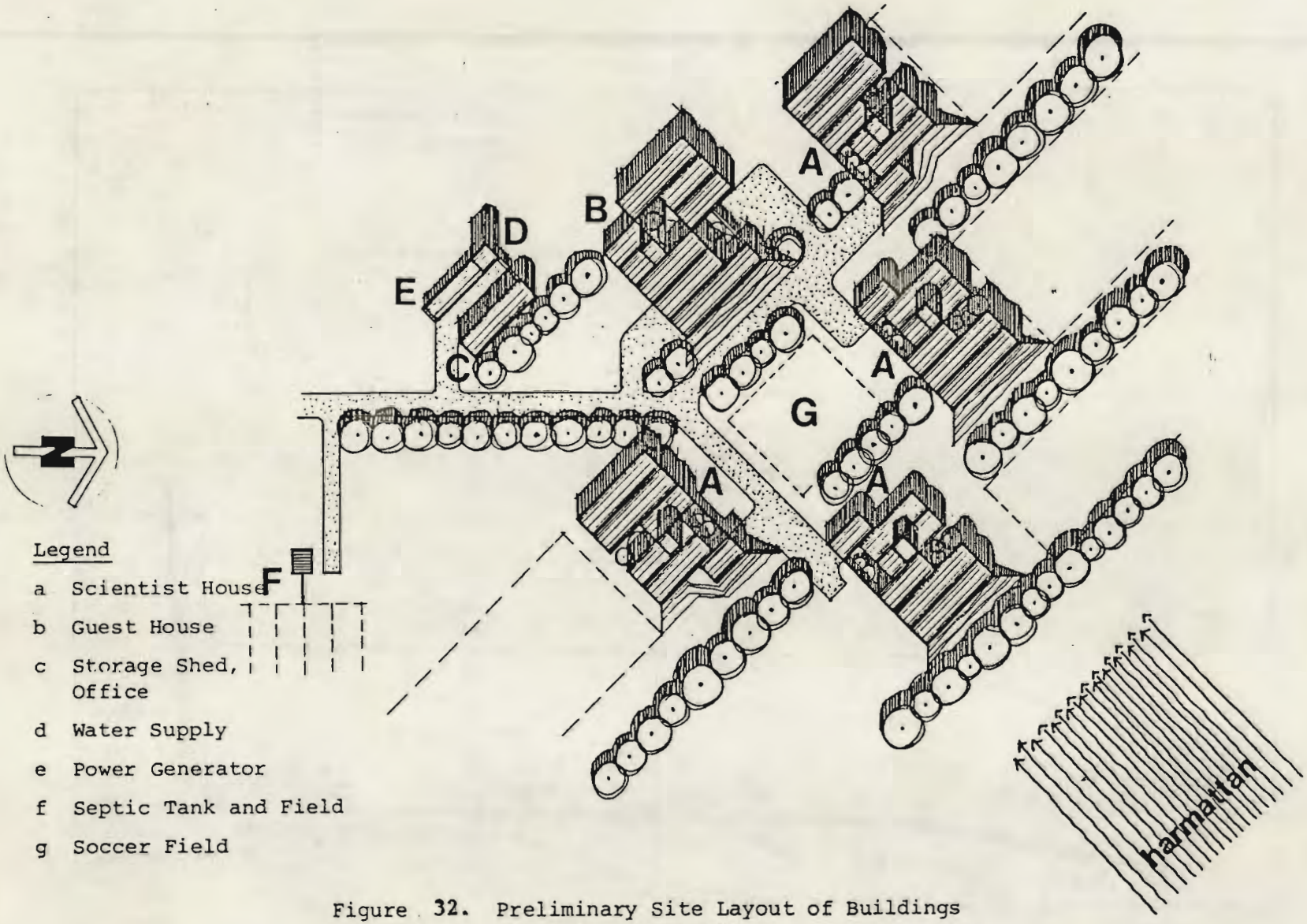


Figure 31. General Arrangement of Fanaye Research Center



Legend

a Scientist House

b Guest House

c Storage Shed, Office

d Water Supply

e Power Generator

f Septic Tank and Field

g Soccer Field

Figure 32. Preliminary Site Layout of Buildings at Fanaye, Senegal

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year. Although the houses are detached from each other, they need to be carefully arranged to avoid the brunt of the Harmattan by mutual wind shading while preserving their individual privacy. The use of earth berms and windbreaks will aid in this sheltering. As a side benefit, closely placed houses can protect exterior play or garden areas. To further reduce the effects of the northeast winds, the houses are slightly cut into the earth and sheltered by overhead barrel vaults placed normal to the prevailing winds. Other facilities at Fanaye include a storage shed, sewage treatment/storage, power generation and a soccer (football) field.

Kaedi, Mauritania

The Mauritania station consists of the housing and administration center in Kaedi and the actual experimental irrigation site at Belinabe. About 15 ha will be developed for research at the new agricultural research station. The site designated for the housing at Kaedi is close to the FAO facilities and guest house, but contains no existing structures. Water line and electric power lines come close to the boundary of the site, so that an independent water supply system and electric power system will not be necessary. Nevertheless, it is recommended that a 50 KW unit be made available at the site as a backup unit for emergencies. FAC is planning the construction of housing, office, and laboratory buildings at Kaedi, and the design of facilities should be coordinated with the design team from FAC.

On the basis of the proposed research program and staff requirements, two, 3-bedroom housing units each with about 135 m^2 floor area, and two small bungalow units with a communal kitchen and dining room of a total of 150 m^2 floor area should be provided at Kaedi. At the research station there will be a small office building of about 120 m^2 floor area, a machine shop and spare parts storage building of about 100 m^2, 100 m^2 vehicle shed with lubrication pit, a 80 m^2 storage hangar, and two 5000 liter buried fuel storage tanks. The general arrangement of the Belinabe station is shown in Figure 33. The preliminary site layout for the buildings is given in Figure 34.

Power at Belinabe would be supplied by a 50 KW diesel generator. Domestic water supply requirements here are estimated at 10,000 l/day which could be obtained from the irrigation system with simple filtration and chlorination. The waste disposal system at both Kaedi and Belinabe would consist of a septic tank system. No foundation difficulties are foreseen.

Kaedi is a somewhat isolated station. There are two flights a week from Dakar and Richard Toll (Air Senegal), but most of the transportation between Dakar-Fanaye and Kaedi goes over RN2 to Tilogne and from there over a 20 km bush road (piste) to Kaedi. The Senegal River can not constitute a major obstacle. However, during the rainy season and/or the flood season of the Senegal River, the "piste" is impassable because of

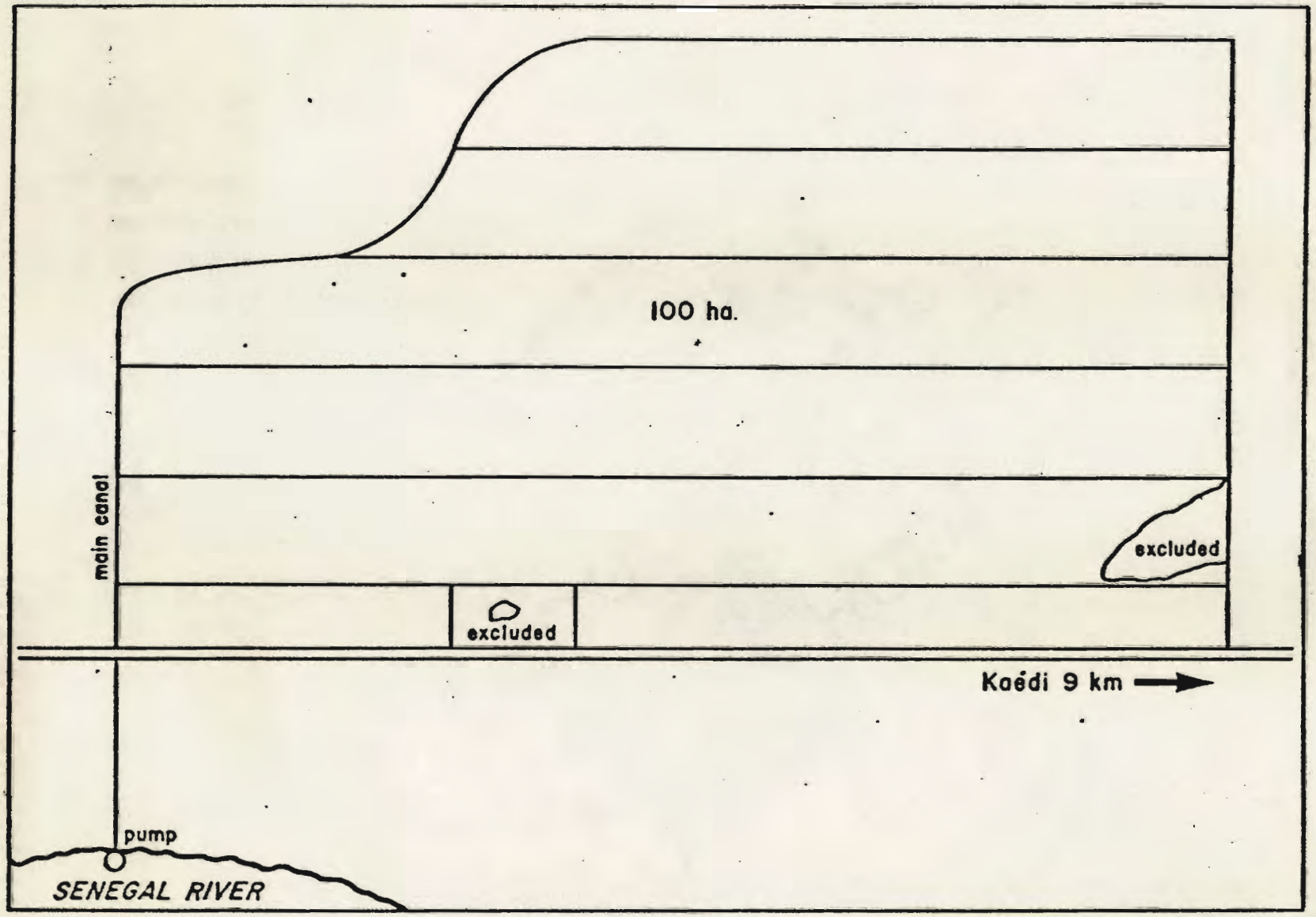
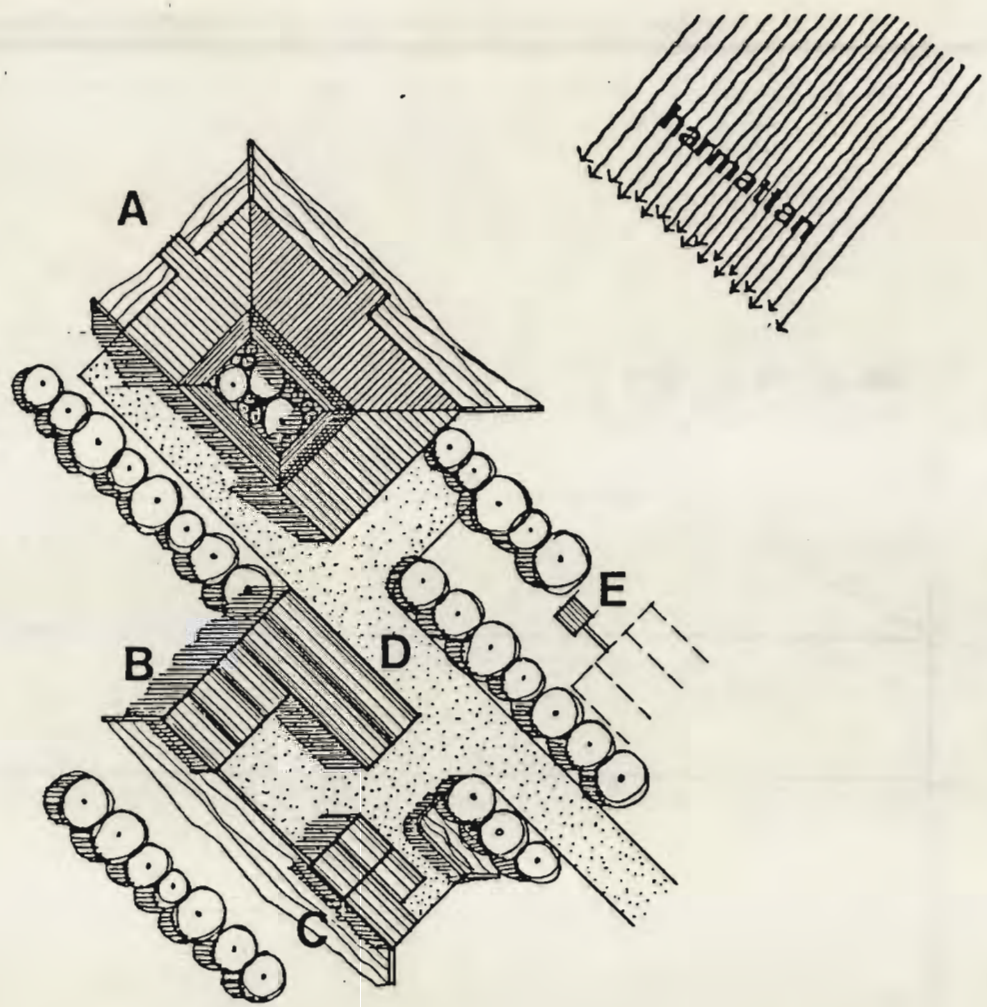


Figure 33. General Arrangement of Belinabe Research Center



Legend

a Office Structure

b Machine Shop & Spare Parts

c Vehicle Shed

d Storage Hangar

e Septic Tank and Field

Figure 34. Preliminary Site Layout for Buildings at Belinabe, Mauritania

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water in the marigots. Improvement of the "piste" to an all-weather road is planned within the framework of a transportation network development in the Senegal River Basin with funding from West Germany.

As shown in Figure 35, the two houses and a guest house will be constructed at Kaedi, in concert with a development proposed by the architects retained by FAC. Again, the houses are sited according to the prevailing winds, using earth berms, windbreaks, earth integration, and the barrel vaulted roof for protection. Exterior activities such as children's play areas, recreational areas, and irrigated gardens all occur in the protected areas between the structures. At Belinabe the offices, vehicles shops, and storage areas are turned away from the northeast winds (see Figure 34.) The office structure, air conditioned by evaporation and/or refrigeration, focuses on a shaded and vegetated courtyard. This patio is protected by the sloping hip roof over the offices which shields the exterior space from the prevailing winds. Earth berms and windbreaks are used to diminish the effect of the winds on the exterior wall surfaces. The hangar area structures will utilize the barrel vaulted roof to provide shade and deflect the northeast winds. A soccer (football) field will be constructed at Kaedi.

Samé, Mali

At Samé there are two houses, a 4-room ex-office building used as storage bins, a repair shop and maintenance area, and a large storage room adjoining the repair shop which is being used to store agricultural products. These buildings are in need of repair; the two houses will be transformed into a guest house and an infirmary. The ex-office building will continue to be used as storage area. The repair shop will be renovated, and th store converted into a spare parts storage room.

The new building requirements are:

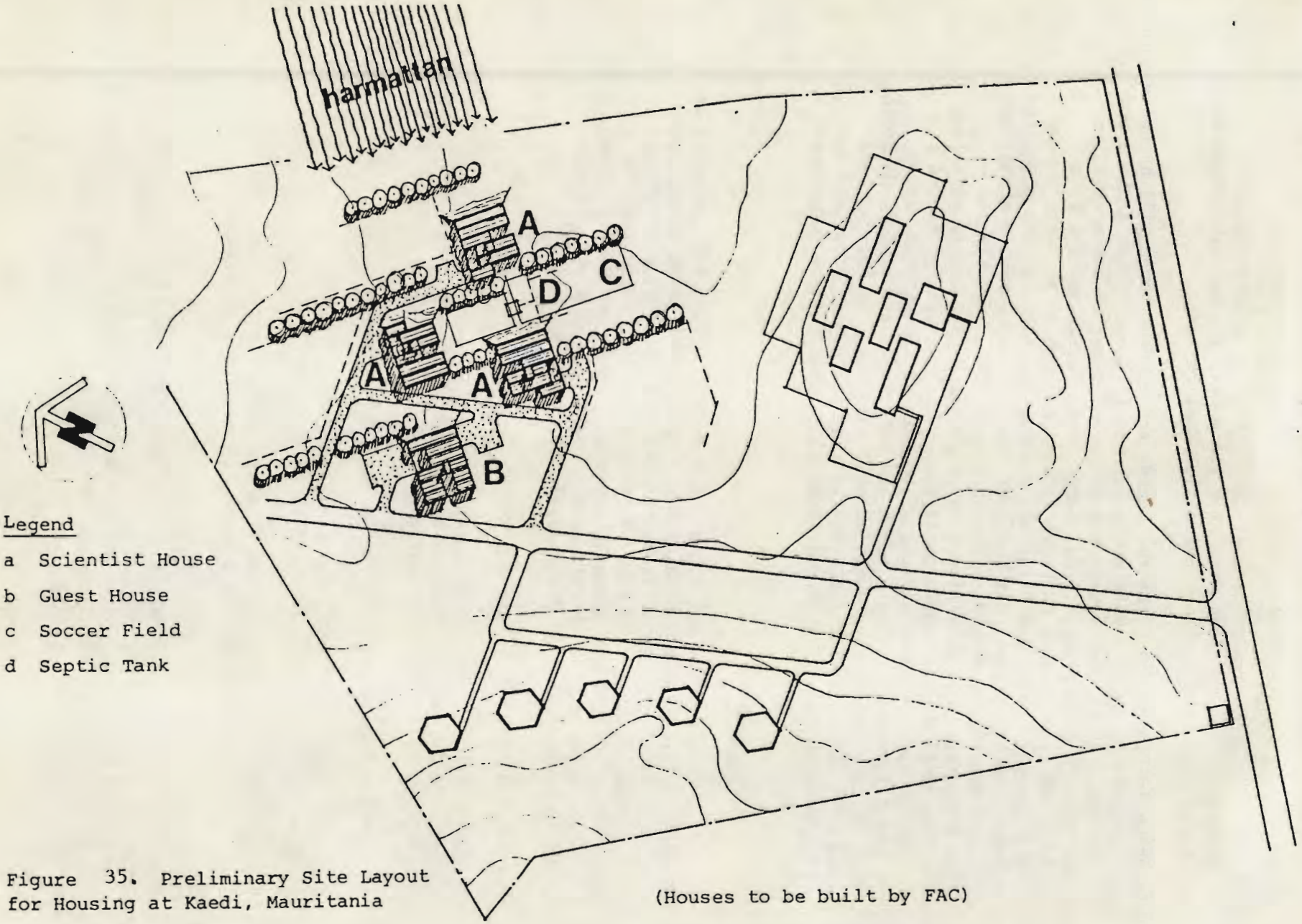
Housing, 5 units each 135 m^2 floor area
Office, 1 unit, 250 m^2 floor area
Laboratory, 1 unit, 60 m^2 floor area

Space will be allocated for future expansion needs.

Equipment storage, 1 unit, 100 m^2 floor area
General hangar, 1 unit, 50 m^2 floor area

The general arrangement of the Samé research center is shown in Figure 36. The preliminary site layout of buildings is given in Figure 37.

Based on a projected population of 65 permanent residents and 100 transients, a domestic water supply with a capacity of 30,000 l/day needs to be developed using river water which should pass through a simple treatment system. A 100,000 liter storage tank would be required as reserve and for fire protection.



Legend

a Scientist House

b Guest House

c Soccer Field

d Septic Tank

Figure 35. Preliminary Site Layout for Housing at Kaedi, Mauritania

(Houses to be built by FAC)

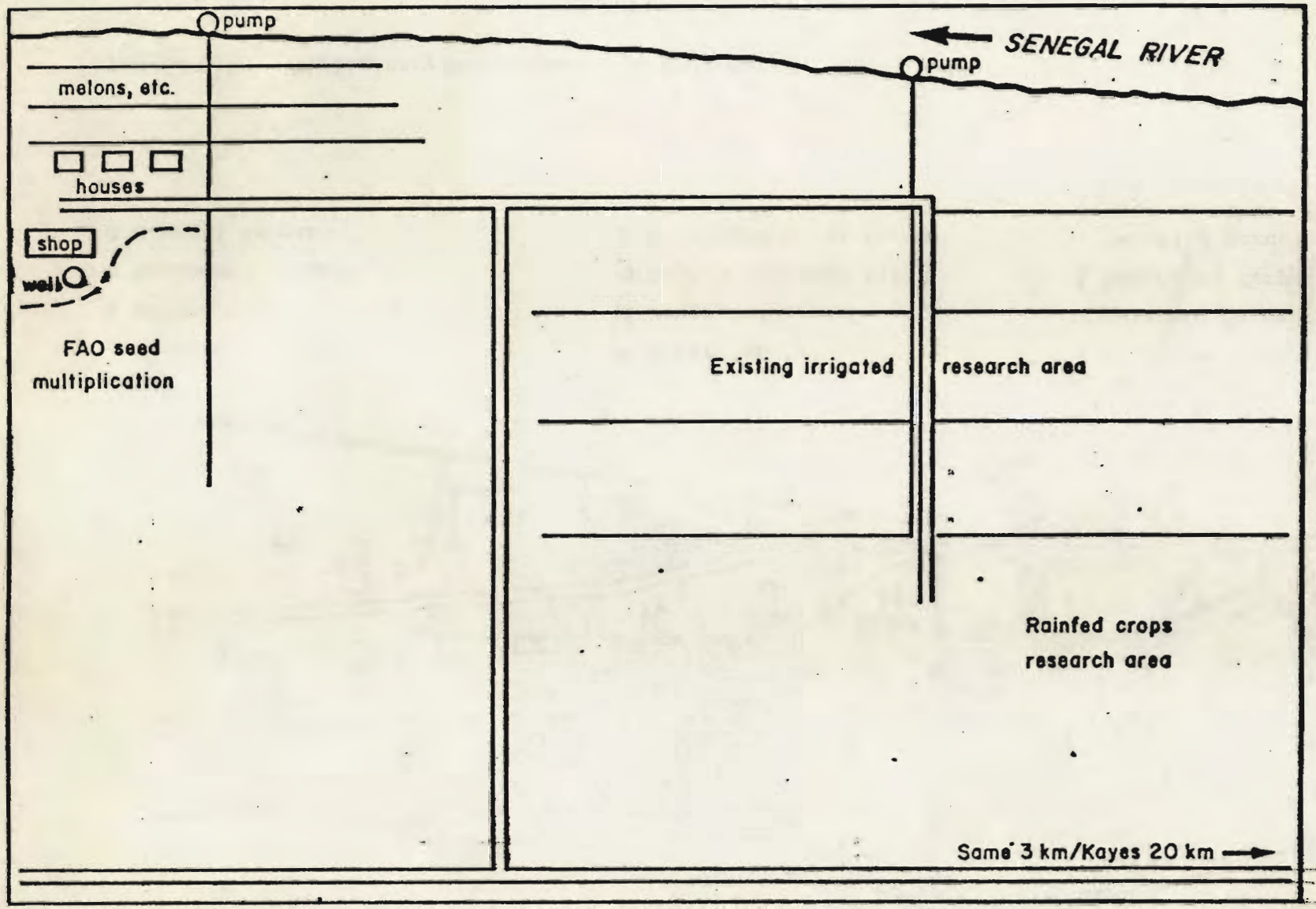
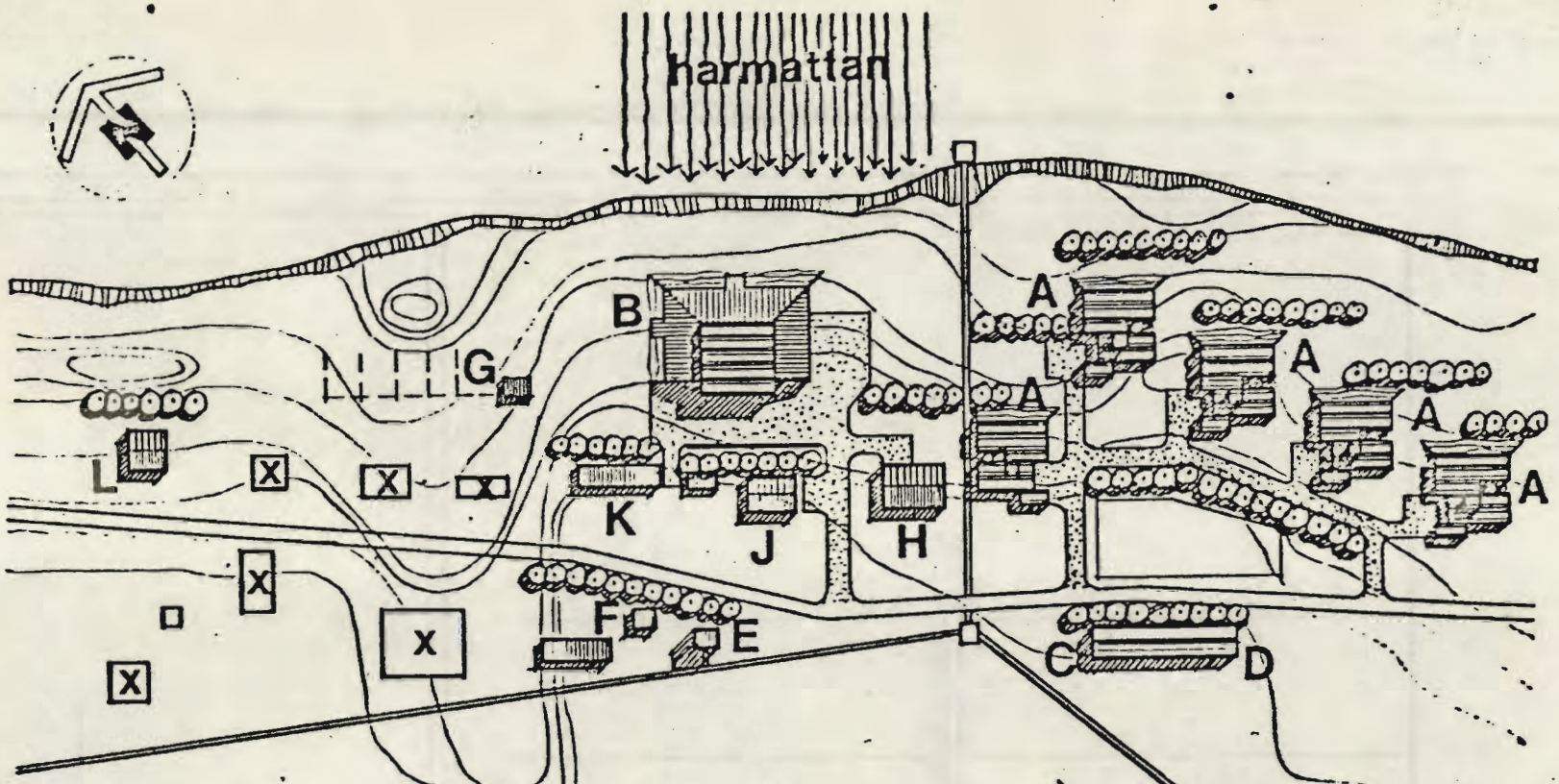


Figure 36. General Arrangement of Samé Research Station



Legend

a Scientist Houses

b Office/Laboratory

c Equipment Storage

d General Hangar

e Water Supply

f Power Generator

g Septic Tank and Field

h Remodeled Guest House

j Remodeled Infirmary

k Existing Storage Bins

l Remodeled Temporary Housing

x Existing structures to be used by other governmental and international agencies

Figure 37. Preliminary Site Layout for Buildings at Samé, Mali

The ground water is reported to be highly corrosive and will be tested further to determine its suitability for domestic (and irrigation) purposes. The electric power needs of this station are two, 100 KW units, one of which will be used as a standby unit. The waste disposal system will consist of septic tanks. A volleyball field and a tennis court are needed as recreational facilities. USAID has already supplied a soccer field, a voleyball field, and a basketball field in connection with the construction of the Agricultural Workers Training Center.

Samé is at present a doubly-isolated station. Its main access is by a dirt road from Kayes, which in the rainy season is negotiable at the lowlying stretches only by a 4-wheel drive vehicle with an experienced driver. Two single lane bridges on this road have the nominal load capacity of 10 tons, but are in constant need of repair. A bush trail connects Kidira at the Senegal border with Kayes, passing through Samé, but in the rainy season and during the flood stage of the Senegal River it is absolutely impassable for any kind of ground vehicle except the train. The main--but not the only--obstacle is the Faleme River. The Dakar-Bamako train can negotiate the same stretch in any season because of bridges and an elevated track bed. At present, however, this is not a recommended train trip. Other access to Kayes is by train or by air from Bamako. Under the best circumstances the train takes 10 hours and is extremely crowded; the plane schedule can be very unreliable.

Improvement of the road between Kayes and Samé will therefore only partially relieve the isolation of Samé. The only justification for improving this stretch without improvement of the general transportation system in the region would be in case of medical emergencies in the rainy season.

The cost of rebuilding all of the 20-km stretch will vary with the width of the road and the type of surface. The cheapest construction is a 6 m wide roadbed with a 4 m wide traffic lane consisting of a 20 cm laterite layer. It can support loads up to 13 tons at speeds of up to 60 km/hr. In terms of June, 1980, prices this road would cost 200,000,000 F.CFA or approximately US $1,000,000. Once built, the road will certainly be used by heavy trucks making the Kidira-kayes run; they would most likely not honor the load and speed limit, causing the early deterioration of the road.

In connection with the construction of the Manantali Dam and the overall improvement of the transportation network, the Tambacounda to Kayes section of the road to Diamou is being designed by DFW. It is expected that West German financing will be available for its construction The Faleme River crossing near Kidira, and the Bafing River crossing near Mahina will have to be bridged. If German financing is made available for the Tambacounda to Kayes section, the Faleme bridge will be included and an all-weather paved road connecting Kayes to Dakar will pass through Samé. Information obtained in August, 1980, in Bamako indicated that the design was completed and that there was a high probability that construction would begin in 1981.

It is therefore recommended that road construction between Kayes and Samé not be included in this project at this time. OMVS should make requests to the Public Works agency in Kayes to have the road repaired sufficiently in the interim for safe passage during the rainy season. It could be accomplished by filling the low spots with laterite and providing proper grading and drainage. Occasional passes with a bulldozer would eliminate ruts and rough spots. If the new all-weather road is not completed before the completion of the Samé research station, it is suggested that a one-time capital expenditure of $50,000 be allocated for the temporary repair of the critical sections of the road.

At Samé, Mali, several existing structures are available, although in need of remodeling and/or renovation. These structures will be remodeled as temporary housing, infirmary, a guest house, and storage shed (see Figure 37). Other existing structures on the site will be used by various governmental agencies. In addition to the existing buildings, it is proposed to add offices, a laboratory, 5 scientists' houses, as well as other support facilities. This should be done in concert with the existing structures, especially those being refurbished for use by the project.

In the Samé site layout the detached houses are buffered from the northeast winds by bermed earth and windbreaks of trees that protect places of outdoor activities. The office/laboratory building is separated from the housing and uses a combination of hip roof and barrel vaults to create a ventilating wind shield. Earth berms on the northeast facade deflect the prevailing winds off the river upward and over the buildings. Access to the office/laboratory building is directly off the main road.

7. Estimated Construction Costs

Data on estimated construction costs for the civil works; furniture, equipment, and spare parts for buildings; and agricultural land development are summarized in Table 38. Additional estimated costs detailed are given in Table 39. All cost estimates are projected October 1981 figures.

8. Assumptions

The following assumptions were made concerning construction and facilities development:

- other donors will cooperate in construction activities;
- construction will be carried out on schedule;
- an effective maintenance program can be implemented;
- personnel will be satisfied with living arrangements.

9. Justification

The proposed construction and facilities development activities are justified because they:

- provide minimum cost method of getting what is needed in place in a timely way;

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Table 38 - Summary of Estimated Construction Costs (projected to October, 1981)

Fanaye and Richard Toll	
Civil Works	720,000
Furniture, equipment and spare parts	148,000
Agricultural Land Development	12,000
Subtotal	880,000
Kaedi and Belinabe	
Civil Works (Belinabe)	296,000
Civil Works (Kaedi)	316,000
Furniture, equipment and spare parts - Kaedi and Belinabe	196,000
Agricultural land development - Belinabe	214,000
Subtotal	1,022,000
Samé	
Civil Works	1,828,000
Furniture, equipment	401,000
Subtotal	2,229,000
Total Estimated Construction Costs	4,131,000

Table 39 - Details of Estimated Construction Costs (projected to October 1981)

	N° Units	Total Cost	($US)
A. FANAYE AND RICHARD TOLL			
1. Civil Works (Richard-Toll)			
a. Housing for researchers)	4	250,000	
b. Housing for assistants) Fanaye	4	181,000	
c. Office buildings)	4	195,000	
			626,000
d. Contingencies (15%)			94,000
Total Estimated Cost for Civil Works			720,000
2. Furniture, Equipment and Spare Parts			
a. Furniture for Housing		110,000	
b. Climatological Station		8,000	
c. Spare Parts for Buildings		30,000	
Total			148,000
3. Agricultural Land Development			
a. Hand dug Wells (for on-farm research sites)		10,000	
b. Contingencies (20%)		2,000	
			12,000
Total Costs for Fanaye and Richard Toll			880,000

Table 39 (Cont'd)

	N° Units	Costs ($US)		
B. KAEDI and BELINABE				
1. CIVIL WORKS - KAEDI				
a. Housing	2	120.000		
b. Bungalow Units	2	100.000		
c. Standby 50 kw generator w/sheltor		30.000	250.000	
			25.000	
e. Imprévus (15%)			41.000	
TOTAL				316.000
2. CIVIL WORKS - BELINABE				
a. Office	1	80.000		
b. Machine Shop & Spare Parts Sotrage	1	60.000		
c. Vehicle Shed	1	50.000		
d. Hangar	1	40.000	230.000	
e. Fuel Storage Tanks			3.000	
f. Engineering & Architectural Services (10%)			23.000	
g. Contingencies			40.000	
TOTAL				296.000
3. FURNITURE, EQUIPMENT & PARTS - KAEDI & BELINABE				
a. Furniture for Housing		70.500		
b. Office Equipment & Furniture		28.500	99.000	
c. Climatological Station			8.000	
d. Spare Parts for Buildings			39.000	
e. Spare Parts for Utilities			49.000	
TOTAL				196.000
4. AGRICULTURAL LAND DEVELOPMENT - BELINABE				
a. Research Field Preparation	15 ha	120.000		
b. Dike Repair	400 m	32.000		
c. Hand dug wells	4	10.000	162.000	
d. Engineering Services (10%)			16.000	
e. Contingencies (20%)			36.000	
TOTAL				214.000
5. TOTAL COST FOR KAEDI & BELINABE				1.022.000

Table 39 (Con't)

C. SAME				
1. Civil Works				
a. Housing	5	400.000		
b.	1	150.000		
c. Office	1	36.000		
d. Laboratory	1	40.000		
e. General Hangar	1	20.000	646.000	
f. Storage Area Rehab		8.500		
g. Guest House Rehab		40.000		
h. Infirmiry Rehab		30.000		
i. Machine shop Rehab		22.000		
j. Spare Parts Rehab		15.000	116.000	
				762.000
k. Fuel Storage Tanks		10.000		
l. Electric Power System		50.000		
m. Water Supply System		250.000		
n. Air conditioning for Office & Lab.		25.000		
o. Waste disposal System		85.000		
p. Recreational Facilities		25.000		
q. Road Improvement		50.000		
				495.000
r. Site Preparation & Landscaping (10%)				126.000
s. Engineering & Architectural Services (10%)				140.000
t. Contingencies (20%)				305.000
Total for Civil Works - Samé				1.828.000
2. FURNITURE, EQUIPMENT & SPARE PARTS				
a. Furniture for Housing		149.550		
b. Furniture & Equipment for office, lab, & Infirmiry		86.450		
			236.000	
c. Spare parts for buildings		60.250		
d. Spare parts for utilities		96.750		
			157.000	
e. Climatodological Station			8.000	
				401.000
3. TOTAL FOR SAME				2.229.000

- avoid problems of "absentee" researchers by providing comfortable work and living conditions on site;

- use minimum of scarce energy resources for climate control while maintaining comfort of occupants;

- take advantage of resources of other donors in the SRB;

- have flexibility to adapt to changing total program needs.

10. Feasibility

The proposed construction and facilities development activities are feasible within the framework of the overall project because:

- The Contractor is prepared to initiate design and construction activities immediately after project approval;

- construction emphasizes use of locally available materials and techniques;

- discussions have been held with other donors to initiate coordination of construction activities;

- local and expatriate contracting firms with necessary skills and experience are available (and working) in the SRB.

11. Impact

The construction and facilities development activities will have impacts of the social and physical environments. These impacts are discussed in the Appendixes on Economic Analysis, Social Soundness Analysis, and Environmental Analysis.

D. EQUIPMENT

Abundant experience in West Africa has shown that agricultural and other equipment not appropriate for the environmental, social, and economic setting in which it is to be used does not aid the developmental process. Equipment "boneyards" are common.

A modest amount of equipment will be required to support the research program at its inception. Local suppliers in Mali, Mauritania, and Senegal will be used whenever possible. Our approach to meeting equipment needs is to order now those items needed immediately but to maintain a substantial part of the equipment budget for purchase of items that will be identified as the program evolves. An adequate supply of spare parts will be ordered with each piece of equipment, and maintenace programs will be developed including training of maintenance personnel.

Equipment is discussed under two headings: agricultural equipment for use by farmers, and agricultural, laboratory, and support equipment (including vehicles and shop equipment) for use on the station.

1. Agricultural Equipment for Use by Farmers

The basic assumption is that equipment for use by farmers in ON-FARM research should be appropriate for the environmental, social, and economic setting in which it will be used. The food production and processing equipment initially selected for use will add to what the farmer already uses.

The use of human and animal power and local materials will be emphasized in water lifting devices and distribution systems for irrigation. There are many techniques that have been practiced for centuries in other parts of the world, such as the sagia or Persian wheel, which can be combined with modern techniques (Stern 1979). It will be evaluated along with other alternatives in the ON-FARM research, and on the research stations as part of the APPLIED and SUPPORTING research. INNOVATIVE research will consider the development of new equipment specifically adapted to the SRB.

There has already been some research in Senegal with appropriate equipment on the Unité Expérimentale (ISRA and GERDAT 1977) and the contractor team will investigate the usefulness of this and other research in Mali, Mauritania, and Senegal for the AR II research program. Economic justification for the use of animal traction is discussed in Appendix II. Economic Analysis,

Research in AR II will focus on the economic and social aspects of the purchase, use, repair, and maintenance of equipment by farmers. This will involve collaboration of all contractor team scientists in considering factors of household and community economics, labor structure, mechanical and agricultural skills, and training farmers in use and maintenance of equipment. While the research program may at first depend on outside suppliers, it will also investigate the possibility of production of equipment and structures by local blacksmiths and other artisans, as well as farmers themselves.

There are many suppliers of appropriate farm equipment around the world, including one in Dakar, SISCOMA, that carries plows, seeders, and animal drawn carts. Among many suppliers contacted, the following examples show the availability of some of the equipment to be used in AR II. Prices given here are estimates obtained in 1980; actual costs will depend on time of purchase and undoubtedly will be higher.

Ets Mouzon Frères S.A.
B.P. 26
60259 Mouy (Oise)
France

Has dealer in Dakar, SISCOMA. Nolle system toolbars 3 "tropicalteur" (Ox-drawn units) with attachments (9 each) $13,000 CIF Dakar

EBRA
Ets Beauvais & Robin
28 Rue de Maine
B.P. 915
49009 Angers
France

3, animal drawn seeders $1,700 CIF Dakar

R. Hunt & Co., Ltd.
Atlas Works, Earls Colne
Colchester, Essex
United Kingdom

Heavy duty maize sheller (hand, pedal, or power driven) 3, $1,575 CIF Dakar

Project Equipment Ltd.
Redhall Industrial Estate
Oswestry, Shropshire
United Kingdom

Anglebar (multi-purpose animal drawn equipment with quick attachment feature) 3, with plow, ridger, cultivator & seeder--$2,250 CIF Dakar

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D.B. Smith Export Corp.
Main Street
Utica, New York U.S.A.

Heavy duty knapsack sprayers; 3, $705 CIF Dakar

Cossul & Company Private Ltd.
123/367 Industrial Area
Kanpur, India

3 Animal powered chain & washer pumps $1,610 CIF Dakar
Also carry push plows and cultivators and handpowered seed processing equipment.

2. Equipment for Use on the Research Stations

More sophisticated agricultural equipment will be used on the stations to insure the greater speed and uniformity required in research work. The emphasis here will also be on minimizing cost and maintenance. The agricultural engineer will develop programs in use and maintenance of the equipment as part of the training program. Human or animal powered equipment and machines with small engines will be used whenever possible in place of heavy machinery. In addition to being more appropriate, the higher labor requirements of the farmer will involve more farmers from the surrounding area and help to speed and sustain interest in work on the station.

A 5-7 hp walking tractor with land preparation, planting, and cultivating attachments will be purchased for each station, and records will be kept to evaluate their appropriateness for use on small-scale irrigation projects in the SRB. A larger tractor and some implements also will be purchased for the Fanaye station because of the lack of equipment there. Six American-made pickup trucks with 4 wheel drive will be purchased for use by the contractor team on the stations and in the field. There is a dealer in Dakar and parts and maintenance can be obtained there.

Laboratory supplies and equipment will be obtained locally where possible to facilitate maintenance and replacement. Purchases will be coordinated with plans of other donors to avoid duplication and unnecessary expenses. For examples, FAC intends to construct and equip a soils laboratory at Kaedi; the proposed IBRD/ISRA project will construct and equip some laboratories at Fanaye.

Tools and equipment required for maintenance programs also will be purchased locally to avoid problems of obtaining parts and service. Simplicity of operation, durability, and service requirements will be among the criteria used in purchasing.

Logistics support for purchasing and shipping is already available in Contractor and can be mobilized quickly to meet the equipment needs of AR II. Access to Dakar by sea and air is relatively good and no significant delays in supplying equipment are anticipated.

E. TRAINING

Additional details of the training program which will be required for implementing the research activities are given below. Assumptions, justification, and feasibility of the training are discussed.

The training program will have impacts on the economic and social environments which are discussed in the Economic Analysis (Appendix II, and Social Soundness Analysis (Appendix III).

1. Training Program Details

a) Counterparts-Trainees: Six "engineers" (Baccalaureate" certificate plus at least four years at a university or institute) will be hired at the beginning of the project. They will be assigned to work with Contractor team members and will be given the opportunity to attend evening English classes. One year later, three of them will be placed in U.S. universities to start an M.S. or Ph.D. degree program. Additional English training will be given in the U.S. if necessary. At this time, three more counterpart trainees will be hired or relocated to replace the departing ones.

At the end of the second year, the three remaining original counterpart-trainees will be sent to the U.S. and will be replaced by three newly hired or relocated engineers. When the first counterpart-trainees return they will continue their education by conducting practical research in the SRB with the Contractor team members. They will be required to complete 2 years of field experience before the degree is awarded. When the first group returns, the third group will be sent to the U.S. When the second group returns, the fourth group will depart.

b) Research Assistants (conducteurs or ingenieur adjoint): Two types of training will be provided:

1. The holders of a "Baccalaureate" will have the opportunity to attend an agricultural institute in a francophone country. For example, they might take an examination at the Institut Agronomique et Veterinaire Hassan II in Rabat and be admitted in the second year of the respective schools (General Agriculture in Menkes, Horticulture in Agadir, or Agricultural Engineering in Rabat).

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If they fail the exam, they will have to start from the first year. We recommend that 6 research assistants be recruited as the project starts. At the end of the first year three will be sent for training. At that time three more will be hired or relocated to replace them. Additional groups will be sent for training at appropriate intervals.

2. The Contractor will organize short term training sessions in Samé, Kaédi, and Fanaye on a rotation basis at regular intervals to cover completely the various aspects of one kind of crop production (cereals, vegetables, or fruit). Examples of training are given in Table 40. At the end of eight or nine sessions, an examination will be given and those passing will receive a certificate as "specialist" in the subject. OMVS has indicated its willingness to give value to such training by raising the certificate holders to slightly higher positions.

c) Field Assistants (Moniteurs): Two types of training will be provided:

(1) Training in Kaédi or Samé for one to two years. Some candidates may be upgraded to Research Assistant following successful training.

(2) Informal training and workshops plus on-the-job training at the stations.

2. Assumptions

We made the following assumptions relative to the training program:

- OMVS and member states will be able to identify, hire, and assign to the project 12 counterpart-trainees who will be interested in and capable of advanced academic training,
- local English classes will be available for them,
- OMVS and member states will continue to pay salaries and other personal costs of their employees while they are training in the U.S.
- U.S. academic training can be made relevant to SRB needs,
- thesis research of counterpart-trainees can be relevant to and part of the project research,
- administrators will allow counterpart-trainees time and resources for thesis research and preparation in SRB.

Table 40. Examples of Training Program and Schedule for Research Assistants

Dates	Location	No. of Trainees	Topics	Lecturers
October (includes 1 day in the field)	Samé	6-9	- Land preparation - Seed bed preparation	Agricultural Engineer, Agronomist
			- Fertilizers and fertilizer application	Agronomist, Agricultural Engineer
November	Kaedi	6-9	- Irrigation principles - Specific practices (including water measurement and control) - Land leveling and layout for irrigation	Agronomist, Soil Specialist, Agricultural Engineer
December	Fanaye	6-9	- Seed quality and types, selection and improvement - Choice of cultivars and adaptation - Seeding	Agronomist
			- Simple seeders and their adjustment and use	Agricultural Engineer
January	Kaedi	6-9	- Weeds - Weed control	Agronomist, Weed Control Specialist,
			- Herbicide applicators, setting and calibration	Agricultural Engineer
February	Samé	6-9	- Pests and parasites of cereals	Plant Protection Specialist
			- Plant protection	"
			- Economics of cereal production	Agricultural Economist
March	Fanaye	6-9	- Maintenance and use of farm machinery	Agricultural Engineer
			- Appropriate cereal production technology	Contractor team

Table 40 -Continued

Dates	Location	No. of Trainees	Topics	Lecturers
April	Kaedi	6-9	- Harvesting and threshing methods (small, intermediate and large machinery)	Agricultural Engineer
			- Storage of crops (cereals), various seed and staple cereal treatments	Agronomist, Agricultural Engineer
			- Nutrition and diets	Contractor team
May	Kaedi		EXAMS	

- OMVS and member states will be able to hire required support personnel (Research and Field Assistant).

- OMVS and team members will be able to design effective local training programs including on-the-job training for administrators, counterpart scientists, support personnel, and farmers.

3. Justification

The proposed training program is justified because:

- human resources development is essential to overall development program success; human resources are severely limited now at all levels;
- after this project terminates, the trained personnel who remain on a permanent basis will be able to continue the research program,
- there has been a lack of motivation among some personnel in the past because they were not given opportunities to understand more completely either the problems of the SRB or the programs designed to resolve them. Training will help bridge that gap.

4. Feasibility

The proposed training program is feasible because:

- B.S. graduates are becoming more available in the member states,
- OMVS has assurances from the national governments of availability of appropriate people,
- Contractor universities have demonstrated capability for graduate education tailored to special needs,
- Contractor universities have prepared and conducted special short courses on relevant topics,
- Contractor universities have special programs for teaching English as a second language, e.g., The Center for English as a Second Language (CESL) at the University of Arizona.
- Institutes are available in francophone countries to provide the training scheduled there (see details following)
- some local personnel are being trained at the present time on other donor projects (see list following).

Francophone Training Institutions:

1. Institute Agronomique et Veterinaire Hassan II (IAVH II) and associated institutions were started in 1966. They give a four year course leading to the "Ingenieur Agricole" Diploma which is equivalent to the U.S. BS degree in such fields as:

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Horticulture (Agadir), Agriculture Engineering (Rabat), Topography (Rabat), Food Technology (Rabat).

A branch school called Ecole Nationale d'Agriculture (in Meknes, Morocco) has a four year program leading to the BS level in: General Agriculture and Agricultural Development.

The IAVH II also has a separate six year program leading directly to the MS level in:

- most fields of agronomy, soil science, rural sociology, and development.
- most fields of veterinary medicine.

The first year is common to all these schools and branches. The Baccalaureat (Moroccan, or French equivalent) is required for admission to the school.

Agriculture technicians who have a Baccalaureat may be admitted directly to the second year of their choice by taking and passing a comprehensive exam specific to their field of study.

They will need only three years training and most of the third year is spent on a research project. In this case arrangements may be made to conduct the research on the experimental stations in the SRB.

2. Kaédi Agriculture School (Ecole Nationale de Formation et de Vulgarisation Agricole, ENFVA):

This school has two programs:

(1) One takes students from the end of the second year lycee (end of U.S. 7th grade) and trains them to become "Moniteur of Agriculture" in three years.

(2) The other takes students from end of the fifth year lycee (10th grade U.S.) to train them to become "Conducteur d'Agriculture in three years, the last one of which is in the field, and could be spent on the experimental stations in the SRB.

3. Samé School (Centre d'Apprentissage Agricole de Samé, CAA):

This school trains students from about 7th grade to the level of "Moniteur" in general agriculture. The training lasts three years. The third year is spent in the field. The school is being rebuilt through USAID funds and can house up to 160 students with full room and board.

This school can be used to train some of the project technicians as well as for seminar purposes.

4. Other schools in OMVS countries:

Senegal

Institut de Développement Rural de Thies (projected: first year started in 1979 at Dakar University, will open in 1981). Trains Ingenieurs Agronomes (5 years), is equivalent to MS degree.

Ecole Nationale des Cadres Ruraux, Bambey, training of "Ingenieurs de Travaux" in the following specialties: agriculture, forestry and water, animal science, agriculture engineering (2 years; graduates are at the sophomore level; they would qualify to enter IAVH II in the second year).

Ecole Nationale d'Horticulture de Camberene, trains technicians in horticulture.

Ecole Nationale d'Economie Appliquee (ENEA) Dakar: trains in administration, planning, statistics, and land management.

Mali

Institut Polytechnique Rural de Katibougou: trains "Ingenieurs" and "Technicians Superieurs" in agriculture, animal science, and forestry (lower than moniteurs, requires 5th grade education, 3 years training).

Scientists and technicians already in or scheduled to be in training in other donor-funded projects:

1. Fanaye-Richard Toll

- Rice Breeders (3) -- (years 3 and 4 of World Bank project)
- Doctorat (3rd cycle) Montpellier, France, sponsored by Canadian funds
- Maîtrise (M.S.) Nitrogen fertilizer, Laval University (in French). Quebec, Canada
- Weed Science, University of Philippines, Los Banos, sponsored by Canadian funds
- English (in Washington, D.C.)
- Training in IRRI Headquarters (Philippines)
- Two laboratory assistants being trained in Bambey and Djibelor, Senegal

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2. Kaédi

- Some training planned by IRRI and FAO/UNDP

Rindiao

- One conducteur went to Montpellier to get DEA (equivalent to BS plus one year)

II. Economic Analysis

To achieve the goal of improving the standard of living of the farming families in the SRB it will be necessary to increase their net production. We make the assumption that as agricultural development proceeds, production for the majority of this population will remain organized on the household and village level. This implies that to produce economically profitable results, agricultural research will have to be oriented toward techniques that will be economically feasible for farm families. AR II will focus on development up to the level of small irrigation projects.

In the following discussion we examine the economic justifications for our assumptions and discuss the economic feasibility of our research program, including the application of results. We begin with a discussion of the macro and micro agricultural economics of the current low levels of food production in the SRB. We then discuss the development of irrigation and its role in agricultural research and development. Applied agricultural research and AR II are then analyzed.

We conclude that the research program of AR II is based on justifiable assumptions about agriculture in the SRB, is feasible, and will produce a net positive impact on agricultural development in the region.

A. Economic Background of the Agricultural Problem in the SRB

The SRB contains about 1.6 million people, approximately 13 percent of the total population of the three countries (See Table 41).

The present level of commercial market activity is quite low. A large proportion of the rural population, especially adult males, has emigrated to places with greater opportunity for employment (OMVS 1980a) (see Appendix III). Over the past decade, low rainfall and a lack of investment in food production have prevented the SRB from reaching food self-sufficiency.

At the national level, all three countries have had increasing difficulty in meeting domestic food requirements. Only Mali has begun to approach food self-sufficiency, however, it too had a large food deficit during 1980. For all three countries, rice imports have been increasing as a supplement to inadequate levels of locally produced millet and sorghum, the traditional staple grains. Cereal production fluctuates greatly as a function of variations in annual rainfall, and food imports vary inversely with cereal production. The average annual ceral imports for 1976-1978 were 60,000 tons for Mali, 122,000 tons for Mauritania, and 382,000 tons for Senegal. In an attempt to decrease their dependency upon the external markets in meeting food needs, the governments of Senegal, Mauritania, and Mali have declared food self-sufficiency as national goals.

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Table 41. Population of the Senegal River Basin

SRB Area		SRB as % of Total Area of Country	SRB Population as % of National Population
Senegal	27,500 Km^2	14	10
Mauritania	75,500 Km^2	7	16
Mali	155,000 Km^2	13	14

Source: Based on OMVS (1980a).

1. Senegal

The economy of Senegal is primarily based on agriculture, which engages over 70 per cent of the labor force and contributes an average of 25-30 per cent of Gross Domestic Product (GDP). The River Region has the lowest crop income of any region in the country. The standard of living has been maintained at subsistence level through remittances from family members who have emigrated to employment centers (World Bank 1979, Vol. 1:77). It has 10 per cent of the Senegalese population (380,000) and 14 per cent of the land surface (27,600 Km^2).

Senegal imports an average of more than 300,000 metric tons of cereals annually, spending 20 per cent of its scarce foreign exchange earnings for that purpose. Production in the SRB has historically focused on export from the region, both in commercial and SAED programs. Because of its food deficit situation, the Senegalese government now accords high priority to staple food production and views the SRB as a potential "food basket" for the country.

2. Mauritania

Mauritania is a sparsely populated country which has per capita income somewhat over the median for all African countries, due largely to earnings from iron mining in the north. Ninety per cent of the population is employed in agriculture; 70 per cent of them are at least partly nomadic. Traditional agricultural activity consists mainly of livestock raising, because 85 per cent of the land receives less than 250 mm of annual rainfall, too little to support rainfed crops. Crop production and fishing are practiced in the extreme south along the Senegal River, where seven per cent of the national land area (about 56,500 Km^2) contains 20 per cent of the population (431,000).

Economic development has been affected greatly by recurrent drought, which has led to crop failures, large-scale losses of livestock, and by the involvement in a war for control of the former Spanish Sahara. The war has drained foreign exchange reserves, distorted normal budget allocations, harmed the important mining industry, and led to political unrest culminating in the recent coup.

Although livestock production is significant in the national economy and dominant in the agricultural sector, the government has established a firm priority for crop production. The only region of Mauritania with significant potential for such activity is the SRB.

3. Mali

The agricultural sector in Mali provides a livelihood for 90 per cent of the population and accounts for approximatley 40 per cent of the GDP. About 90 per cent of cultivated land is devoted to food crops. Continuing drought conditions are exacerbating food deficits.

Traditionally, agriculture production has been confined to cultivation of cereals, vegetables, and dates, the latter serving as a cash crop. Seventy-five per cent of cereal production, mostly millet and sorghum, occurs in irrigated areas. Irrigation development in Mali has been concentrated in the Niger River Valley at the expense of development in the SRB. The SRB in Mali comprises 13 per cent of the land area of the country (155,000 km^2) and contains 14 per cent of the population. The government has assigned high priority to food production here, particularly the staple cereal crops.

B. Development Strategy for the SRB

The most important aspect of SRB development for the purpose of this PP is increasing agricultural output. Plans for the construction of the Manantali and Diama dams have raised the hopes of the three governments (especially those of Senegal and Mauritania) of transforming the SRB into an area of surplus production.

These dams comprise a major portion of the OMVS plan. The Diama Dam, scheduled for completion in 1986, will prevent salt water intrusion that has caused salinization problems for irrigation schemes in the delta region while at the same time increasing the need for drainage. The Manantali Dam, to be completed in 1989, will provide control over the flow of the Senegal River, presently subject to extreme seasonal and annual variations. In order to allow for a gradual transition from the present flood-dependent farming system to year-round irrigation from the river, which will affect much of the land presently used for flood recession agriculture, a period of 15 years, during which artificial flooding will be maintained, is planned. It is the aim of the OMVS to use the intervening period to build up the infrastructure necessary for the revitalization of the region.

The OMVS plan also includes strengthening of the transportation infrastructure. Construction of the Podor-Ndioum-Dieri road and the completion of the Dieri-Ourossogui-Bakel road is planned, as is the construction of similar all-season roads linking Kaedi, Boghe, and Mbout to the Nouakchott-Nema road. These and other connnecting stretches of road within the region will help to open up the region and will allow for the development of inter- and intra-regional trade. The control of the river level will allow year-round navigation up to Kayes, Mali. This should lower the costs of transporting agricultural produce such as rice, wheat, and vegetables to the urban areas, where demand is growing rapidly.

Along with the dams, road, and navigation, other components of the plan are aimed at electrification using the power generated by the dams, health programs, and regional reforestation.

OMVS strategy is to continue the agricultural research activities at the stations along the river in combination with intensification of extensions effors to introduce irrigated agriculture to the farmers of the SRB. Present plans call for an increase from about 28,000 hectares under irrigation as of July 1, 1980, to 255,000 hectares in 2028 (Gannett et al., Inc.

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1979). It is estimated that the potential for irrigation is 430,000 hectares (World Bank 1979).

Only large scale cultivation has the potential to meet long-term regional and national agricultural production goals (OMVS 1980b). However, the OMVS emphasizes that large scale irrigation projects have not been as successful as small projects. Large-scale irrigation techniques and organizational skills of irrigated agriculture. This pool is most likely to appear with the evolution of small-scale irrigation in the Senegal River Basin.

Therefore, the OMVS has evolved a strategy that involves a three-phase progression from small irrigation projects to large projects (OMVS 1980b). For the first five years, the aim will be to introduce farmers to irrigation through the development of small irrigation projects. This would be the most effective means of exposing the population of the SRB to the potential of irrigated farming while allowing the greatest latitude in matters of organization and technology.

These small irrigation projects will occupy 60 per cent of the area brought under irrigation during the first phase. It is thought by OMVS that the potential in the SRB for small projects as presently surveyed will be realized by 1986-1987. As familiarity with and enthusiasm for irrigated farming increases and as the development agencies become more efficient in their extension and more successful with the farmers in the SRB, larger projects will be developed. Farmers there will be introduced to more complicated forms of organization and schemes of water management, but will still have their own plots. During these first two phases, food crops will be emphasized: staple crops to meet subsistence needs for the farmer and a surplus of food crops, including vegetables, to provide a cash income and thus integrate the population into the cash economy. From 1985-1990, plans call for development to be focused on the large irrigation projects, with emphasis placed on industrial crops and agribusiness.

Overall levels of irrigation in the SRB are projected by OMVS to reach 41,000 ha by 1990. Of this, the majority will be concentrated in Mauritania (with 52.4% or 21,480 ha) and in Senegal with 41.5% or 17,000 ha). The remaining 6.1% in Mali will, in the first phase be concentrated on small pilot projects. Then approximately 300-400 ha per year will be added between 1985-1990.

The AR II research program is based on available knowledge of the SRB as well as on OMVS and national development goals. We believe that past experience with development indicates that smaller scale, locally managed development projects are economically and socially preferable to large projects managed primarily by governments. (The long run effect of numerous productive small projects will be greater production than a smaller number of inefficient larger units). AR II research, then, takes a bottom-up approach, starting with the average small farm family, believing that real, sustained development must grow out of the existing system.

C. Economics of Subsistence Farming and AR II

Traditional subsistence agriculture does not now produce adequate food for the farmers of the SRB. This means that food must be imported into the region, people emigrate from the region, and there is widespread malnutrition (Appendix III.B). The reasons for this inadequate production include an environnment characterized by a highly variable water supply and poor soils, labor shortages, and lack of readily available appropriate agricultural improvements.

The following yields from the Guidimara region of Mauritania seem typical of goods years in the SRB (Bradley et al. 1977:100):

sorghum (fella)	700-800 kg/ha
sorghum (nienico)	400-600 kg/ha
millet	450-650 kg/ha
maize	650-850 kg/ha
groundnuts	400-650 kg/ha.

Since an adult can cultivate an estimated .27 ha on the uplands and .17 ha in the flood plain, the average production is under 200 kg/person/year.

Weigel (1980) estimates that the average Soninké household consisting of 16 people with seven active in agriculture cultivates 7 ha in a good year. Assuming an average ratio of one good year to every bad year, the average household produces 1,700 kg of millet, 600 kg of rice, 860 kg of peanuts, and small quantities of vegetables. This represents 195 kg of food per person. These estimates of production are far below acceptable consumption levels (FAO/WHO 1973). Consumption above the level of locally produced food must be made up through imports. With little income other than remittances from absentee family members, it is the level of these remittances that determine the level of consumption above local production.

Environmental constraints to production have been discussed in Appendix I.A. AR II calls for research on supplemental irrigation from shallow wells and soil improvement through the application of manure and other readily available fertilizers.

While population densities in the SRB are low, densities on the most productive land in river bank, levee, and flood plain areas is often very high. There is a scarcity of good land, reflected in the tenure rules, which limit access of lower socioeconomic groups (see Appendix III.B. and III.B. AR II research will seek ways of increasing the productivity of marginal upland fields and increasing equity of access through community organization of small projects, as in presently existing small irrigation projects.

An important constraint in the SRB is the shortage of adult male workers due to migration. This has resulted in the increased importance

of women, children, and hired labor in agricultural activities, but labor scarcity remains as an important constraint to increasing production. The contributions of the different age and sex groups to production are discussed in Appendix III.B.

The labor shortage is very seasonal in traditional agriculture, as shown in Figure 42, based on data for the upper valley. The situation is very similar in the middle and lower valley (OMVS 1980a; B.I. 73, Boutillier et al. 1962:67).

At the beginning of the rainy season there is competition between the sowing of sorghum and maize on the levees and the weeding of millet, sorghum, and maize in the uplands. The distance of the uplands from the village and the number of men who have emigrated decide which of the needs for cultivation is given highest priority.

The guarding and harvesting of rainfed levee and upland crops conflicts with preparation and planting of the flood recession fields. The conflict increases from lower to upper valley as the floods come earlier, and as the importance of rainfed agriculture increases. When levee cultivation is major part of the farming activities, development of the flood recession fields is usually limited to a level that does not interfere with farming on the levees.

Activities in flood recession farming and cultivation of riverbank fields overlap and interfere. The relatively limited area of riverbank fields minimizes this conflict, however.

In rainfed farming, the major labor requirements are for clearing land (which is done by cutting and burning trees and brush), soil preparation, weeding, and guarding newly planted fields and ripe against birds and other animals.

On flood recession land the major contraints are the clearing of new growth, hoeing, and guarding againts birds and other animals. It is estimated that weeding requires 25 person days/ha.

AR II research includes a strong emphasis on labor-saving techniques, primarily simple animal and human powered equipment for irrigation, cultivation, and food processing. SUPORTING research with small scale irrigation projects will emphasize management through community-based farmer organizations to minimize conflict between traditional and irrigated farming.

D. Irrigated Agriculture

Irrigation in the SRB was first introduced in the delta and lower valley and only recently has progressed to the middle and upper valley. Richard Toll, Senegal, was the site of the original irrigation development scheme begun in 1891 (Gannet et al., Inc. 1979). In 1922 an experiment station was officially started here, and in the 1940's and 1950's the

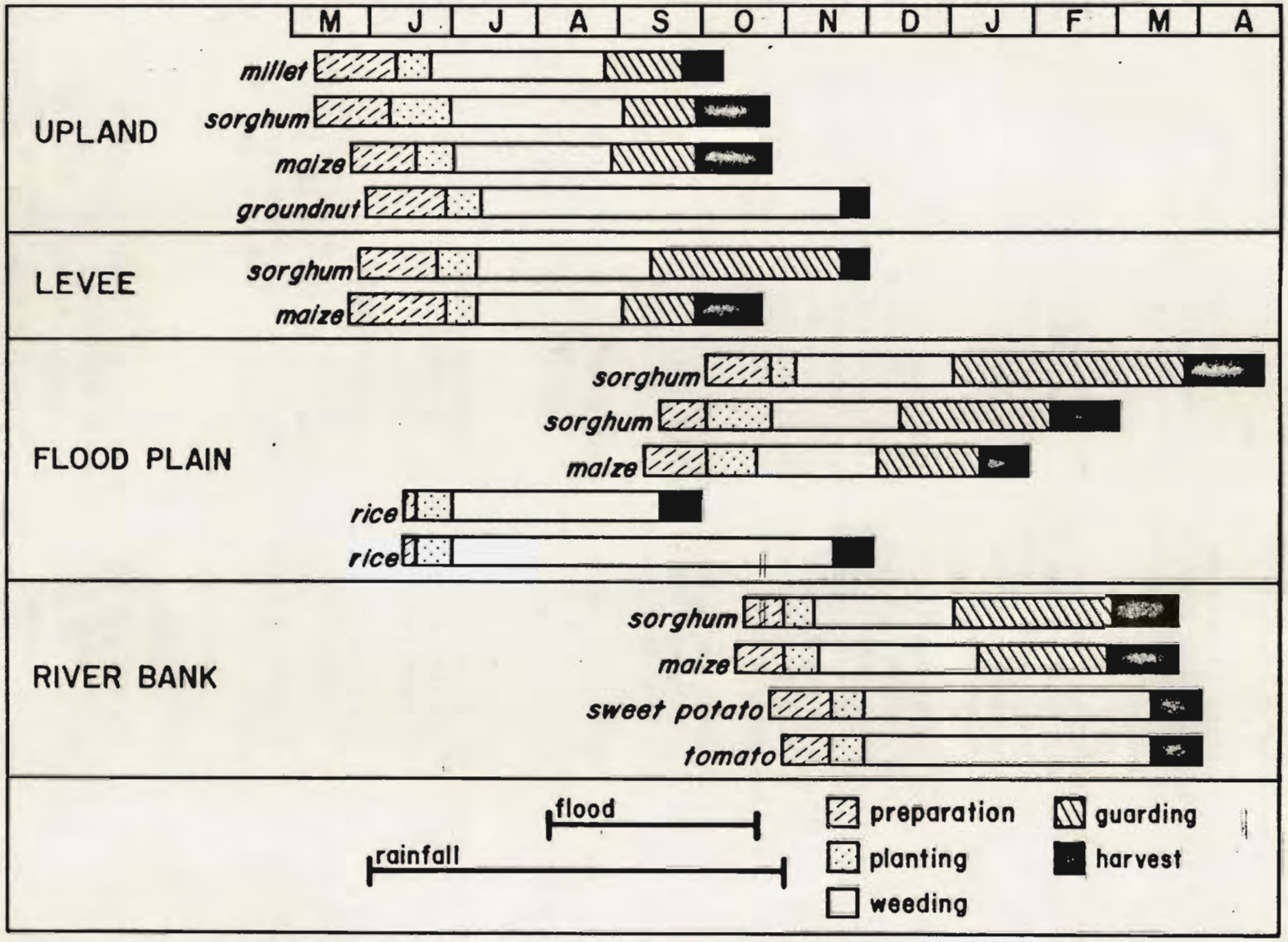

Figure 42. Calendar of agricultural activities in the different zones of the riverine system. (Source: Bradley et al 1977:75)

most important development and expansion was achieved. Control passed from a private French company to the new government with independence in 1960. It was converted from government to private land and from rice to sugar cane in 1970, and is now a large-scale commercial operation.

Senegal has the most area under irrigation and the Delta Development Agency (SAED) headquartered in St. Louis is now responsible for implementing irrigation development throughout the River Region. Under SAED the Senegalese portion of the SRB is divided into seven perimeter regions within which are irrigated developments or projects. Irrigation in Mauritania is less extensive and is administered by SONADER, with its field center in Kaedi. Irrigation in the SRB is least extensive in Mali, where OPI/API is the responsible agency, with its field center at Kayes.

Despite long experience with irrigation in the SRB, this new technology has not yet overcome the problem of inadequate food production. Analysis of irrigated agriculture has provided guidelines for the development of the AR II research plan. The greater success of the smaller projects, more responsive to and more completely managed by the farmers themselves, has led us to emphasize them in our proposed research relating to irrigation projects.

1. Incentives and Constraints to Irrigation

Proper irrigation results in a high degree of water control, lower yield variation and higher average yields compared to the traditional system. With an assured water supply, the farmers have the possibility of larger, less variable harvests, and of raising a greater variety of crops. Once they have met their subsistence needs and paid their debts, they can market their surplus. A reliable harvest, providing the possibility of nutritionally adequate consumption as well as surplus for sales, is the measure of the value of the system for the farmers. However, there are many elements in the present system that threaten the production of an adequate and reliable surplus.

Though the risks of traditional agriculture may be avoided, the introduction of irrigation brings its own set of risks. The system of management that must be mastered by the farmer is very different than that traditionally practiced, and the farmer normally becomes much more dependent upon the external economy. Inputs such as seed, fertilizer, and pesticides must be made available on a timely basis. Activities such as transplanting, fertilizing, weeding, and water applications must be properly timed. The labor requirements for irrigated crops are generally greater and may be more evenly distributed throughout the cycle. If necessary inputs are lacking or if activities are improperly timed, yields can be seriously affected. Introduction of new varieties and intensive cultivation may increase the risk of crop disease. A breakdown in the water control system could destroy an entire crop.

Aside from the risks inherent in the system of production itself, the involvement of the farmers in activities such as credit and marketing create great dependencies against which the farmers must be cushioned if they are to adopt the new system. The farmer is generally provided inputs such as fertilizer, seed, and pump maintenance on credit and must pay an annual amortization fee on the cost of the pump. A crop failure due to disease, pests, or a breakdown in the water supply system, a lack of adequate markets or inadequate prices for farm products could lead to the inability of the farmers to pay off their debt at the end of the season.

The following list summarize problems encountered in irrigated agriculture:

a) Competition of traditional rainfed farming with irrigated farming where and when rains are favorable.

b) Land tenure--traditional land rights conflict with plans to establish and expand irrigated areas. In Mauritania, there are problems due to ownership of large areas of land that are desirable for irrigation development but whose influential owners have been able to block attempts, notably of SONADER, to gain control of the land.

c) Difficulty of assuring a timely and adequate supply of inputs such as seed, fertilizer, pesticides, and technical advice.

d) Lack of adequate water supply in the river, especially in the upper valley during the hot-dry season.

e) The tradition of emigration men, especially from the middle and upper valley to Dakar and France, contributing to problem of meeting certain labor requirements.

f) High costs of irrigation due to the farmers' lack of knowledge concerning optimal levels of water application, and excessive water losses due to runoff and seepage and erosion of unlined ditches.

g) Problems associated with scale: determination of optimum sizes of irrigated areas and parcels within them. Inadequate size parcels discourages reliance and investment in irrigated land. Yet the relative inexperience of local farmers warrants caution in making parcels in these new systems too large.

h) The lack of experience and rigidly bureaucratic approach of some of the representives of the government development agencies, resulting in non-responsiveness to farmers' needs.

i) The high cost of building protective dikes of adequate quality.

j) The maintenance and repair of pumps and motors.

k) The high cost and variable availability of diesel fuel.

l) The limited effective demand for products now grown in the dry season, such as tomatoes and other vegetables.

2. Large Irrigation Projects

Irrigation works in the SRB can be classified into large and small perimeters. The large projects have been developed mainly in the delta area and have evolved in three stages, primary, secondary, and tertiary (Gannett et al., Inc. 1979; Waldstein 1980). With development from primary to tertiary, there is increased control over water supply through greater precision in leveling, division of the area into small polders separated by dikes and canals, and replacement of flood supply of water by engines and pumps. The first tertiary works were developed in 1970 in the delta area of Senegal. By now most of the secondary systems in the delta have been converted at large cost into tertiary systems.

In the lower valley there has been a concentration on larger projects (greater than 500 ha) including the 6,400 ha sugar cane operation in Richard Toll, the 2,000 ha project in Dagana, the M'Pousie project of 1,800 ha, the Gorgol project, and the Nianga project (Boutillier 1980).

For 343 surveyed fields in large projects 43 per cent of average yields were between 3 and 5 metric tons per hectare (T/ha) with 23 per cent greater than 5 T/ha (OMVS 1980a). The returns to labor were 155 CFA/person/day for fields yielding 3-4 T/ha and 338 CFA/person/day for fields with yields of 4-5 T/ha. Only 23 per cent of the plots returned more than 338 CFA/person/day. The overall average yield of large projects is 4.2 T/ha. In 34 per cent of the fields, yields were less than 3 T/ha, for which no positive returns to labor were received (OMVS 1980a).

The size and organization of large irrigation projects are controlled by the sponsoring agency. In spite of some of the advantages of scale, such as more accurate land leveling and soil preparation through the use of machines, the large projects have been characterized by irregular yields and irregular total production. Major causes for this disappointing performance have been poor conception and implementation of projects; poor management by the agencies, especially with respect to their treatment of the farmers working the plots; high maintenance costs; inadequate personnel, machines, and support to carry out the required mechanized tasks; and physical factors such as salinity and losses of birds and insects (Gannett et al., Inc. 1979). The annual cost per hectare for large projects (excluding the amortization and maintenance of the civil engineering work, the overhead cost of the development organization, and the cost of extension) is 76,770 CFAF, or the equivalent of 1.8 T/ha of rice. The total costs are about 3 T of rice per hectare, the difference being subsidized by the

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government or international organizations. The average yield of 4 tons per hectare therefore provides a 1 T/ha net. Such a level of production cannot justify the widespread development of large projects under prevailing conditions (Boutillier 1980, Tuluy 1979, Franzel 1979).

3. Small Irrigation Projects

In contrast to the lower valley, the upper and middle valleys have been dominated by smaller projects, generally 10-50 ha, but with some as large as 150 ha (OMVS 1980a).

Small projects are often conceived of as training grounds for farmers destined to move to large projects. The greater success of small projects economically and socially points to the necessity of under-standing farming systems and the farmers' priorities in implementing development. At the same time, problems of small projects can serve as starting points for AR II SUPPORTING research, and research results of AR II will lead to innovations useful to farmers as they become more involved in irrigated agriculture.

After leveling the fields and building dikes, often with the help of large equipment furnished by development agencies, village cooperatives provide the labor to build the canals, generally under the guidance of the government development agencies. Plots are assigned to the farmers by the cooperative. Supplies are provided by the development agency in return for an agreement by farmers to sell the rice produced in payment for the inputs and maintenance and amortization of the pump (Tuluy 1979, Weigel 1980).

Labor requirements vary greatly due to the novelty of the technology to the farmer and because the size of the plots cultivated is highly variable (Boutillier 1980). Estimates range from 130 person-days per ha for rice grown in Bakel (based on 0.2 ha plots). Table 43 presents the average work time in irrigated rice production as determined in the OMVS Socio-Economic Study (OMVS 1980a). As the technology becomes more widely applied and plots become larger, labor time can be expected to diminish, as it has on the more sucessful plots represented in Table 44.

Available information is consistent in showing weeding, maintenance of the irrigation system, and land preparation as the activities that demand the greatest amount of labor and are ultimately the limiting factors that determine the size of the plots that can be worked by the farm family. An unpublished SONADER study concludes that labor constraints during transplanting limit the farm family to cultivating a maximum of 0.4 ha of irrigated rice. According to an OMVS study, the minimum area required to fulfill a family's consumption needs and debt requirements is 0.4 ha, double-cropped (cropping intensity = 2.0) or 0.5 ha if cropping intensity is 1.5 (OMVS 1980a). Boutillier (1980) estimates that between 0.4 and 0.8 ha are needed, depending upon cropping intensity. Thus far, few irrigation projects have a high percentage of double-cropping and plots remain around 0.25 ha (see Table 45).

Table 43. Average Number of Days Worked in Irrigated Rice Production

	Small Irrigation Projects				Large Irrigation Projects			
	Men	Women	Children	Total	Men	Women	Children	Total
Plowing	25	1	4	30	13	-	4	17(4)
Leveling	13	1	2	16	6	-	1	7
Nursery	14	1	1	16				
Transplanting (1)	32	27	20	79	56	6	28	90
Spreading Fertilizer	2	-	-	2	1	-	-	1
Weeding	32	20	15	67	5	3	6	14
Mowing (2)	23	13	10	46	23	5	10	38
Threshing (3)	33	29	11	73	28	18	14	60
	174	92	63	329	132	32	63	227

Sources: OMVS (1980a), cited in Boutillier (1980:10).

(1) Transplanting includes pulling up the plants, putting them in bundles, transport and replanting.

(2) Mowing includes cutting, gathering into bundles, transporting them and stacking them.

(3) Threshing includes threshing itself, winnowing, sacking and transport.

(4) An exceptional case observed in the Gorgol because in general the plowing is done with tractors on large irrigation projects.

Table 44. Labor Requirements per Hectare, Bakel (Senegal) Irrigation Project, 1979-80 Season

Labor	Worker-Days		Cost (CFA)*
	Rice		
Land preparation	40		10,000
Seed bed	5		1,250
Transplanting	50		12,500
Weeding (hoe)	46		11,500
Maintenance	87		21,750
Harvesting	16		4,000
Threshing & bagging	20		5,000
Total Worker-Days:	264	Total Cost:	66,000
Labor as Per Cent of Production Costs: 59%			
	Maize		
Land preparation	40		10,000
Planting	10		2,500
Weeding & Maintenance	133		33,250
Harvest	17		4,250
Threshing	3		750
Total Worker-Days:	203	Total Cost:	50,750
Labor as Per Cent of Production Costs: 47%			

*Labor valued at 250 CFAF per worker day.

Source: Le (1980).

Table 45. Cropping Intensities Under Irrigation in the SRB*

Mali (ORSTOM)	:	.3
Bakel (SAED)	:	1.36
Matam (SAED)	:	1.34
Aere-Lao (SAED)	:	1.81
Mauritania (FED)	:	.91
Mauritania (SONADER)	:	1.27
Gorgol (SONADER)	:	.50
Guede (SAED)	:	1.89
Nianga (SAED)	:	.84
Dagana (SAED)	:	.84

*1.0 = 1 crop per year
2.0 = double cropping

Source: OMVS (1980a).

Average yields vary greatly on small irrigation projects in the SRB. The average for the valley was 4.4 T/ha, with best results achieved in the zones of Samé-Maghama (5.6 T/ha average) and Matam-Kaedi (average over 6 T/ha) (OMVS 1980a). Salient characteristics of the program in these regions are that irrigated agriculture was first introduced into the valley at these sites; allocation of plots followed the traditional system; the farmers themselves were responsible for project organization; a relatively high density of projects was established; and remittances were used to pay for inputs including hired labor (Boutillier 1980).

OMVS concludes that differences between small projects in yield, given similar climatic and soil conditions, are due to human factors such as disagreements between farmers and the agency installing or managing the projects, absenteeism, problems with traditional social structures, and land tenure conflicts (OMVS 1980a).

Estimates of returns to farming on small irrigation projects vary, depending on the assumptions made about the producer price, yield, and fixed and variable costs. For example, rice produced in the rainy season in Kayes is shown to lose 8,458 FM/ha when sold at the official price, but will return 131,,542 FM/ha if sold at the open market price. Rice in Bakel returns 52,460 CFAF/ha according to Franzel (1979), and 97,300 CFAF/ha according to Le (1980), who assumes an average return of 5 T/ha to Franzel's assumption of 3 T/ha and the figure offered by OPI of 4 T/ha.

Using estimates from the same sources on labor requirements, returns in rice farming per person day in CFAF are: Franzel, 228; Le, 368; and OPI, 414. Higher estimates of labor requirements and lower estimated yields account for the lower returns in Franzel's study. But Franzel (1979) shows that even for the small irrigation projects at Bakel, when all costs, including those subsidized by the government, are included, net economic returns are negative. He attributes much of the poor performance to problems typical of large projects: management problems, stifling of local participation, and pumping inefficiencies.

Pump-related costs account for 17-40 per cent of total costs per hectare of irrigated corn and rice in small irrigation projects. Costs rise greatly during the dry season due to the greater fuel costs of increased pumping of water.

Where returns are adequate, hired labor becomes a possibility. Weigel (1980) has observed that the major innovation compared to the traditional farming system is in the massive employment of paid workers. In certain areas, where emigration is great, remittances sent home by absent village men have been used to hire labor and cover pump-related costs (Boutillier 1980, Waldstein 1978, Bradley et al. 1977, Weigel 1980). The availability of such funds has lowered the risk of involvement with irrigated agriculture.

Small irrigation projects have increased rapidly in area due to increased participation by individuals and groups, high and stable yields, and a high rate of increase of total output. This relative success has been ascribed to efforts of the farmers who have been attracted by the greater autonomy compared with the larger projects (Boutillier 1980, Fresson 1978). This autonomy seems to have made the farmers more receptive to such innovations as irrigation. Unable to afford the least decline in production, they rightly perceive that projects must be adapted to their specific needs, and that only they can insure that this is done.

One of the major limitations to government sponsored development in the SRB has been the high cost of innovations so that the net economic returns are often very low or even negative (Tuluy 1979, Franzel 1979). Even with subsidies, returns are often not large enough to provide adequate incentives for farmers.

Many optimistic estimates of future increases in returns assume increasing efficiency as experience accumulates and economies of scale as the size of irrigation projects and total irrigated area increase. These estimates do not adequately consider the possibility of decreasing efficiency resulting from inadequate infrastructure and management, loss of farmer control, and increasing cost of inputs like fuel, machinery, and commercial fertilizers and pesticides.

Areas proposed for research by AR II are those that would lead to innovations with low initial cost. Local community management is emphasized to minimize recurrent costs of infrastructure (see **Appendix III**).

E. The Role of Applied Research in Development

1. Returns to Agricultural Research

The research proposed by AR II is expected to have net economic returns as results are taken up by extension agencies. The integrated rural development project proposed by OMVS and USAID will coordinate extension work in the SRB and is expected to work closely with AR II. The proposed strengthening of the extension and transportation infrastructure will create an environment conductive to transformation of the traditional mixed crop system into a more intensive irrigated system. Agricultural research has, in the past shown substantial returns to investment. Table 46. shows the results of several studies on the returns to research done under widely differing circumstances in both developed and developing countries. The annual internal rates of return ranged from 20 to 90 per cent. Given the diversity of these research programs, it might be expected that returns to research in the SRB would be at a similar level (World Bank 1979: Vol. 1).

In Africa, however, returns to research have often not been great, and in many cases have even been negative. This is partly because much research was directed toward commercial agriculture and chiefly benefitted

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Table 46 Estimated Internal Rates of Return on Investment in Agricultural Research in Selected Commodities and Countries

Commodity	Country	Study	Period	Annual Internal Rate of Return %
Maize	USA	Griliches (1958)	1940-55	35-40
Sorghum	USA	Griliches (1958)	1940-57	20
Poultry	USA	Peterson (1966)	1915-60	21-25
Wheat	Mexico	Ardito Barletta (1970)	1943-63	90
Maize	Mexico	Ardito Barletta (1970)	1943-63	35
Cotton	Brazil	Ayer (1970)	1924-67	77
Maize	Peru	Hines (1972)	1954-67	35-40
Rice	Japan	Hayami & Akino (1975)	1930-61	73-75
All agriculture	USA	Peterson & Fitzharris (1975)	1957-72	34
All agriculture	Japan	Tang (1963)	1880-1938	35
All agriculture	India	Jha & Evenson (1970)	1953-71	40

Source: Adapted from Ruttan (1977:203).

plantation owners and foreign companies (NAS 1974). A concomitant of this approach was that indigenous systems were considered of little value, and therefore research did not have to consider them.

Lele (1975) examined several development programs in both East and West Africa that were aimed at increasing the economic viability of a neglected region in as socially equitable a manner as possible. An adaptive system of research, in which research units are linked with rural development programs in order to go beyond isolated crop-specific research, was found to be crucial. Such an approach requires that existing research capabilities be reinforced and that channels be established between research and extension to promote mutual cooperation in developing and extending appropriate agricultural technology. The extension services must accent the responsibilities of identifying farm-level constraints upon which research can have an effect. Such guided research, known as the farming systems approach, can improve the existing techniques and result in more effective extension efforts. Achieving this level of cooperation will certainly require research and extension staff experienced in an adaptive approach to development.

The research at the OMVS stations in Kaedi, Samé, and Fanaye thus far has been primarily on-station. The present priorities have been listed in OMVS (1980b) as varietal research, resistance to cold and heat, nitrogen efficiency, crop rotation system, semi-mechanization, and cultural techniques and fertilizer uses. Varietal trials and rotation schemes that could lead to triple cropping of rice have been emphasized. While necessary for the long-range development of the valley, this basic research is insufficient. A program leading to the application of the results of research that has already been carried out in the SRB and elsewhere must be instituted now if those results are to be utilized in the SRB over the next few years of small irrigation project development. Though the three governments have recognized the need for applied research (OMVS 1977:10; for Senegal see ISRA and GERDAT 1977) the applied research components is presently lacking in the overall plan. It is the aim of AR II to provide the necessary applied research within the SRB.

The farmers in the SRB have developed methods of cultivation very specific to their environment and social situation. The scale and scope of operations at the OMVS stations must be relevant to their experience. Research must take into consideration the scarcity of resources at the small farm level, and stress the development of food crops as well as various cash crops.

2. The Farming Systems Approach

In examining the role of the small farmers and agricultural production in Africa, Johnston (1978) observes that farmers will "adopt innovations that they find suitable, profitable, and a low risk." He goes on to say that there is now an urgent need to strengthen the capacity of national and

regional research organizations to generate an 'efficient sequence' of technical innovations that meet those requirements, taking into account the limited purchasing power of the typical small scale farmer.

He asserts that there must be a "systematic study of the characteristics of existing farming systems" within the research program. The implication is clear to him that researchers must work directly with the farmers to ensure that innovations are specific responses to the small farmer's land, labor, and capital constraints; "Providing for a dialogue between farmers and researchers is difficult under present conditions in Africa, but is essential for increasing the impact of research on farm productivity and output."

Such an approach is in line with USAID policy in the Sahel Regional CDSS FY '82 (USAID 1980), which states that the emphasis in the next decade "should be on local adaptative research and on the nature and characteristics of local farming and herding systems, including research in social and economic constraints faced by farmers ... The development of intermediate mechanization technologies is critically needed to overcome a constraint imposed by periods of peak labor demands."

The farming system is comprised of two elements, the technical and the human (Norman 1980). The technical element refers to the technological and biological possibilities that can be incorporated into a farming system. The human element refers to both exogenous socioeconomic conditions (those that are outside of the farmer's control, such as local traditions and organizations, extent and conditions of transportation net-work, input supply systems, and population density), and endogenous conditions (those that are in the farmer's control such as allocation of available labor to various farm enterprises and, to some extent, the choice of crops). Norman argues that farmers have failed to adopt supposedly improved technology because "most conventional approaches to technology development, utilizing a 'top-down' methodology, tend to modify the technical elements to fit crops or animals and to ignore the human element." Farming systems research (FSR) in particular, will increase the potential for selecting the animal or crop most appropriate with respect to both elements. The aim is to increase the overall efficiency of the farming system by developing technology that increases productivity such that the farmers can optimize their returns given their resources and constraints. This technique, requiring close cooperation with the farmers and careful identification of constraints at the farm level, is therefore consistent with Johnston's.

3. Returns to Farming Systems Research

One of the results of the farming systems approach has been the recognition that mixed cropping is more advantageous to the small scale farmer than sole-crop farming (Norman 1980). In studies conducted in northern Nigeria, Norman found that while there was more labor per hectare invested in mixed than in sole cropping, it was much less (10% more) when figured for

the labor bottleneck period of the weeding season than for the whole year (23% more) (Norman 1980). Returns per person hour for the whole year and just for the labor bottleneck period were, respectively, 28 per cent and 57 per cent greater for mixed cropping, showing that mixed cropping helps to alleviate the labor bottleneck problem. The net return per hectare was 32-41 per cent higher depending on how costs or labor were evaluated. Another important advantage of mixed cropping is that it decreases the risks due to unstable yields in an environment characterized by highly variable weather patterns.

The farmers in the SRB have experience with mixed cropping in flood recession culture as well as their regular intercropping of cowpeas with cereal crops. The proposed research program will build on this experience to make more efficient use of the limited available labor.

The use of the FSR approach can also lessen the problems of non-adoption. In Nigeria an improved cotton variety was developed on the research station for which annual yields and annual returns to total hours of labor were greater than traditional (Norman 1980). However, the labor requirements for the crop intensified the existing labor bottleneck. Additionally, the improved variety had to be planted earlier, and the farmers were faced with a conflict between weeding their food crops and planting the improved cotton. Because the researchers ignored the farmers' labor constraints and requirements for food crops, the new variety was rejected.

F. Analysis of AR II Applied Research Program

1. Cost Effectiveness

The usual procedure in evaluating long-term investments is to compare the flow of benefits over a relevant time period with the associated costs through a discounting procedure. As with most research projects, this technique cannot be meaningfully applied to AR II. Neither the long-run cost nor the benefits that might be forthcoming can be estimated with the requisite precision. The potential benefits of agricultural research, and in particular applied research at the national level, were discussed in Appendix II.E. Benefits and costs at the farm level will be examined in Appendix II.F. This section will examine the cost effectiveness of the proposed program; that is, the degree to which it makes efficient use of the scarce resources that will be committed to the project.

a) AR II will use the extensive knowledge of local farmers in planning research at the three stations. Before controlled experimentation begins, Contractor team personnel will familiarize themselves with farming systems in the area. Initial research will be in direct response to problems perceived by farmers and will build on the best of their existing practices.

The exchange between farmers and researchers on the farm will allow for quicker testing under typical production conditions. By this constant evaluation of the farmers' management capabilities and farm-level constraints, the program will not waste time developing inappropriate techniques or inputs. Constant feedback from cooperating farmers who belong to the OMVS development plan's target population will allow for a self-correcting program that should result in readily transferable technologies.

b) The scientists at the stations will be used more efficiently in the proposed project than in the traditional approach. They will use on-farm trials of crops and methods to supplement the more controlled on-station research. In addition, the use of plots of the four major land types will give a wider scope to the scientists' work than would the classical approach and will allow them to focus on directly productive lines of study.

c) Counterpart trainees will be sent to the U.S. for graduate-level training. In order to best prepare the candidates for their academic work, the host country researchers will be required to work for two years with a CID team researcher prior to departure. Following completion of their course work, two years of research experience will be required. This approach maximizes the usefulness of academic training for appropriate research. However, even if they leave the research stations upon fulfilling their requirement, the countries will still benefit from their training. Training at the research assistant and field assistant levels also will rely heavily on in-service training by project personnel at the stations.

d) The training program will take advantage of previous AID and other donors investments in such schools as Hassan II Institute Agronomique et Veterinaire in Morocco for training of technicians, and the ENFVA and CAA schools at Kaedi and Samé for training field assistants.

e) The research program draws upon the results of research done over the past 50 years in the SRB and in other stations in the OMVS member countries. This research has been sponsored by FAC, WARDA, ORSTOM, UNDP/FAO, AID, and others. Pertinent studies have included the testing of rice, corn, and wheat under irrigation, double- and triple-cropping, and pedology and other topics (Appendix I.A).These results will provide the starting point for AR II, especially for ON-FARM and APPLIED research.

f) The program avoids duplication of infrastructure and personnel. The research program is designed around the existing and planned infrastructure in the stations in Fanaye/Guede, Kaedi, and Samé (Appendix I).

The research program will provide researchers with skills that are complementary to those of the experts already on the stations, and will call for cooperation among all researchers in the implementation of the research programs. (Appendix I.B.) for details on team composition and the interaction among the researchers.)

Many bilateral and multilateral donors are providing development assistance in the SRB. Most of their activities have some relationship to our proposed agricultural research program. We examined the donor-funded activities to determine the possibilities for cooperation and/or coordination of efforts. We assume this will be a mutual benefit. The results of our study are summarized in Tables 47 and 48 and described briefly in Appendix VI.

The kinds of coordination and cooperation possible were categorized as:

(1) avoidance of duplication;

(2) exchange of ideas and information about their programs and about ours;

(3) interaction of scientists;

(4) training for project personnel (we will assist in training their personnel; they will assist in training ours);

(5) joint use of research facilities (buildings, land, and equipment);

(6) provision of assistance to each other in scientific or technical specialty.

The status of possible cooperative effort is reported as:

(1) recognized (examination of documents, third-party discussions);

(2) observed in field by Contractor design team;

(3) discussed by CID design team with

(a) project planner(s)
(b) scientist(s) and other project personnel
(c) project administrators;

(4) agreed upon.

2. Farm-Level Analysis

The ultimate success of agricultural research is measured by the effect it has at the household level on the methods, and on quantities

Table 47 Summary of Bilateral Donor Activity in SRB

Country (Agency)	Contribution	Types of Activities	Locations	Possible Coord. with A R II
Belgium	Personnel and expenses	Crop research	Fanaye Richard Toll	Observed
Canada (IDRC)		Improve vegetable crop production	Samé Kayes	Observed
Canada (IDRC/CIDA)		Integrated rural development, agricultural mechanization, literacy training	Noro du Rip (Mali)	Observed, discussed
England	Personnel	Crop research	Fanaye Richard Toll	Observed
France (FAC)	Personnel, funds	Crop research, construction of facilities	Fanaye Richard Toll Kaedi Sotuba, Mali	Discussed, agreed upon
France (FAC/CCCE)		Training irrigation technicians	Ndiaye	Recognized
France (FAC/CCE)		Training technicians small perimeter projects	Matam Aere-Lao	Recognized
France (GERDAT)	Personnel	Planning irrigation development	Kaedi to Bakel	Discussed, agreed upon
France (IRAT)	Personnel, operating funds	Crop research (horticulture)	SRB	Discussed, agreed upon
Holland		Small perimeter irrigation projects	River Region, Senegal	Recognized

Table 47 --Continued

Country (Agency)	Contribution	Types of Activities	Locations	Possible Coord. with A R II
Saudi Arabia and France (FAC)		Livestock production including water resources development, construction of facilities	Kayes	
Switzerland (SENDA)	Personnel, operating funds	Corn production	St. Louis	Observed
Switzerland		Forage research	Guiere Lake, Senegal	Observed
U.S. (AID)	Funds	Irrigation project development	Kayes	Recognized
U.S. (AID)	Personnel, funds	Crop research, construction of facilities (PL 480)	Fanaye Richard Toll	Recognized
U.S. (AID)		Community development, literacy training, day care	SRB	Recognized
U.S. (AID)		Maintenance and repair of heavy and light machinery, training workers and extension agents	Richard Toll Ross Bethio	Recognized
U.S. (AID)		Vocational agriculture training, construction of facilities	Samé	Observed
U.S. (AID)		Integrated rural development	SRB	Discussed

Table 47 --Continued

Country (Agency)	Contribution	Types of Activities	Locations	Possible Coord. with A R II
U.S. (AID)	Funds, personnel	Improve agricultural economics capability	Senegal	Discussed, agreed upon
U.S. (AID)	Personnel, funds	Environmental impact study	SRB	Using their information
U.S. (AID)	Personnel, funds, equipment	Mapping, aerial photography	SRB	Discussed, agreed upon
U.S. (AID)	Funds	Establish machinery cooperatives	SRB	Recognized
West Germany (GTZ)		Reforestation, nursery	Kayes	Observed
West Germany (GTZ)	Personnel, funds	Rangeland, forestry, entomology, construction of facilities	St. Louis Fanaye	Discussed, agreed upon

Table 48 Summary of Multilateral Donor Activity in SRB

Agency	Contribution	Types of Activities	Locations	Possible Coord. with A R II
CILSS	Funds	Crop research (pest control), construction of housing	Fanaye Richard Toll	Observed
FAO/UNDP	Personnel	Crop research	Fanaye, Guede, St. Louis, Kaedi, Samé	Discussed, agreed upon
FED		Small irrigation projects	Kaedi	Discussed, agreed upon
IBRD (World Bank)	Personnel, funds	Crops and farming systems research, construction of facilities	Fanaye Senegal (general)	Discussed
IMPHOS		Phosphate (fertility) trials	Fanaye Rindiao	Observed
IRRI/ICRISAT/CIMMYT	Personnel, funds	Variety trials	Samé	Observed
UNDP/FAO		Seed production	Samé	Observed
UNDP		Maintain agricultural equipment, train mechanics	Matam, Bakel, Aere-Lao	Recognized
UNDP		Farmer training, literacy training, office management	Matam, Bakel	Observed
UNICEF		Well construction	River and Eastern Regions, Senegal	Recognized
WARDA	Personnel, funds	Rice production research	SRB	Observed

and consumption of production. At present, 85 per cent of the population in the SRB are members of subsistence farm families. The subsistence farm produces for its own consumption, with any surplus stored against poor years or sold and bartered in local markets for other essential commodities.

However, even this level of production has been decreasing over the last 20 years due in part to drought, which affects flood recession agriculture through low levels of flooding, and rainfed agriculture through inadequate and poorly distributed rainfall. The drought has increased the large-scale migration of males out of the SRB, especially from the Soninké population in the upper valley (Boutillier 1980, Bradley et al. 1977). This has reduced the effective labor force in the SRB but , because these emigrants send wages home, cash income in the region has actually increased.

Low yields, a shortage of labor, and the capacity to import food-stuffs have prevented the local farmers from benefitting from the increased purchasing power of the region and have contributed to an ever-increasing dependence of the region upon the exterior (Bradley et al. 1977).

3. ON-FARM Research System

The comprehensive research system as described in Sections III.C. and III.C.5 focused at the farm level, is an attempt to increase yields and production without creating unacceptable levels of risks. The approach is that of farming systems research, practiced increasingly successfully over recent years. After identifying bottlenecks in present farming systems, tools and techniques will be developed and introduced onto the farm plots, where further modifications will be made based upon the farmers' experiences.

Results of the research will reach a large population by virtue of building upon the traditional agricultural system. The use of wells as sources of permanent and supplemental irrigation will be encouraged. This allows for easy, immediate extension of irrigated farming to the uplands, presently neglected in farming research. At present, irrigation projects are concentrated on the levees, which are subject to traditional land use regulation and are limited to 30 to 5,000 ha each in the SRB (Weigel 1980). Use of the uplands is less restricted by land tenure traditions than is the case in other land types. In flood-free areas there will be the advantage that protective dikes, presently a great expense on small-scale development schemes, will not be necessary. The ability of the farmers to accept only those elements which they perceive as advantageous to them will lower the risk of adopting innovations and will allow the farmers to tailor improvements to respond to the constraints under which they are presently operating.

Le made estimates of the labor requirements of the system using animal-powered water lifting devices proposed for development by AR II and compared them with those under small-scale pump irrigation at Bakel (Le 1980). The labor requirements of the farmer are only 29 per cent of that of the pump-irrigated plots. In fact, a farmer could cultivate 3 ha using the

ON-FARM system with less labor than on a plot with a motorized pump. Total labor requirements for 3 ha would be only 86 per cent of those for 1 ha using methods presently employed at Bakel.

The present small-scale irrigation schemes often allow only specific crops (usually rice), at a fixed price that is often considered inadequate by the farmers. The farmers are often forced to produce rice to pay off debt they have incurred. The ON-FARM research system will allow for greater flexibility in cropping patterns. The farmers will be able to choose a mix of cash and food crops according to their own evaluation of the economic environment.

4. Animal Traction

Johnston (1978) refers to the use of animal draft power as "the most promising means of modifying existing farm system." The research program will test plows, seeders, and other animal-drawn equipment as well as animal-powered pumps.

In using oxen instead of engines as the source of power for raising water, the farmer is less tied to external, expensive inputs such as fuel, machine parts, and knowledge of complex machinery. Additionally, whereas the engine depreciates rapidly over a period of three to five years, "the costs of rearing and maintaining animals are largely internal" (Johnston 1978). The oxen appreciate in value over the time the farmer uses them (until they die, or are sold), and the farmer is able to feed them crop residues available locally. However, if every farmer has oxen, the crop residues may not be adequate. If properly handled, manure can be a valuable addition to the soil. Franzel (1979) estimates the appreciation of oxen at 28,000 CFAF/year in Senegal. The use of an internally maintained technology allows for greater independence of the farmer. In minimizing reliance upon external inputs, the farmers lessen their risk of incurring debts.

Animal traction, coupled with machines specifically developed for use in various soil types, may reduce overall demand for labor. "The use of livestock for draft power will not only ease seasonal bottlenecks but permit fuller year-round utilization of the available labor force in productive activities because the patterns of labor demand tend to be more complementary than competitive" (Johnston 1978). We have concern about feed for the animals and point out the need for investigation of feed sources.

5. Multiplication Effects

There are over 1.5 million people in the SRB. Over a million of them are involved in subsistence farming. These million people are those who can potentially benefit from the proposed research of AR II.

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Demonstration effect: The ON-FARM plots will provide an opportunity for the farmers to see the results of adopting various tools and techniques to their own systems of farming. As the system will be developed so that it can be adopted in part or as a whole package, the farmers can calculate risks and judge the innovations accordingly. Positive response by the farmers can lead to the spread of the techniques considered successful by other farmers, and can create a demand for the tools developed. The tools will be simple ones that the local artisans can fabricate on demand. Though limited, the spontaneous nature of such adoption of tools and techniques can do much to prepare other farms for the work of the extension agencies.

Extension effect: The final implementation of the results of the research in this program will not be limited by reliance upon the demonstration effect among the farmers near the test plots. The results will be taken up by the extension agencies within the SRB and will also be an important foundation for the proposed OMVS/USAID integrated rural development project. Though extension has been difficult in the SRB, the development agencies are gaining experience and flexibility in their approaches to extension. An article in Le Soleil (May 31, 1980) discussed the weakness inherent in former strategies of small irrigation project development and outlined a new approach on the part of SAED, in which farmer organizations would be responsible for expressing the needs of the farmers:

Here, the training program will be worked out in cooperation with the farmer organizations instead of being imposed. Agents in direct contact with the farmers will complement and be capable of listening to them and proposing solutions that will be adapted to the problems of the rural world. In effect they will be agricultural advisors. There will exist at the farmers' level a technician elected by the members of the cooperative or the group, the same as the president or the treasurer.

This sort of commitment will provide an improved vehicle for the utilization of the results of the research program. The project will work with the development agencies to ensure adequate understanding of the nature, advantages, and limitations of innovations developed by AR II.

Ultimately, the returns to farmers will rely upon the increased marketing efficiency of the region to ensure that there will be a high enough effective demand to provide incentives to the farmers. The increased incomes of the families in the SRB will stimulate demand for goods and services within the region and increase the flexibility of the production system as demand for vegetables and other products rises--an event which often follows a general rise in income.

As the quantity and variety of foods consumed increases, a general improvement of health and productivity of the SRB population can be expected.

With proper incentives, production in the SRB can be used to reduce the heavy burden that the imported food, especially rice, places upon reserves of foreign exchange. From 1961 to 1975, rice imports averaged 10 per

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cent of the value of annual export earnings. Food imports were 25.5 per cent of total imports into Senegal for the period 1973-1977.

The concentrations of investments in the SRB has been justified in that "rates of return would be acceptable on a national basis when income distribution weights are given to the benefit streams" (World Bank 1979; Vol. 1).

The AR II program is aimed at giving small farmers control over their productive resources, and thus supports such an investment strategy.

Table 49 Projection of Expenditures by Fiscal Year (US $000), OMVS Agronomic Research II (Phase II)

Fiscal Year	AID *	Title III	Host Country	Other(s)	Total
1980					
1981	2,432		900	200	3,532
1982	2,954	524	400	200	4,078
1983	2,835	1,700	400	200	5,135
1984	1,535	422	400	200	2,557
1985	1,563	262	400	200	2,425
1986	1,533	267	400	200	2,400
Total	12,852	3,175	2,900	1,200	20,127

* Does not include contingency, inflation, or pre-project request, or Phase I expenditures.

Table 50. Summary Cost Estimate and Financial Plan (US $000), OMVS Research II (Phase II)

Source	AID Title III Funds FX	AID Title III Funds LC	AID Title III Funds LC	OMVS Member States FX	OMVS Member States LC	Other(s) FX	Other(s) LC	Total
Technical Service	5,740					1,080		6,820
Operation and Maintenance		891	1,309					2,200
Training	308		314			120		742
Construction and Improvements		2,284	4,438	500				7,222
Agricultural Equipment	250		100					350
Irrigation Equipment	150		100					250
Vehicles	125							125
Labor Personnel				2,400				2,400
Total	6,573	3,175	6,261	2,900		1,200		20,109

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III. Social Soundness

The agricultural research plan for AR II has been developed with the goal of improving the quality of life of the SRB farmers foremost in mind. It is sensitive to the fact that the research organization must itself function within a complicated social structure, and that research results will only be useful if they can be adopted by farmers using their present system as a starting point. If benefits of research are to accrue to the farmers, then research design must grow from understanding of and communication with farmers.

There is growing awareness that agricultural research in West Africa has had little impact because it was done without considering agriculture as a system that includes environmental, technical, economic, and especially social components (Norman 1980, NAS 1974). By contrast, the AR II research plan takes a farming systems approach which has been outlined above (Appendix II.E.2)

The goal of AR II is to improve the quality of life of the SRB farmers: benefits should accrue equitably, existing farming systems should be a resource on which to build , and should be manageable at a household and community level. Several assumptions have been made about how best to assure this goal is fulfilled. While our research approach is based in part on these assumptions, our program also calls for the treatment of these assumptions as hypotheses for testing. The net social impact of the research will be positive. Negative factors will be minimized by including their study in the research, and by making the research plan responsive to feedback (see Section VI).

Social and institutional analysis of implementation of the research program itself is largely covered in "Administrative Analysis" (Appendix IV).

A. Assumptions

In this section we will summarize the three major social assumptions (equity, farming systems, and community management). In following sections we will justify these assumptions and discuss the feasibility and impacts of the research plan.

Benefits should accrue equitably to all segments of the SRB farm sector. A good understanding of population distribution, ethnic group differences, caste structure, household structure, population dynamics, and political organization is required in order to assure equal access to the benefits of the agricultural development. Discussions by Contractor team members with selected farmers in the SRB confirms the common perception that their major needs are felt to be more food and potable water.

Existing farming systems are a resource for research. The AR II approach starts at the farm level where current systems are analyzed and problems, as perceived by farmers and the Contractor team, are determined. Agricultural experiments are designed to produce results that can be combined with the best parts of the existing system. In implementing the results, farmers can be given the choice of individual innovations and not presented with a package. Farmers would be able to adopt new practices when they think they will result in a long run net increase in production. Consideration of the risk involved in the highly variable environment is an important factor in their decision-making.

To assure the adoption, spread, and continued use of innovations they must address the needs perceived by the community itself and be suitable for development and management by local communities. We proposed to work with the communities near each station in developing our research. Initial work by all researchers will require thorough familiarization with local agriculture and social systems, and their continuing research will be oriented toward these systems. ON-FARM research will directly involve only a few farmers, chosen through the local community structure. These farmers will become a focus of attention, however, involving many other people in discussion of the work they do in cooperation with the University Contractor team. By working with farmers in this way, the products of research will be appropriate, so that farmers will be motivated to adopt suggested practices.

B. Social Structure: Assuring Equal Access

The research plan of AR II is designed to maximize equality of benefits to all segments of SRB society, ethnic groups, castes, and age and sex groups. Much agricultural research has led to development which has been inappropriate for small scale farmers and has therefore tended to be unequal, favoring the large scale farmers and putting the smaller scale farmers at a disadvantage. This has too often been the case with the "Green Revolution" (Norman 1980, Wade 1974, Greenland 1975).

The AR II research program focuses on improvements that can be adopted by the majority of farmers, so that greater disparity in standards of living will not be encouraged. Within the large area of the SRB the Project concentrates on the riverine zone where the great majority of the population resides. In selecting communities and farmers to cooperate, especially in the ON-FARM portion of the research, it is essential that the household, ethnic, caste, and political structure of the society in the vicinity of the research stations be well understood. It will be advisable to select farmers from different groups. Research in this area will begin as soon as possible.

1. Population Structure and Dynamics

The size, growth, and structure of the population of the SRB are essential factors to be considered in the development of agriculture and irrigation in the SRB (cf. Boutillier et al. 1962:52).

The major demographic forces in the SRB today are rapid population growth and migration. Decreasing mortality with sustained high fertility has led to rapidly growing populations with a large proportion of young children (see Table 51). Emigration of adult males has led to a population with lower ratios of workers to dependents, many more women than men in the middle ranges, shortages of agricultural labor, and high rates of urbanization.

These demographic factors affect access to development benefits in many important ways. A rapidly growing population without adequate rural economic opportunity leads to increased emigration, which in turn can reduce productive potential at home, though it increases cash flow through remittances. Different ethnic groups may grow at different rates, possibly increasing tension between groups in proximity. The age and sex structure of households and the population as a whole determine the proportion of consumers to producers and the potential contribution of different groups to agriculture. The large number of children in a labor intensive farming population makes a contribution to food production. The large proportion of women in the middle age ranges created by male emigration has led to changes in their agricultural and domestic activity. Shortages of agricultural labor also lead to increased use of hired labor and substitution of purchased for produced food.

a) Population Growth, Health, and Nutrition. While the major cause of population growth in recent decades in the SRB has been declining mortality, mortality rates remain high. Infant and child mortality rates in particular, are especially high, as in most African populations (Adegbola 1977, Boutillier et al. 1962). The major cause of this high mortality is malnutrition and infectious deseases, which exacerbate each other (Dillion and Lajoie 1980).

The high mortality rates not only represent great human suffering, but are a major drain on scarce resources of time, food, and cash in treating sick children and losing so many before they become productive community members.

Malnutrition in adults, especially during the weeding season when demands on labor are the highest, can lead to lowered productivity.

AR II concentrates on food crops for local consumption. The improved productivity which should follow the dissemination of research results

Table 51. Population Dynamics in the OMVS Member Countries (OMVS Etude Socio-Economique, Avril 1980)

	Population Estimates		Population Growth Rate (%)	
	Senegal River Basin	Total National (Millions)	Senegal River Basin	Total National
Senegal	510,000	5.1	1.7	3.2
Mali	840,000	6.0	1.8	2.6
Mauritania	256,000	1.6	1.5	2.7

will lead to decreased mortality by directly improving nutritional intake. While cash crops for export can lead to higher cash incomes, there are many instances in which they do not improve, but rather lower, nutritional quality of the diet. Results of the research will lead to increased production that will decrease the high mortality and morbidity rates. Improved health will help to form a basis for increased agricultural production.

b) Migration. Migration has been an important demographic force in the SRB for a long time. The transhumance of the herding peoples follows the seasonal cycles of vegetation and water availability and is discussed below (Section 10.3). Emigration to cities in the SRB, to member state capitals, to France and its ex-colonies in West Africa, was established during the colonial period. Decreasing economic opportunity, accentuated by the recent drought, has reinforced this pattern. This movement out of rural areas to find alternative ways of making a living has affected the Senegalese and Mauritanian areas of the SRB the most, where 25% or more of the riverine village population may be absent (Nelson et al. 1974, Bradley et al. 1977). In Mali this figure is only about 4% (OMVS 1980:A. II.13).

The drought-related impact on river basin emigration cannot be easily reversed. While the urban drift intensified during the Sahelian drought, there was only minimal return movement accompanying the return of normal rainfall.

Remittances from migrant laborers contribute significantly to the local economy, although the pattern varies throughout the valley. From the upper to the lower valley, the proportion of the population that has migrated to the urban centers and other parts of Senegal and Mauritania increases. At the same time, remittances from the workers who have left the upstream region are much greater than from those who have left the downstream region. The potential for wealth accumulation, therefore, is much greater as one moves upstream. Repatriation per inhabitant over a one-year period was found to be 40,000 CFAF in the Soninké zone, 10,000 CFAF in Matam, and less than 1,000 CFAF near Podor and Dagana (OMVS 1980a:B.III. 18).

c) Urbanization. The movement to cities and large towns is an important factor in the SRB as in the rest of West Africa.

Annual rates of growth for cities within the SRB have far exceeded that for the general population: in Senegal between 1957-58 and 1976 they grew at a rate of 6.1 to 8.1% and in Mauritania between 1961-62 and 1977 at an average of 5.8% (OMVS 1980a:A.III. 2-3). Among the major ethnic groups, it is the Toucouleur of the middle valley that are most affected. A survey in 1957 found about 25% of men 14 years or older having migrated outside of the valley, while very few women had left (Boutillier et al. 1962:242-43). Dakar is the most popular place to which to migrate, with an estimated 100,000 Toucouleur living there in the early 1970's (Nelson et al. 1974:71).

d) Emigration to France. The sub-Saharan African labor force in France in 1973 was estimated at 70,000 of which 75% were Soninké from the SRB (Nelson et al. 1974:75). There is a heavy concentration of emigrants among males living in villages along the river where an average of 35% of the population is absent (Bradley et al. 1977:51-52). Is has been from 1960 onward that much of this growth occurred. This migration is normally long term, with the migrant leaving his family at home.

In 1975 France adopted a policy of no longer admitting new migrant workers. This could have a major impact in the medium to long term in areas most dependent on migrants' remittances. The most important question becomes therefore not the anticipated patterns of outmigration, but the absorption of the returning migrants into the economic system. Emigration has not meant the abandonment of agriculture production in the area, but has rather permitted the current productive population to remain in place under adverse conditions while supplementing their incomes from outside sources.

e) Migration, Agriculture, and Development. Adaptation has been made to accomodate the long tradition of young male migration. As noted above, much agricultural work is done by lower caste salaried laborers and leaseholders. Women have become involved in the production of basic subsistence and commercial commodities, and migrant workers from outside the region have increasingly contributed to agricultural production.

The remittances migrants send home have a great impact on the economy of the SRB. One study showed that for Mauritania as a whole the average annual total remittances reached $6.5 million in the early 1970's, an amount greater than the average annual amount received in aid and loans between 1963 and 1968 (Bradley et al. 1977:54-55). Although most migrants hold low paying, menial jobs they are under pressure from migrant peer groups and their kin at home to send as much as possible (Bradley et al. 1977:57).

Remittances are commonly controlled by the elder males of the village, themselves returned veterans of the rural exodus. This may allow a greater control over the fruits of the labor of the migrant workers than would be possible in case where the migrant, if living in the SRB, was farming independently.

The increased amount of cash in the SRB as a result of remittances has tended to raise bride prices increasing the flow of wealth from younger men to older men. At the same time, however, younger males and wives of the household may also gain more autonomy through use of their share of the remittances (Weigel 1980, Bradley et al. 1977, Nelson et al. 1974:103).

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In addition to the purchase of consumer items such as transistor radios, personal investments such as cattle, and community projects such as construction of mosques, remittances play an important and direct role in agriculture. The money is used to compensate for the migrants' lost labor by purchasing food and hiring labor. It appears to have also become increasingly available for investment in long term development, for example wells or irrigation projects (Bradley et al. 1977, Weigel 1980).

While a major goal of development in the SRB has been to decrease migration (Diagne 1977, OMVS 1980b), past experience has shown that there are differences in response to labor demand of river basin development schemes, and it is unclear whether or not these projects will necessarily lead to an increased standard of living for SRB residents. It may be that the large perimeters could increase emigration by decreasing the options of farmers. One study of two settlements in the middle delta reports that because of low yields and underemployment in off-season tomato production, farmers become itinerant dry season traders, or permanent migrants to towns returning only to supervise the cultivation at critical times of the year (Waldstein 1980). By developing regional centers SAED was to slow down the population movement to urban areas (Diallo 1975). Instead, as a result of its tenure relationships, SAED's delta projects actually encouraged migration.

Even with successful agricultural development, migration may continue to be significant. Among the Soninké of the upper valley for example, income from irrigation agriculture does not yet exceed that to be gained from illegal migration to France (Weigel 1980). This brings up the importance of "pull" factors attracting migrants way from rural areas. The increasing independence of young people and the continuing attraction of city life will continue even as the "push" factor of limited economic opportunity is reduced.

If agricultural opportunities in the SRB are made attractive enough, it may be that the tide of migration may be stemmed and there would be a swell of return migration. The effects that this might have on development in the SRB are difficult to predict, and will be a subject of AR II research on community and household structure. A greatly decreased proportion of absent males would alter the present position of senior males who control remittances. It would also reduce the need for hired labor and women in staple crop production. The AR II research program is aimed at producing results that will increase productivity under irrigation in organized projects and by individual families, using supplemental irrigation. This will encourage investment by returning migrants, and help insure production adequate to support a larger population.

2. Ethnic Groups

Among the six major ethnic groups in the basin, subsistence food production is the primary economic activity, with 85% of the rural basin residents and many urban residents participating in subsistence agriculture. Most of the people in the river basin are sedentary, especially in Mali and

Senegal, and Mauritania has recently experienced a dramatic shift from transhumant herding to sedentary farming. The drought has played a critical role in destabilizing much of the traditional economic activity of the region, creating increased uncertainty of production.

The three research stations included in the project are located from the lower middle (Fanaye) to the upper (Samé) area of the river basin (see Table 52). The projected spread of research results is thus expected to eventually apply to peoples along the whole river basin. From St. Louis to the site of the Manantali Dam, there are four major groups of sedentary cultivators living in the Senegal River Basin. Proceeding up river from the delta, they include: the Wolof, the Toucouleur, the Soninké (also referred to as Sarakole), and the Manding. They live in villages of as many as 1,000 people which may be a century or more old. In addition, there are Peul (*) and Maure scattered throughout the area, who are traditionally transhumant herders, following established north-south seasonal routes to provide water and forage for their cattle. Increasingly, the Peul live in semi-permanent settlements, sometimes with minimal travel by women and young children.

While members of different groups have home areas where they form the majority, they are often intermingled, especially where their home territories overlap, but they retain a distinct group identity. Except for some residual hostility between the Maure herders and the settled farmers, explained by the importance in the traditional economy of the former of raids on the latter, there is little overt ethnic tension (Curran and Schrock 1972:51-52).

While the groups maintain their distinct ethnic identity, there are abundant social contacts, some of which are formalized as in the "joking" relationship (Nelson et al. 1974:78-79). Many groups share some common origins and their history has involved extensive intermarriage, which in some cases may still occur, as between Peul and Toucouleur (Nelson et al. 1974:71, OMVS 1980a:B.I. 40). Economic contacts are common, particularly in the form of barter between herders seeking grain and agriculturalists interested in milk and meat products.

3. Castes

A persuasive system of stratification into castes traditionally characterized the major ethnic groups in the basin (Nelson et al. 1974:83-103). People have been divided into three strata: free people, including rulers and cultivators; largely dependent artisans, including musicians; and

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(*) The Peul call themselves Fulbe (singular Pullo) or some variant of that name. Outsiders usually refer to them as Peul in French-speaking countries and Fulani in English-speaking countries. The related Toucouleur and Peul are sometimes grouped together under the name Halpulaar (see OMVS 1980a:A.III. 9).

Table 52. Distribution of Ethnic Groups in the Senegal River Basin (based on Nelson et al. 1974, Curran and Schrock 1972, OMVS 1980a, Boutillier et al. 1962)

Area	Research Station	Dominant People	Secondary People
Upper Valley	Samé	Soninké, Manding (Kassonke and Malinke)	Bambara, Peul Toucouleur
Middle Valley	Kaedi Fanaye	Toucouleur	Soninke, Peul, Maure, Wolof
Lower Valley and Delta		Wolof	Peul

slaves. Membership was fixed by birth and there was little or no mobility, although the castes complemented each other economically and there was probably little difference in living standards. Cultivators were considered noble everywhere, except among the nomadic Peul and Maure.

Colonialism and subsequent independence have led to modifications of the caste system. Members of the slave castes are legally free, but the social stigma remains and some continue to pay tribute to their masters. Toucouleur society is the most complex and has remained largely unchanged, especially in the Fouta Toro. The Wolof, whose colonial experience was more intense than that of the other groups, and whose caste system was less rigid, have adapted more easily to modernization. There is little marriage across caste lines.

With the emergence of a money economy and greater links to the rest of the world, there were increasing opportunities for lower castes to obtain new status and wealth through local jobs outside of the traditional economy and through emigration to Dakar and other parts of West Africa and Europe.

Benefits from irrigation schemes are available to interested members of all castes at the local level. Where land has been appropriated by a government development agency they can acquire direct access to flood recession land now under irrigation that was formerly denied to them because of the caste system (see e.g., Schmitz 1980). Along with migration, this produces an opportunity for upward mobility for members of "lower" castes. Some of those who were once members of the lower castes have gained leadership positions in the irrigation bureaucracy.

The recent social and economic changes occurring in the SRB have also sometimes led to greater inequity, by allowing members of the traditionally "higher" castes to gain even greater control over the new resources. Those not normally involved in agriculture production, including the clerical caste, local merchants and businessmen, may be allowed to accumulate land in excess of the standard allotment. There may be a decline in productivity.

With excess accumulation of prime agricultural land requiring more than family labor capacity, a new underclass of share croppers and wage laborers may be created. The emergence of this dependent class structure could nullify any gains in upward mobility experienced by other groups. Thus, changes in the structure of agricultural production which have been a part of the social transformation in the twentieth century have reinforced some of the existing structures which have traditionally limited access to resources. Instead of access being based on hereditary class membership, it may more and more be based on economic position, but the result is the same.

The approach of AR II is to aim for research results that will be as equally available to different ethnic groups and castes as possible, and which will not exacerbate traditional inequities or create new ones. This will be achieved through the emphasis on low cost innovations that can be combined gradually with present farming systems. Supportive research will emphasize small irrigation perimeters because farmers there retain more control over production and existing inequities in access to land can be reduced (see Appendix II).

10. Land Tenure

The land tenure system throughout the basin is quite complicated, closely related to the caste and ethnic structure, and has important implications for the access to resources and distribution of benefits among the basin residents (see OMVS 1980, Bradley et al 1977). The current system is characterized by many small plots which make up larger family holdings.

A complex system of rents and tithes has developed for the rich flood recession lands. These relationships have declined in importance due to the lack of extensive flooding over the last ten years. By contrast, tenure rules concerning the uplands, dependent on high erratic rains, are generally more casual. A token fee is usually collected for their use, but there is no implication of transfer of ownership.

Among sedentary farmers in the SRB, farming is a high status occupation and is considered proper work for high caste persons, while herding people traditionally denigrate the very act of farming. Member of lower castes often own no land, and are commonly found as laborers or leaseholders on the lands of higher caste families.

Household land-holdings are managed by the male head of the household. All men in a family are assigned plots for their own direct use for food cereals like millet, sorghum, and rice, and for commercial crops such as peanuts. The harvest is their own, to be dispersed in subsistence consumption or on the market, within the constraints of contributing to family security. Over time, particular individuals develop personal ties to particular pieces of land. Property remains a trust, as the basic resource to be passed to future generations.

At any time some land of any family may be out of production, because of lack of labor or the competing demands of other agricultural activities, or to renew fertility by fallowing. Formal leasing arrangements may be used, with payment made in cash or kind, for more attractive parcels.

However, less desirable lands are also liable to use. Would-be farmers are obliged to inform the head of the land holding family of the intention to cultivate. A token payment is commonly made as a sign of respect for the family head. There is no implication of transfer of ownership.

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Herders must leave the river during the rainy season to avoid animal damage in the fields under cultivation. After harvest, as water sources distant from the river dry up, they return to the river for water and to graze their herds on crop residues left in the flood recession fields from recently harvested grain.

Tenure and Agricultural Development. Despite the gradual modification of the traditional caste system, the proscriptions against land alienation among the farming people of the region offer slight promise for altering these land-holding patterns outside of wholesale reorganization such as occurs with the establishment of village irrigation projects, which themselves create much social disruption.

The river bank and flood plains are highly prized and are the core of the existing agricultural system. To the extent that these lands are lost to government developed plots or research stations, social disruption may occur (see Appendix III.D.2).

Utilization of the levees, on the other hand, incorporates fewer social implications because land there is relatively abundant. Although the sandy soil requires much water, experience has shown that with careful water management, the economic return of these parcels can be improved. If production is good on the levees, this may further decrease land pressure on the flood plains, permitting larger scale development on these lands at a future date, and with less social tension.

Because access to land is traditionally unequal, amounts of land owned by families can vary independent of their need for it. Landless laborers are an integral part of crop production throughout the basin, particularly in irrigation projects and near urban centers such as Kaedi. In Mauritania in particular, landless slave castes continue to work the fields of the powerful landowners.

Continued interest in river basin development has resulted in increased intervention by the state in terms of land holdings. Senegal, which is the most dependent of the three OMVS countries on the promise of the SRB, has done the most agricultural development there in recent years, through SAED. A 1964 law gave the government the right of eminent domain over most rural land in Senegal. In Mauritania, opposition led by land-holding religious leaders has prevented any such legislation. Malian law is comparable to Senegalese law.

The 1964 land reform law in Senegal has not yet been fully implemented in the River Region, but is scheduled to be in conjunction with OMVS developments. The law provided four classifications, two of which may be applied to the river valley with quite different results.

1) Certain areas may be declared "pioneer zones" in which the title to the land is vested in the development agency assigned to it, as in SAED projects.

2) Areas may be classified "homeland zones" in which the title accrues to any farmer who cultivates the land two years in a row; it is not heritable or salable. Local political control is assumed by a rural council composed of civil servants and village representatives.

Implementation of either system breaks the historical link between the family and the land which is the basis for local social organizations, and is one of the major factors holding yound people in rural areas.

In Mauritania, there is no land reform law, but the government responds in a similar manner. For development of large irrigation schemes such as at Kaedi, the state becomes the land owner, and everyone else becomes a wage laborer. Small perimeter development in Mauritania, however, focuses on the levees with relatively little disruption of existing practices. The land owners agree to land allocation patterns through consensus decision-making once they realize that they retain ownership of land holdings within the irrigated area. For the few scattered small-perimeters in Mali, the government has rights of appropriation, but so far has not used them.

Large scale state irrigation schemes generally reinforce the alienation of certain groups through one of three forms:

1) "State Farm" approach with a salaried work force with no control over production decisions. This is not successful economically, encourages the formation of a large seasonal labor force, and disrupts the traditional social unit of production and consumption leading to conflict.

2) Tenant production in which a tenant is obligated to cultivate a certain crop. A fraction of the harvest may be used to pay for inputs or each tenant may contract his debt repayment schedule.

3) Cooperative organizations promoted particularly in Francophone West Africa provide few benefits to the tenant, but rather facilitate the administration of the systems.

When large scale irrigation projects are close to urban centers, business men and merchants often become landowners who employ a seasonal migrant force to work in their fields.

The emphasis on small scale irrigation in the AR II research program, especially in SUPPORTIVE research, is based in part on the experience that shows that farmers are able to maintain control over production and that tenure arrangements can become more equitable. The economic reasons for favoring small perimeters have been presented in Appendix II.

Small irrigation schemes in rural areas generally permit the local social systems to maintain control over the production system. Equal access to this land is generally assured by the development agencies permitting formerly landless peasants in the traditional system to acquire this valuable resource. Inequities in access remain, but generally to a much lesser degree than in

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large scale schemes, or in traditional agriculture. By developing systems to increase production on rainfed land through the use of wells, AR II will give the poorer farmers who do not have access to flood recession fields the means to procure more of their own food rather than work for wealthy landowners.

5. Lineage and Household Organization: The roles of Men, Women, and children

The household or the extended family is the basic unit of production and consumption in the SRB, and is a lower order division of the lineage system. With the exception of the Wolof, who have both matrilineages and patrilineages, lineages in the SRB are patrilineal.

Clan members tracing their lineage through male (or female) lines of descent form corporate units which perform political and economic functions. In larger villages, several lineages compose a clan. Each lineage is headed by the oldest male member who manages lineage land. Within each lineage there are several households, each of which work land in common. Lineage ties among the migratory herding societies like the Peul are weaker.

Throughout the region, men are traditionally responsible for production of the staple grains. Women work vegetable plots which provide an important addition to household nutrition, and are also used for barter and sale. Women also have their own fields where they traditionally produce such crops as cowpeas, rice, sorrel, peanuts, cotton, and indigo (OMVS 1980a, Fieloux 1980:11, Bradley et al. 1977:114).

Wolof women have more economic independence and are more involved in vegetable production for sale than are Soninké or Toucouleur women. They are also more involved in cereal and peanut production, working plots on which they have established rights of production, and profiting from the fruits of their labors as they contribute to the economic well-being of the family.

Although not generally taking part in the heavy labor of land preparation or in overall management, women have become more and more involved in staple crop production as men have not fulfilled this task. This has often been at the expense of women's traditional role in vegetable gardening.

About one-half of the population in the SRB is less than 15 years old, and these children make a significant contribution to agricultural production. A large portion of this contribution is devoted to guarding fields from birds and domestic animals. This is an important task, especially well-suited to their relative lack of strength and skill.

Table 53 shows the contribution of men, women, and children to agricultural production in the SRB. It shows that women and children together contribute about one-half of the total, under varied conditions.

Table 53. Division of Agricultural Labor by Age and Sex

	Men	Women	Children[1]	Total	Location	Date	Source
				Traditional			
Days per ha per year	82.4 (53%)	341. (22%)	39.7 (25%)	155.9 (100%)	Middle Valley	1958	Boutillier et al. (1962:106-111)
Total days per production unit per year	215 (51%)	91 (21%)	114 (27%)	423 (100%)			
Total days per production unit per year	46 (23%)	54 (27%)	102 (50%)	202 (100%)	Bow, near Matam (Toucouleur)	1979-80	Fieloux (1980:10)
Days per person per year	21	18.5	102				
				Small Irrigation Projects			
Total days per production unit per year	96.8 (52%)	42.1 (23%)	48.2 (26%)	187.1 (100%)	Bow, near Matam (Toucouleur)	1979-80	Fieloux (1980:10)
Days per person per year	44	14.5	48				
Days per crop (irrigated rice)[2]	174 (53%)	92 (28%)	63 (19%)	329 (100%)	SRB irrigation projects		OMVS (1980a)
				Large Irrigation Projects			
Days per crop (irrigated rice)[2]	132 (48%)	32 (14%)	63 (28%)	227 (100%)	SRB irrigation projects		OMVS (1980a)

[1]Children are males and females under 15 years of age.

[2]Time spent guarding crops, mostly done by children, was not included in this study.

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Much of women's and children's contributions to the family economy is in food preparation such as hauling water and wood, threshing, winnowing, grinding, and cooking. Innovations that reduce time necessary for these tasks would increase time available for farming. AR II research includes testing and development of inexpensive, appropriate food preparation devices such as driers, shellers, winnowers, and grinders.

a) Women in Development in the SRB. When given the opportunity, women do seem eager to participate in irrigation projects on their own plots. One study of Soninké women in Bakel showed that in a sample of 19 households women produced as much under irrigation as under traditional rainfed and flood recession fields (Weigel 1980). In this sample with a large proportion of male migrants, the women produced 1100 kg per household under irrigation compared to 1500 kg for men. On flood recession and rainfed fields the production figures per household were 1050 kg for women and 1250 for men.

In a SAED irrigation project in the middle valley women spontaneously organized a production group for dry season production of tomatoes under irrigation, when men proved not interested (Waldstein 1980).

A study of the Toucouleur at the Matam irrigation project where plots were assigned to families, and women were not given individual plots, showed women's labor input to be much less in irrigation than in traditional farming (see Table 53). (Fieloux 1980).

Comparisons of labor input in rice production between large and small irrigation projects in the SRB showed women's contribution at 28% of the total in small perimeters, but only 14% in the large perimeters (see Table 53). (OMVS 1980a, in Boutillier 1980:10).

These data suggest that when women's traditional roles in food production are explicitly recognized in development projects, women can make a large contribution to increase production, but that when their roles are limited, especially in the large perimeters, it may be much reduced with the increased labor demand of irrigation, women may be called upon to contribute more labor to the production of staple and cash crops on family fields controlled by the household head. This is especially true when large numbers of adult males are absent due to migration. This may not only mean a loss of some economic independence for women, but to a negative effect on family nutrition as vegetable production and gathering activities decline.

The involvement of women in agricultural development is already underway in the SRB. Several projects in Senegal have focused on building pre-cooperative village organizations as a basis for increased social and economic activities. Goals have been to increase rice, vegetable, and poultry production. One project was initiated by a young Senegalese female agronomist

(USAID 1979). Within the OMVS area several projects emphasizing women's participation are currently being proposed or are underway (see Appendix VI).

Other programs for Senegalese women have focused on alleviating the burden of women's daily tasks by the introduction of mills and decorticators. If women are spending less time on housework, they may choose to become more involved in agriculture, especially cash cropping.

With many of these projects, the women are actively deciding and acting on their own needs, not simply receiving benefits from the government. For example the Federation of Women's Associations of Senegal has created a commission charged with seeing to the enhancement of cooperative, egalitarian relations by rural and urban women.

In the government of Senegal, there is a new position, Minister for Human Welfare, which is concerned with the development of the capabilities of all members of the population. The Minister is Madame Maimouma Kane, who is especially interested in setting up new village production groups to facilitate women's economic development.

Some women officials in Senegal believe that there is a need for research concerning the current agricultural activities of women in the SRB which will lead to a strategy enabling women to fully participate in new agricultural and irrigation programs. It has been pointed out that there are no women representatives in the OMVS governing group and that women's interests may not be receiving sufficient attention in OMVS planning.

Projects directed toward the needs of women have been found to be highly feasible, especially in certain areas where traditional cooperative work patterns exist. Work groups have, in many areas, evolved into mutual aid associations where each woman contributes a small sum regularly; amounts being given to each member in turn, in a form of saving bank system without interest. It has been pointed out that such groups are considered legitimate by men and are linked in some areas with government projects (Kock-Weser and Herbert Smith 1979).

In many of the groups of the Senegal River area, female members of related extended families cooperate in domestic and agricultural tasks, in some cases supervised by the senior wife of the family head (OMVS 1980a). Among the Soninké, for example, the women of a household organize themselves so that each can take 3-4 days away from domestic chores to work in her individual fields.

Research on women would be used to develop further appreciation of women's agricultural needs based on adequate data and to build information into our on-going agronomic station activities. The goal of all research

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would be the development of concrete suggestions about how women can participate in agricultural research and extension in the OMVS area so that they can benefit directly from agricultural development.

C. Farming Systems

Farmers (cultivators, herders, and fishers) in the SRB have developed an agricultural system based on many generations of experience. Their knowledge of climate, soils, crops, and social organization is evident in their ability to make a living under very difficult conditions. Nevertheless, while the traditional system is constantly changing it has not been able to keep pace with the great increase in social, demographic, and political change imposed from the outside during the colonial period, and especially since WW II. That it is presently not adequate to supply the needs of a rapidly growing population is shown by the high rates of emigration, morbidity, and mortality. Nevertheless farmers' knowledge, practices, and attitudes concerning agriculture form the most important resource upon which to base research in the SRB.

The farming systems approach to agricultural research to be used in AR II requires starting with farmers' knowledge and opinions, and not segregating the components of the system into separate research projects that are unrelated to each other. In the past this latter approach has led to ignorance of much important information useful for the improvement of farm production, and caused the incompatibility of recommended changes with the existing system. The sociocultural organization of farming must be specifically included in all research design. There is growing recognition in developing areas that the farming systems approach is necessary if sustainable increases in per capita production are to be achieved.

1. Farmers

Most farmers in the SRB cultivate plots on several or all of the major types of farmland: river bank, levee, flood plain, and upland. Within these major types are many different minor types (Bradley et al. 1977). The allocation of crops, labor, and material resources to plots in many different types of farm land throughout the farming season is extremely complicated and requires the balancing of risks to ensure an optimal yield that varies as little as possible from year to year (Boutillier et al. 1962, OMVS 1980a, Bradley et al. 1977, Fieloux 1980, Weigel 1980).

Some of the details of household labor organization have been covered in the previous Appendix III.B.5 and the physical and economic parameters in preceding Appendix II and I.A.

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The introduction of irrigation has created conflicts in demand for time and labor with traditional agriculture. Farmers make decisions on which type of farming to which to devote their resources based on their assessment of the risks involved. A lack of commitment by farmers to some irrigation projects has been the result of not participating in or even understanding how decisions were made.

However, when farmers see a clear potential for increased returns by adopting a new practice, they are quick to do so (Netting et al. 1980). In Kaedi, for example, farmers have spontaneously moved near the research station in order to be in contact with station personnel and ideas that have won a good reputation. By focusing research within farmer's systems, AR II will produce results that are adoptable by farmers.

2. Herders

Herder population movements follow the seasons. From June to October, during the rainy season, the herders move away from the valley with their animals to the temporary water holes returning to the river banks from October to January to take advantage of the seasonal flooding. This regular transhumance between the rainfed grazing land and the flooded areas forms the basis for their traditional economy, based on extensive herding and, for partially settled populations, two crops: millet on the rainfed fields, followed by dry season sorghum in the flood-recession fields. It has been estimated that a male adult is busy in agriculture 153 days a year and an adult woman 57 days.

Herders have a number of free periods throughout the year during which they try to engage in lucrative secondary activities: Acacia gum harvest, charcoal manufacturing, and marketing of small livestock. These activities are undertaken during the dry season between the planting and harvesting of the flood recession fields and between this harvest and the beginning of the rainy season.

The introduction of irrigation projects results in a restriction on herder movements or the displacement of the herds. Certain grazing lands that are used in the dry season may be incorporated into the irrigated perimeters as they are developed. There will be a loss of access to not only the land transferred directly to the perimeters, but to a greater area around the perimeters to avoid damage to crops and the physical works. These off limit areas may stand between the herds and the river, which is the only source of water during the rainy season. Finally, there may be a disruption of herds crossing the river if access to established fords is cut off by perimeter construction in the future.

These situations usually result in increased desertification as well as social dislocation. As herders are increasingly displaced by dry season farming, they tend to overgraze land around the remaining perennial watering points such as Lake Guiers. Rather than give up their rights to traditional dry season grazing areas, herders may elect to farm the newly established perimeters, becoming increasingly sedentary (Waldstein 1980). When the older men work in the irrigated plots, the herds may be left in charge of the unmarried men who generally suffer from a lack of discipline away from the supervision of the more mature adults. The adults, meanwhile, will stay in their home area to profit from the proximity of the irrigated perimeters.

Livestock is not only important to Peul and Maure, but to a lesser degree to the settled farmers on the SRB. AR II emphasizes animal traction in the research plan and an understanding of the role of stock in all farming systems of the SRB is therefore important.

3. Fishers

The role of fish in the economy and diet of the SRB population is often overlooked. Fish production in the SRB is presently about 25,000 T/per year, supplied by about 10,000 fishing families (Bureau of Reclamation 1976:63-4, 103).

Since raw fish is about 20% protein (Leung 1968), this 25,000 T is equivalent to about 50 x 10^7 gm of protein. If there were 1.5 million people in the SRB, this protein could be supplying about 20% of the daily protein requirement based on FAO/WHO standards (1973).

If control of the river leads to decreased fish production, as is usually the case (Welcomme 1979), then increased production of other foods will have to make up for this loss of high quality protein.

D. Community Organization: Vehicle for Development

An important lesson to be learned from the history of development in the SRB and from development in Africa in general (Lele 1975) is that the proper infrastructure must exist to ensure that development can be sustained. OMVS and other government agency managerial ability is stretched thin over vast and complicated mandates, whereas local communities have existing organizational structures that are often neglected as resources in development. As with farming systems, it may be that they are not adequate in their present context and form to provide an adequate standard of living, but could still provide a valuable base for development. This may be largely due to the many changes caused by external forces. The responses of

communities to the need to organize within small irrigation projects shows, however, that they are capable of responding adaptively and making an important contribution to development.

The AR II research plan calls for the establishment of village farmers' committees in the village where ON-FARM research is to be carried out. This calls for an understanding of community structure and function that will be part of ongoing commodity and regional research. The Contractor's experience in the Upper Volta Village Livestock Project has been that such committees are extremely important in ensuring a productive relationship with the local population.

AR II will work with farm communities from the survey of farmers' needs and of farming systems, to the evaluation of research results. It will not pick out isolated plots or even isolated farmers, but will work through existing community organizations to reach the individual farm family or farm plot. Social research will focus on how community organizations can be used to provide for the adoption and spread of innovation.

1. Religious Organization

Important Islamic commercial and political interests were integrated into the Senegal River Basin as early as the eleventh century (Fage 1969). Since that time, Islam has been a major factor in the internal reorganization of SRB societies. Muslim minorities continued to grow in power and by the mid-nineteenth century, Islamic revolts had overthrown most secular rulers, and leaders from the Muslim clerical caste were substituted. Islam is now the predominant religion throughout the SRB (except for the Mali highlands) and has become a potent political force in the area. The economic and political positions of the religious leaders are quite strong.

The local population, however, has varying degrees of personal commitment to Islam, and much of Islam's strength lies in its flexibility in accomodating traditional religious beliefs.

Islam dominates Toucouleur village life with social and political organization completely integrated. The marabouts are religious leaders who also claim much political power. In parts of the Upper Basin where Islam plays a less significant role, parallel community structures exist and there continues to be a horizontal cleavage between the ruling families and the marabouts, although the latter still maintain important economic and religious roles. In all instances, the religious authority seldom crosses village boundaries, and there are strong social forces maintaining this village level autonomy.

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2. Irrigation Development

Most irrigation projects are not possible without external intervention. If institutions underwriting development do not seek advice from village organizations, one can expect a decline in productivity (see Adams 1977).

Three social factors, therefore, are critical to project success:

1) the compatibility between the structural features to be introduced with those of the traditional system.

2) the delegation of the responsibility for the social organization of production to the villagers.

3) allowing the villagers flexibility in adaptation of preconceived innovations to village-level constraints.

Technicians conceive a project according to scientific and engineering methodologies, while villagers react according to their immediate reality; when the two are not compatible, the farmer will reject the project.

There will necessarily be competing interests in the degree of local autonomy and control allowed. The governments are officially opposed to the hierarchical caste system found among the SRB populations in which former slaves and lower castes have limited access to land and must fulfill customary obligations to their patrons. On the other hand, to maximize efficiency and local acceptability the decision-making, articulation, and implementation modes intrinsic to the traditional system must be integrated into the new system.

One of the biggest problem in large-perimeter development is a lack of motivation due to an inappropriate irrigation bureaucracy. Small-perimeter development with increased local participation and accountability has resulted in fewer problems. If there is not a pre-existing basis for social cohesion, it is of no use to form an irrigation bureaucracy. If a local organizational pattern is to work, it must emerge spontaneously, from below.

Secondly, the training model proposed by AR II research has important implications for the integration of technological innovation into the local system. One may introduce techniques for two or three years, but then must step back and allow the basin residents to assimilate the technology in their own milieu. Currently SONADER uses a fairly flexible approach to project organization of farmers. SAED too has been orienting its program toward village farmers in its development in the Middle Valley.

It may be that development of tertiary perimeters with their smaller plots may help farmers to gain more control over production. This has been the case in the delta perimeter settlements of Kassack Sud and Kassack Nord,

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Senegal (Waldstein 1980). Producer groups of 12 to 15 family heads formed spontaneously when SAED annonced the conversion to tertiary works. While the members rarely farm their plots collectively, they do cooperate to see that member needs, especially water, are met. This points out the importance of traditional household structures, even in this instance where the new settlements were largely formed by SAED from people of many divergent ethnic and geographic origins.

In the Bakel perimeter Soninké farmers formed an organization to deal with SAED when they were informed that they would be placed under its control (Weigel 1980). The farmers were thus able to effect changes to their advantage in their contacts with SAED.

The OMVS Socioeconomic study has shown that the development of small perimeters has developed its own momentum. "Not only does each village at the middle valley want its own perimeter or perimeters but also it is prepared to obtain and construct it. The village communities where the first perimeters were built have shown . . . remarkable qualities of agreement organization and management" (Boutillier 1980:12).

IV. Administrative Analysis

Agronomic Research II is a project of real organizational complexity. Several organizations have important roles in the project. The administrative challenge of Agronomic Research II is to assure that the internal operations and the interagency communications of these separate organizations serve to promote the cause of agricultural research and extension in the Senegal River Basin to improve the circumstances of the subsistence farming family. The organizations expected to be most directly affected in the project include:

1. USAID: The source of funds for the project. There are separate USAID missions in each of the three countries where agricultural research stations are located --Senegal, Mauritania and Mali-- as well as a regional office in Dakar.

2. University or Institution: This organization will be involved in the management of the project in cooperation with OMVS in the research program and the supply of technical personnel.

3. Senegal River Basin Commission (OMVS): This organization was formed in 1972 by Senegal, Mauritania and Mali as a tripartite agreement to promote the integrated economic development of the Senegal River Basin. It is the indigenous counterpart agency for Agronomic Research II with particular interest in assuring the operational linkage between agricultural research and extension.

4. a.) Senegalese Institute for Agronomic Research (ISRA): The Senegalese national research agency, headquarted in Dakar, is responsible for managing the work of agricultural research at the Fanaye, Senegal research station among other stations in the country.

b.) National center for Agricultural Research and Development (CNRDA): This is the Mauritanian national research agency headquartered in Kaedi. It is responsible for managing agricultural research at the Kaedi, Mauritania research station and other locations.

c.) Institute for Rural Economics (IER): This is the Malian national research agency headquartered in Bamako. It is responsible for managing the agricultural research at the Samé, Mali research station and other sites in Mali.

Also related to Agronomic Research II are the agencies of the member states of OMVS concerned with promoting agricultural development in the Senegal River Basin. These agencies are expected to contribute to the project in defining the character of needed agricultural research and in assuring the widest diffusion of the results of the research. These agencies are:

1. Agency for Development of the Senegal and Falémé Valleys (SAED): Senegalese development agency, headquartered in Saint-Louis, actually responsible for agricultural development reaching beyond the delta of the Senegal River to include the entire River Region of Senegal. SAED was founded in 1964 as a quasi-private company under the Ministry of Rural Development. SAED is managing about 15,000 ha in both small (10-50 ha) irrigated perimeters and in large (1000-4000 ha) irrigated perimeters . The agency is of a development nature but also does some extension work. It operates by preparing the land for irrigation, buying all the equipment needed and advancing agricultural inputs to the farmers. It also buys the production and deducts any loans and expenses incurred on a pro-rata basis. SAED has been strictly controlled by the Senegalese government. This has caused delays in the development and implementation of SAED programs. More recently there has been an effort to increase its independence to allow more flexibility in its operations.

2. National Agency for Rural Development (SONADER): This development agency headquartered in Nouakchott is responsible for agricultural development throughout Mauritania. It was started in 1975 and assists farmers through provision of technical services and inputs. SONADER is attempting to develop small irrigated perimeters in the SRB part of Mauritania. The total area developed in Mauritania until now is estimated at around 4,000 ha.

3. OVSTM, ODIPAC: These are two different agencies operating in the SRB in Mali (first region). OVSTM is the Senegal Valley Agency (Office Vallée du Sénégal Terrekole-Magui) responsible for development of the area. ODIPAC (Office de Développement Intégré de la Production Arachidière et Céréalière) is the Food Crop and Peanut Agency. It attempts to implement improved production techniques for peanuts and staple food crops.

OVSTM has overall responsibility of all development activities in the SRB portion of the Malian First Region.

A. Functional Character of Agencies Involved with Agronomic Research II

The nature of the administrative challenge of Agronomic Research II may be presented in functional terms. This involves a discussion of the matters of agricultural research, the association of agricul-

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tural research and extension as they apply to this project. USAID and the Contractor have had limited direct involvement in agricultural research in the Senegal River Basin. USAID has had involvement and continues to take part in agricultural development in the Senegal River Basin, notably in cooperation with SAED. This has been more concerned with increasing production through the introduction of mechanized agriculture, than with promoting agricultural research to the intended benefit of small-holding subsistence farmers. Of course, USAID has had considerable experience elsewhere in agricultural research. It remains to adapt this expertise to the peculiar demands of successful agricultural research in the Senegal River Basin.

OMVS was organized in 1972 as the most recent attempt of the Senegal River nations to exploit the resources of the basin (see OMVS organization, chart, Figure 54 and Table 54 for details). Its immediate predecessor, the Organization of Senegal River States (OERS) had been founded in 1968 for the same purpose. It was disbanded when then-member Guinea insisted on forming a political as well as economic alliance among the member countries. OERS, itself, was preceded by a less formally organized inter-state committee which held conferences on the future development of the Senegal River from 1963 to 1968. The Mission to promote the Senegal River (MAS) was the last of the French colonial organizations concerned with the economic potential of the basin.

OMVS has been much taken up with the hard work of establishing an identity and an independent organizational existence. However, a basic theme has dominated its operations. The mission of OMVS has been to promote the integrated economic development of the Senegal River Basin. This has taken the direction of seeking international donor funds for financing two dams. One is planned for Diama at the river's mouth to control the intrusion of sea water in the Senegal River bed in the dry season. The other is intended for Manantali on the Bafing River to regulate the flow of the river's water. Thus, a direct focus on the microlevel of the small-holding farming family represents a new direction for OMVS.

OMVS has actually had some experience in agricultural research through a UNDP/FAO project grant held by OMVS bur managed by FAO personnel, and carried out at Guede-Senegal, Kaedi-Mauritania and Samé-Mali from 1969 to the present. Also, researchers of the national agencies, while not surrendering their responsibility or loyalty to their own organizations, have been seconded to OMVS and provide that agency with regular reports of their work.

OMVS is not to carry out the actual program of agricultural research under the Agronomic Research II program. Indeed, the task facing OMVS is to coordinate the research activities of the stations in terms of the stated goal of ameliorating the conditions of the population in the SRB. An absolutely inescapable dimension of its work is to forge the linkage, between agricultural research and agricultural extension.

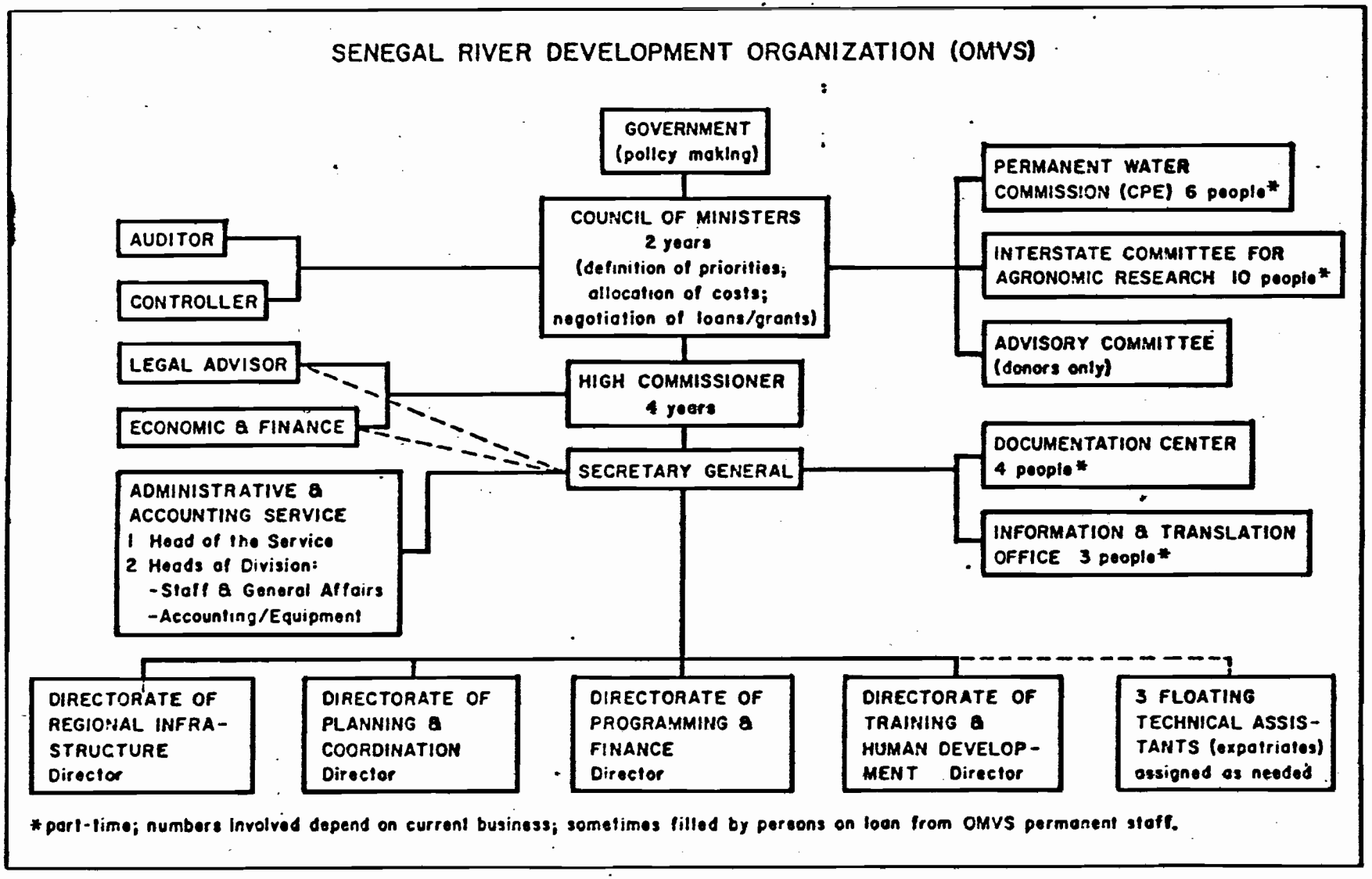

Figure 54 OMVS Organization Chart

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Table 54. OMVS Directorate Personnel

Directorate of Regional Infrastructure Director	Directorate of Planning and Coordination Director	Directorate of Programming and Finance Director	Directorate of Training and Human Development Director
Manantali Project Manager Mining and Power Diama Project Manager Transportation Mapping Projects 1 Surveyor 1 Geodesist 1 Mapping Engineer 2 Water Supply Engineers 1 Hydrologist *Total = 13 nationals 3 expatriates	1 Chief of Agricultural Div. 1 Chief of Animal Husbandry 1 Chief of Hydro-Agricultural Installations 1 Chief of Energy, Mining and Industry 1 Economic Studies and Cooperatives and Exchange Expert (to be recruited) 1 Coordinator of Agricultural Research Research Stations: 3 Directors--Fanaye (Senegal) Samé (Mali) Kaedi (Mauritania) 1 Livestock Engineer *Total = 9 nationals 5 Expatriates 1 Agricultural Expert 1 Rural Engineer 1 Hydraulic Engineer 1 Training Advisor 1 Statistician	1 Head of Department (Budget, Accounting, Investments) 1 Contracting Department (vacant) 1 Financial Advisor *Total = 3 1 Expatriate	1 Planning/Training 1 Training Program *Total = 3

Note: Directors appointed by Council of Ministers; division chiefs and staff are recruited by the High Commissioner.

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OMVS serves this project as an agency of planning and coordination rather than direct implementation. Therefore, in considering the administrative feasibility of Agronomic Research II it is necessary to consider how the working agenda of national research and national development agencies may contribute to the final outcome of the project.

Each of the national development agencies has it own organizational traditions and professional experience. It is in this context that the operational mandate of each is defined. This immediately brings the national level organizations into some degree of tension with OMVS. The potential controversy with OMVS lies in the fact that its mandate is regional, whereas, national agencies have their national concerns. Within countries the tension between research and development agencies is of a functional nature. These are not simply matters of organizational turf jealousies, but also involve a recognition of the lack of physical and human resources in the discharge of their narrowly defined functions.

There are ideological considerations which serve to counteract these tendencies. In the case of OMVS, there is the commitment of the member states to a regional approach to the integrated economic exploitation of the SRB. At the national level there is a quasi-commitment to the linkage of research and development. Research should modify the practices of development. However, agricultural research in the OMVS member states has been traditionally weak in its application while agricultural development has emphasized production.

There is increasing recognition that some shift in the functional priorities of agricultural research and agricultural development is necessary to take better account of the needs and interests of the small-holding family farmers of the region. Insofar as Agronomic Research II can achieve its stated aims, it may even contribute positively to this shift in focus of the national functional agencies.

B. Structural Character of Agencies Involved with Agronomic Research II

The separate organizations participating in AR II each have their own structural arrangements which must be taken into account in considering the likely outcome of the project. USAID, for example, has separate field missions in each of the OMVS member states in addition to its regional OMVS office. Regular communications among the staff of the USAID missions responsible for working with OMVS and the national level agencies can serve to emphasize for USAID and for these agencies, the USAID commitment to this project as a regional endeavor. The nature and frequency of such communication are a matter for USAID's own determination. However, this can contribute

positively to USAID's oversight role in AR II.

The challenge for the contractor-University is to locate and retain the technically skilled people needed to fill the positions of experts in this project. At the same time, the administrative role of the Chief of Party is critical.

OMVS has few limits in its charter in regards to the scope of its authority to act to promote the integrated economic development of the SRB. The OMVS has managed to establish a real measure of organizational identity. This has had the result of developing a cadre of technically capable personnel drawn from the member countries of OMVS, supported in some cases by United Nations personnel, who are loyal to the organization and who view the potential of the Senegal River Basin in regional terms.

This vision must be transmitted to the national level research and development agencies in carrying out the work of AR II in promoting the amelioration of the circumstances of the small-holding farming family of the Senegal River Basin. It is the aim of the research design of AR II to formalize the structural arrangements which will most sharply define the functional purpose to maximize the prospects of a successful project. These relationships are shown graphically in Figure 55.

The research design of AR II operates at four levels. There is a general policy committee (CIERDA) made up of representatives of the national research and development organizations, the OMVS Director of Planning and Coordination , and the OMVS coordinator of Agricultural Research. We propose that for this project they be joined by ad-hoc members representing USAID, Contractor-University head, and farmers of the river basin. It is the responsibility of this committee to formulate the basic standards for project effectiveness, drawn from the goals of a regional perspective and a focus on the small-holding farming family.

AR II significantly improve the capacity of the national research stations in Fanaye, Kaedi and Samé in the supply of working facilities and materials and living quarters and, through the collaborative relationship with team members, in the availability of more skilled indigenous research personnel. This is without question a major attraction of the project to the national research agencies. However the objective of AR II's approach is to address problems and find solutions for the subsistence farming families of the region, increasing their options to improve their economic condition. The role of CIERDA is exactly to guide the Agronomic Research II project along those lines and to identify activities which will promote these ends (see Table 55 for details).

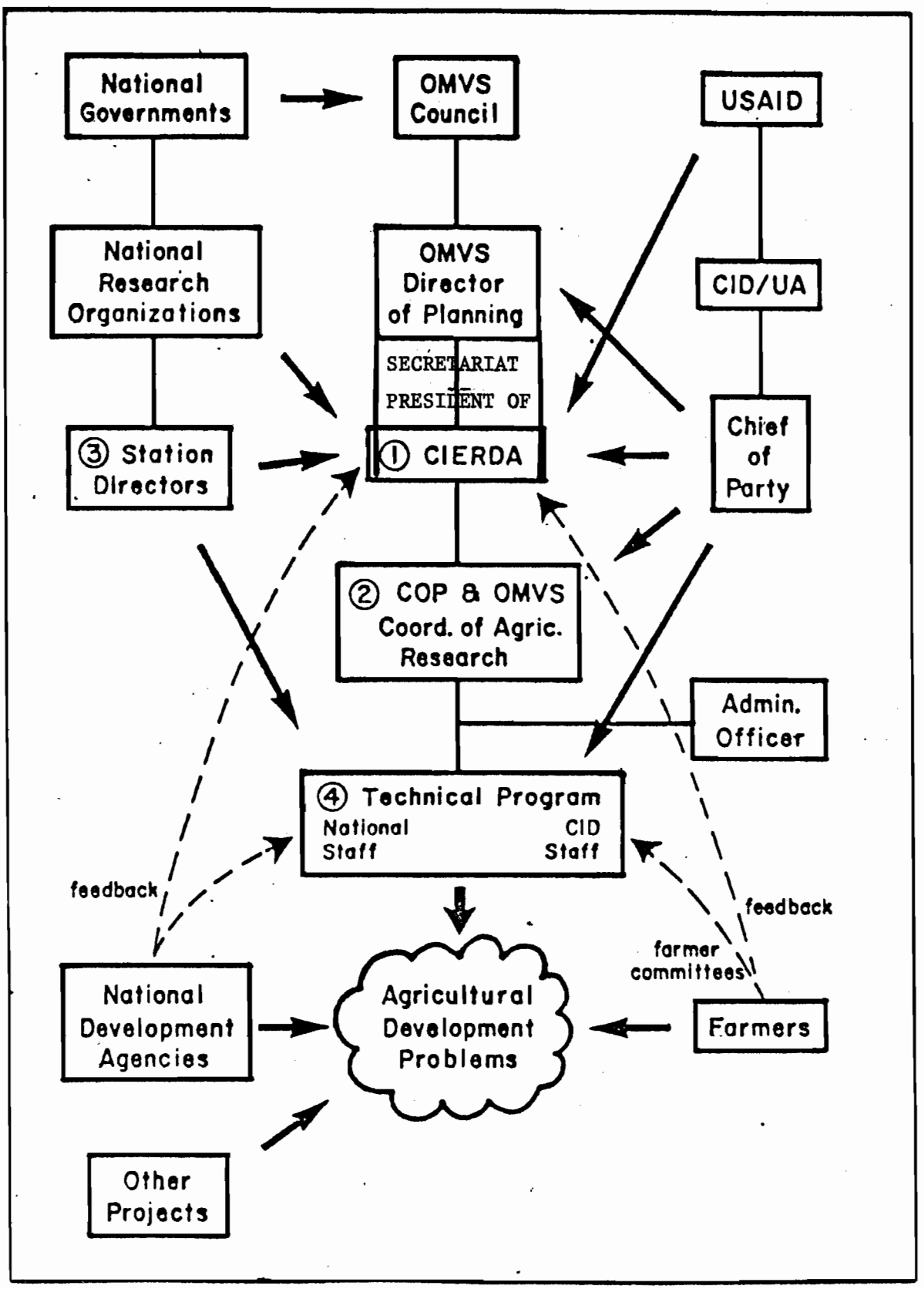

Figure 55 Administrative Structure and Function of Agronomic Research II

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Table 55 Research Administration

1. Interstate Committee on Research and Agricultural Development * (CIERDA)	Policy articulation on research and development, Setting of priorities and changes, Approval of distribution of funding, Annual evaluation of global program, Reports to Council of Ministers.
2. OMVS Coordinator of Research and University Contractor Chief of Party	Receive, evaluate and approve proposals, Allocate respective funding to stations, Analyze research reports and activities, Organize biannual seminars, Report to CIERDA.
3. Station Directors	Manage research stations, coordinate OMVS research with other activities, Maintain facilities, Review proposals and results.
4. Researchers (National and University Contractor team)	Propose projects and activities, Carry out projects and activities, Assist and participate in seminars, Prepare reports.

* CIERDA is comprised of the OMVS Planning Director (Chairman), the OMVS Agricultural Research Coordinator, the Research Directors of the three national research agencies, the three Station Directors, and three representatives of national development organizations. The Chief of Party, USAID representative and farmer representatives should meet with the CIERDA concerning all matters of this project.

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At the second level of AR II are the Chief of Party and the OMVS Coordinator for Agricultural Research. It is their task to establish programmatic content, in terms of determining the timed phases of the activities approved by the general policy committee.

At the third level, is the research center. The center is under the direct management of the centers' director. Based on the activities and policy guidelines approved by the CIERDA, the director works with the Chief of Party to assure that these objectives are carried out. However, all materials, equipment, vehicles, and buildings constructed under the project remain the responsibility of OMVS and the University-Contractor until the end of the project.

The fourth level of AR II is made up of the local and team researchers themselves. It is these people who conduct the work of the project, and on the basis of their findings and professional opinions are to contribute both to the decisions as to what may constitute appropriate activities and how these activities may be brought to a fruitful result. Two important elements of the project at this level are (1) that each researcher have the freedom to work on a short-term basis both at the other research centers and in the field with the region's farmers (On-Farm research) as their assignment would demand. Decision-making arrangements are shown in Figure 56.

C. Final Comments on the Role of Small-Holding Farm Families

AR II can aspire to be a success only if the farmers of the SRB are drawn into active participation in the project via On-Farm research. It may be expected that there will be some resistance to such participation on the part of the small-holding farmers of the region. This is explained by the not common perception among village level farmers that they have sometimes been the victims rather than the beneficiaries of development related activities.

There is no solution to this problem other than to change popular perceptions of local people as to the goals to be realized from the project. There is no fixed time frame for this process to occur. All that can be said is that the best prospects for success will obtain where existing villages would be used as the basic setting for project outreach activities and where appropriate account is taken of the variable patterns of organizing the labor force by such factors as family structure, sex, age, crop cultivator, and exploited land among the different peoples of the river basin.

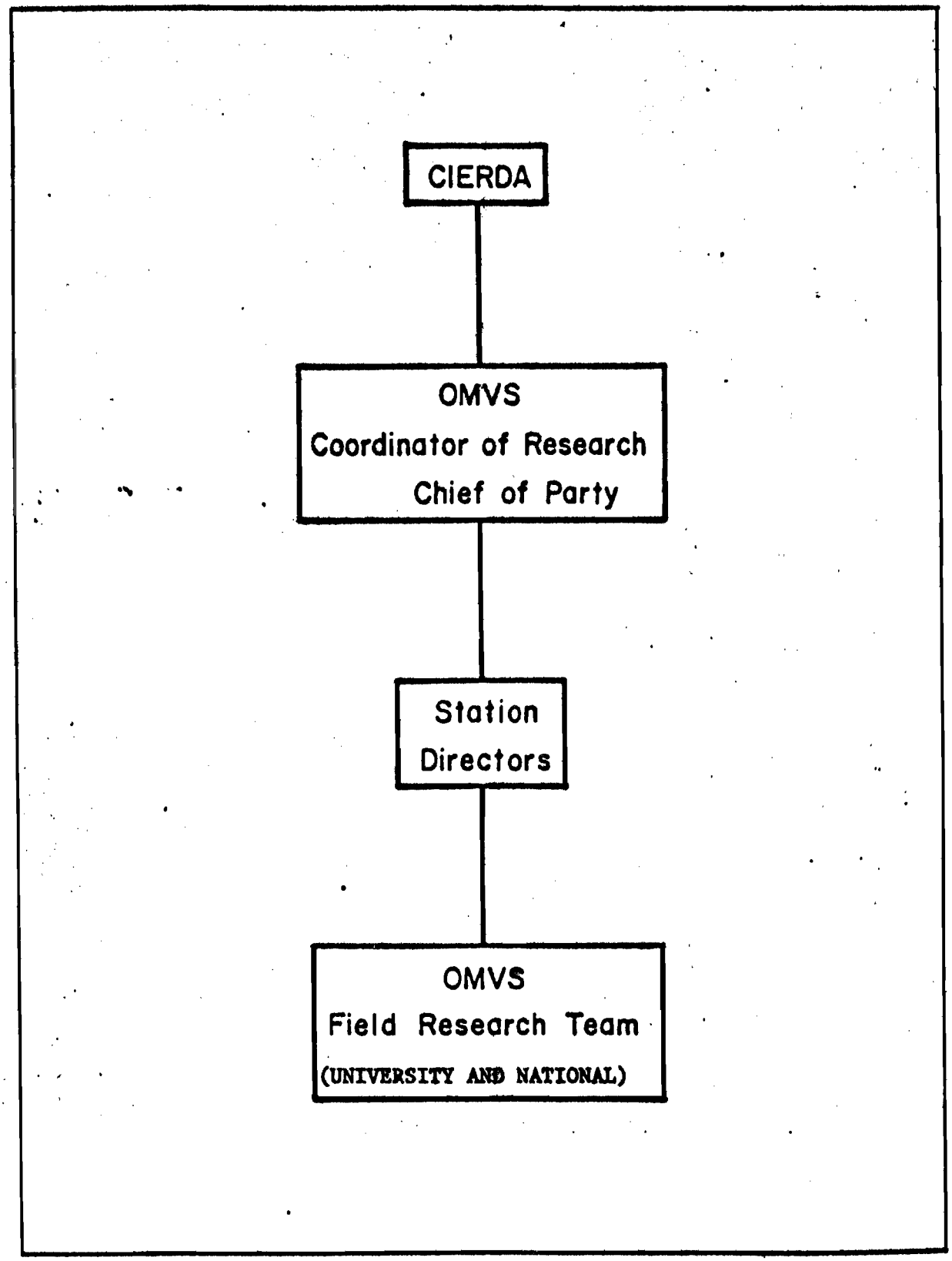

Figure 56. Decision-Making for Agronomic Research II

VII. Environmental Analysis

The long-range plans of the OMVS for agricultural development in the Senegal River Basin involve massive environmental engineering. Two large dams will alter the river flow regime and will require major adjustments in agricultural technology. The potential gains of the plans are great, but so are the risks involved in environmental manipulation on such a scale.

The proposed agricultural research project outlined in this paper is designed to function as a stage by which farmers in the SRB can be introduced to more productive agricultural practices. This proposal takes the approach of making small adjustements in the indigenous system of rainfed and flood recession agriculture, working within the environmental constraints of weather and soil variability and uncertain annual flood flow. It introduces simple technologies such as crop rotation and improved crop varieties, and provides for development of irrigation and drainage techniques which the farmers will have occasion to use when dam construction is completed.

A. Basin Geomorphology

The Senegal River is the second largest river in West Africa. It is over 1,800 kilometers long and drains a watershed of more than 300,000 Km^2.

Forty-five per cent of the river's length forms the border between the countries of Mauritania and Senegal. Fifty-five per cent of its drainage area is in Mali. About fifty per cent of the water in the Senegal River originates in Guinea, outside the boundaries of the OMVS member states (Gannett et al. 1979). Several tributaries empty into the Senegal River, including the Bakoye, Bafing, and Faleme Rivers.

The Senegal River Basin is typically subdivided into three regions: the Delta, the Middle Valley, and the Upper Valley. The delta begins at a poorly defined point between Mbagam and Ntiagar and ends at Saint-Louis where the river enters the Atlantic Ocean. The only tributary stream of significance in this region is the Gorgol, which is dry much of the year. The Middle Valley begins at Bakel, Senegal, where the shape of the valley changes from a narrow, well-defined channel with steep banks to a flatter profile characterized by alluvial flood plains 10 to 25 Km wide. The Middle Valley ends where the extremely flat Delta begins, at Richard Toll about 100 Km from the ocean. The Upper Valley includes all the basin upstream from Bakel and thus lies mainly in the country of Mali. Senegal and Mauritania share opposite sides of the Middle Valley and Delta regions.

The three agricultural research stations that will be developed by the project are located in the different regions of the river. Fanaye, Senegal, is the upstream portion of the Delta region; Kaedi, Mauritania, is in the Middle Valley region; and Samé, Mali, is in the Upper Valley region.

The average slope of the valley is extremely low. The high point of the riverbed at Bakel is about 25 to 26 meters above sea level. Near Richard Toll the corresponding point is only 4 m above sea level. The distance between the two points is 430 Kilometers, so that the average slope is on the order of 0.005 cm per cent or 5 cm per kilometer. The respect to irrigation sytems which can be utilized. It makes the use of gravity distribution systems difficult, because the feeder canals would have to start far upstream and be located high on the flanks of the valley. Thus, the use of irrigated areas (perimeters) with the water being pumped up to them is indicated. This can only be done on a widespread and permanent basis when the water level in the river is more stable.

Alluvial deposits occur along the entire valley. Micro-relief determines flow from velocities during flooding so that the texture of the deposits ranges from coarse sand where fast-flowing water occurs, to heavy clays in backwater pools.

The river meanders in large arcs. It divides into arms near Salde, downstream from Kaedi; the arms rejoin near Podor. The meandering Senegal and Doue cut through many alluvial deposits which are often deep and extensive. The irregular system of abandoned terraces and old stream channels of the river encloses a multitude of ponds which vary widely in size and shape.

The flow of the river follows an annual cycle low flow at the end of the dry season to high flows during the season when the Guinea highlands are receiving their heaviest rainfall. The river annually inundates large areas of land along its banks. Recognition of this recurring pattern is important for an understanding of the soils which are found in the Basin and of the systems of farming used along the river.

B. Vegetation

This section is based on IUCN (1979).

In the upper SRB in Mali and Senegal, the natural vegetation has been deeply modified by centuries of human influence including agriculture, woodcutting, grass fires, and grazing. What woodlands remain are found on rocky hills and ironstone plateaus. Larger trees (8 to 12 m tall) include *Anogeissus leiocanpus*, *balanites aegyptiaca*, *Lannea microcarpa*, *Prosapsis africana*, and *Sclerocarpa binea*. Among the subdominant tree species (roughly 6 meters tall) are *Combretum glutinosum*, *Strychnos spinosa*, and *Terminalia avicennioides*.

The lower SRB along the border shared by Mali and Mauritania is characterized by a semi-desert grassland vegetation with scattered trees. In this zone, with its wide variation in rainfall from season to season and from year to year, annual grasses predominate because of their ability to grow and set drought-resistant seed during the brief periods of available moisture. *Aristida mutabilis*/*Eragrostis tremula* is a common association; *Schoenfeldia gracilis* is found on loamy-sand soils, and is a popular

fodder for livestock; and Aristida pallida, a perennial species with low feed value, is the third major grassland types represented in the region. The hardly tree species which dot the terrain include the evergreens Balanites aegyptiaca and Maerua crassifolia, which may be the only source of fodder at the end of the dry season. Commiphora africana, Grevia spp., Zizyphus, Cordia rothii, and Combretum aculeatum shed their leaves at the beginning of the dry season, thereby greatly reducing moisture loss due to transpiration. Acacia raddiana and several other species keep their leaves for part of the dry season. All of the trees in the lower basin have suffered greatly from recent drought, especially from the practice of lopping limbs and leaves for fodder as other sources of food for livestock became less and less available.

C. The Climate and its Impacts on Agriculture

1. Climatic conditions. Detailed information about the climatic conditions of the Senegal River Basin are in "Agrometeorology" (FAO/UNDP 1976). The annual cycle in the Senegal River Basin is divided into three season: the rainy season, the cold dry season, and the hot dry season. The rainy season begins at the end of June or the beginning of July and is called "hivernage" in the French literature. The cold dry season begins at the end of the rains in November and continues until the end of February or early March, when the temperature begins to rise markedly. This is the beginning of the hot dry season, which lasts until June or sometimes into July (OMVS 1977).

Precipitation within the basin is extremely variable in timing, duration, and amount (Figure 57). The rainfall in the upper reaches of the SRB is from 1000 mm to 1500 mm per year. This amount decreases as one moves north and is about 250 mm in the Podor region. The duration of the rainy season decreases from five to three months going from south to north.

The hot dry season is characterized by "harmattan" winds, which are extremely hot and desiccating. The harmattan begins in February and also may occur in March and April, although it is not continuous. This wind causes considerable damage to crops by scalding leaves, and reduces yields by 40 to 50 per cent or destroys the whole corps if plants are in flower during a harmattan wind (Gannett et al. 1979).

Solar radiation at the top of the atmosphere averages 11.2 hours of insolation per day, with a radiation intensity of 680 cal/cm^2/day in December and 900 cal/cm^2/day in June. At the surface of the earth in the Middle Valley and Delta, solar radiation averages more than eight hours per day with an intensity ranging from 400 to 600 cal/cm^2/day.

Hours of sunshine received in the SRB range from 80 to 90 per cent of the possible maximum. The percentage of solar radiation received at the earth is less than its potential because of attenuation caused by dust particles in the air. During the rainy season when clouds block radiation

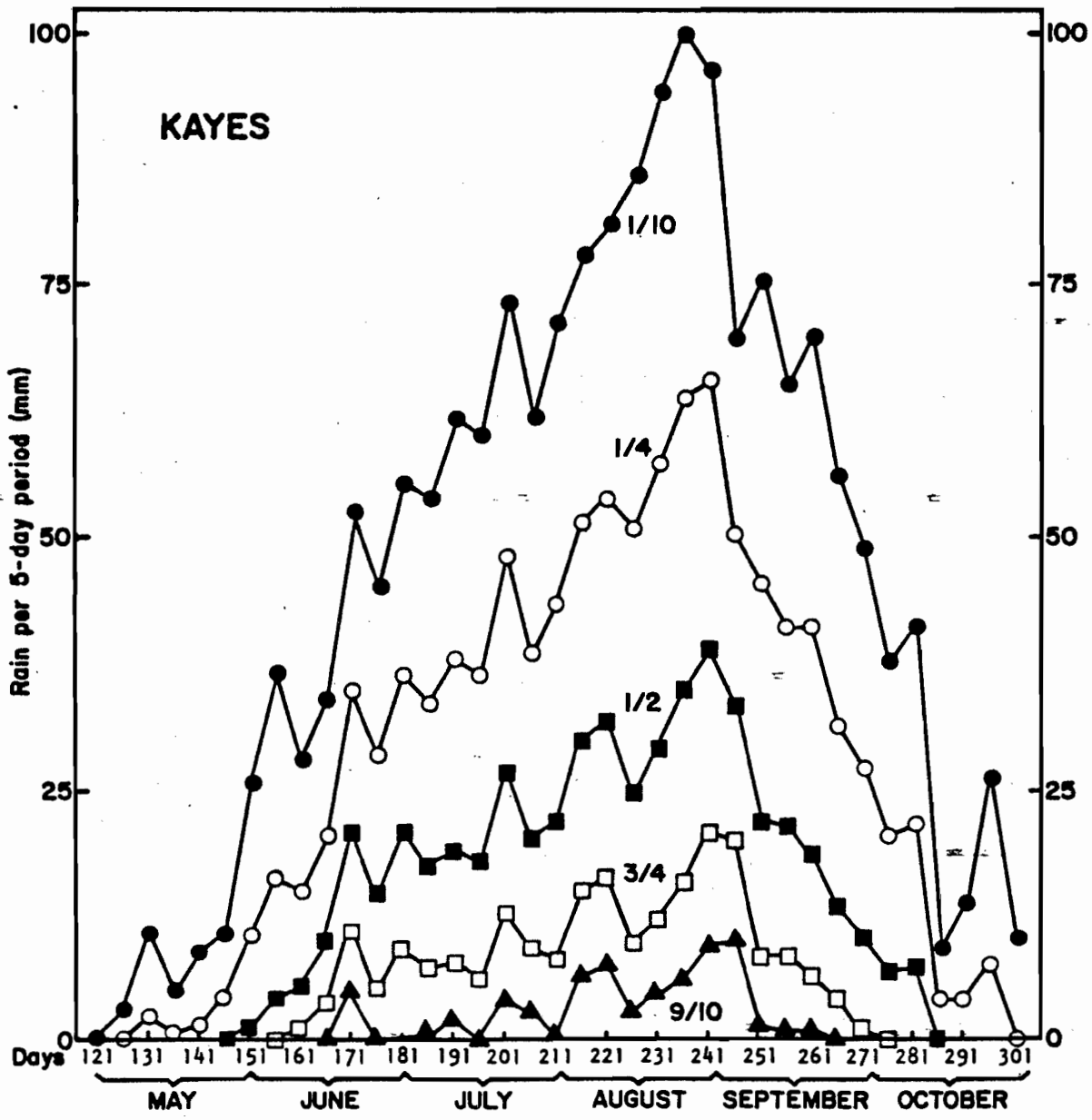

Figure 57 - Excedence probability of rainfall at Kayes. Fractions for each curve express the number of years in which rainfall is greater than the indicated amount. Units are mm received in a five-day period. Note extreme inter-annual variability. Source: FAO/UNDP 1979

for part of the time, this loss of radiation is compensated for by reduced airborne particulates during clear weather resulting in more intense radiation, so that the amount of solar radiation received throughout the year is remarkably stable. These radiation levels allow crop growth throughout the entire year, even though the potential rates of photo-synthesis are never as high as they are during spring in the temperate regions (see Table 57).

Daily temperatures (Table 57) are high due to high radiation intensities. Daily temperatures fluctuate only slightly during the wet season, but as much as 20°C during the rest of the year. These conditions increase rate of respiration while allowing only moderate rates of photosynthesis. The results may be unfavorable with respect to the accumulation of dry water during the rainy season. Advection of moist or dry air may play an important role in the determination of conditions for plant growth. This role could be very important over small irrigated fields in an otherwise dry area. Excessively high temperatures, e.g., 44°C, may be a problem with sexual reproduction of certain crops; however, this problem has not been studied because temperatures rarely rise this high during the wet season. With the introduction of irrigated agriculture, however, high temperatures and dry winds could become an important climatic restraint.

High rates of evaporation are characteristic of arid regions. Evapotranspiration (water transpired by vegetation plus that evaporated from soil) is a crucial consideration in both rainfed and irrigated agriculture. Estimates of evaporative demand can be used to determine irrigation requirements during the dry season. The nature of the crop cover during the rainy season influences the amounts of both surface and ground water available for irrigation (Dancette and Hall 1979).

The potential rate of evaporation is high, ranging from 6 mm/day in August to 12 to 15 mm/day in March at latitude 15° north. Evaporation rates at Kaedi and Guede are reported in Table 58.

2. Cropping Season. The farmer of the Senegal River Basin recognizes three cropping seasons, as follows:

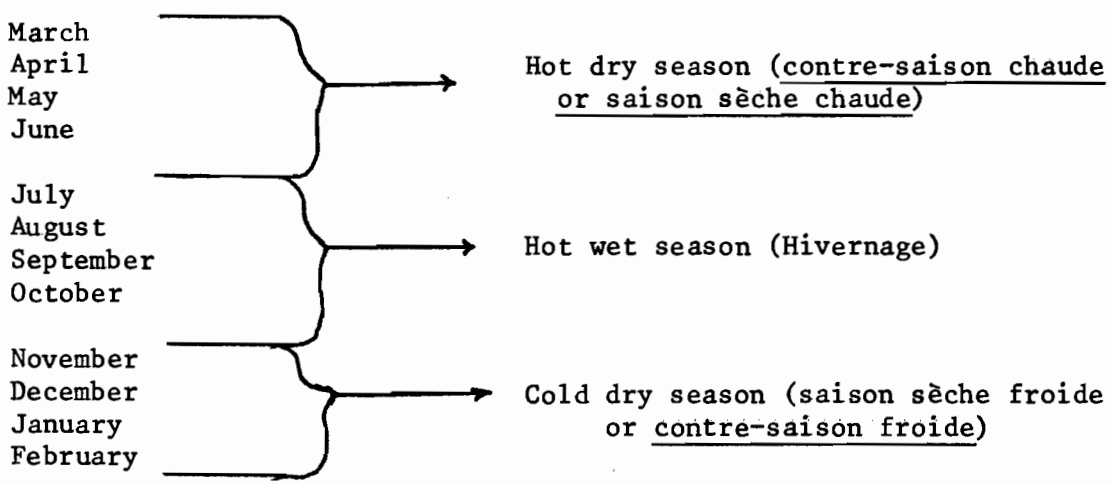

Table 57- Average Temperatures (°C) for the First 10 Days of Each Month, Measured at Kaedi During 1970-72. Td - dry bulb temp.; Tw = wet bulb temp. Temperature measurements were made in shade.

Year		T_{max}	T_{min}	0700 T_d	0700 T_w	1200 T_d	1200 T_w	1800 T_d	1800 T_w	Radiation
		(°C)								cal/cm^2/day
1970	A	33.6	24.8	25.6	23.8	30.0	24.7	31.8	25.6	-
	S	33.7	25.3	24.8	23.9	30.5	26.0	32.9	26.3	-
	O	37.7	24.0	24.7	22.1	34.7	25.0	35.2	25.1	-
	N	38.3	21.6	22.2	15.2	35.2	19.4	35.3	20.3	-
	D	35.1	18.3	19.1	11.0	31.3	16.7	32.1	17.7	411
1971	J	32.3	15.1	16.1	09.1	28.0	14.7	30.0	15.6	188
	F	35.5	18.7	19.8	10.1	31.1	15.1	34.1	16.9	200
	M	35.7	18.0	13.9	10.7	31.2	15.9	34.3	17.6	248
	A	38.6	23.5	24.3	14.1	34.4	18.2	37.1	19.5	318
	M	40.3	25.4	26.7	15.6	37.1	19.2	38.3	19.4	312
	J	43.9	27.2	28.4	17.3	39.7	21.0	42.4	21.6	594
	J	37.3	25.0	25.9	22.2	32.2	23.4	35.9	24.1	533
	A	34.4	24.7	25.7	22.8	31.4	24.0	32.5	24.1	-
	S	34.1	24.7	25.6	23.4	31.0	25.2	32.2	25.0	516
	O	38.3	23.8	24.2	20.5	35.3	22.9	35.9	23.4	519
	N	38.2	19.4	20.8	13.9	35.3	18.6	34.6	19.8	463
	D	33.3	17.7	18.4	10.6	29.4	15.1	30.7	16.9	380
1972	J	33.1	15.2	16.2	09.6	30.5	15.5	32.1	17.0	432
	F	40.1	16.0	16.7	10.9	28.7	15.5	31.9	16.5	513
	M	40.1	19.3	19.8	10.5	29.7	14.7	31.2	15.4	-
	A	40.0	23.2	23.8	13.8	36.4	18.3	38.4	18.9	-
	M	40.0	27.1	27.5	15.8	36.8	19.8	38.5	20.2	-
	J	38.1	26.0	26.7	21.7	35.0	23.7	38.5	24.0	550
	J	37.8	27.0	27.5	22.0	35.0	23.7	38.8	24.4	553
	A	41.5	26.7	27.5	22.7	34.4	24.1	35.9	24.4	511
	S	39.4	26.3	26.5	23.4	34.3	24.9	35.3	24.4	523
	O	41.5	29.1	29.6	23.6	37.9	24.8	39.7	24.7	506
	N	39.4	21.7	23.2	14.9	36.5	19.0	36.2	19.6	432
	D	41.5	29.1	29.6	13.6	37.9	24.8	39.7	14.7	506

Source: FAO/UNDP (1976).

Table 58- Monthly Evaporation from a Class A Evaporation Pan on Bare Soil at Kaedi and Guede (mm)

	1973		1974		1975	
	Kaedi	Guede	Kaedi	Guede	Kaedi	Guede
	mm					
January	-	-	360	354	308	303
February	-	-	343	282	293	295
March	449	342	460	391	389	374
April	552	372	489	407	460	413
May	511	398	514	480	514	477
June	445	462	464	445		
July	395	396	343	354		
August	261	342	180	286		
September	238	323	176	249		
October	296	356	254	297		
November	309	304	263	267		
December	294	279	268	244		

Source: FAO/UNDP (1976).

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The beginning of each season varies from year to year. Transitions one season to the next are gradual.

The rainy season is the most important in the traditional farming system. It is the principal season during which there is opportunity for meaningful agricultural production. All activities planned throughout the year center around this season and the flood recession period which follows. The other two seasons are called "contre" or "off" periods because traditionally they are not used for agriculture.

The assessment of the value of the season changes dramatically in irrigated agriculture. Now the contre-saisons become very good growing seasons. The crops introduced from temperate zones are best suited for the cold dry season whereas the crops derived from tropical regions are best suited for the hot dry season. Much of the agricultural research conducted to date has been concerned with developing cropping sequences suited to each season.

Double cropping and even triple cropping become possibilities with the availability of irrigation water. Each cropping season is about four months long. Using traditional farming technologies, a farmer needs ten to twenty days to change from one crop to the next. Thus, triple cropping demands either that the growing season be no longer than about 100 days, or that some technology be employed which allows the change of crops to be accomplished more quickly. Double cropping allows more scheduling flexibility.

3. Climatic Limitations. Agrometeorological observations in the SRB have been carried out during a period of about five years. The studies were funded by UNDP/FAO (1976).

As far as radiation intensity is concerned, note should be made of the fact that insolation is usually reduced in November and December. The filling of grain grown during the rainy season occurs during this period. Crops with a growing season of 110 to 120 days, to be grown during the rainy season should be planted before the end of July, so that the total radiation will be sufficiently high for normal growth to occur in November.

During the dry season there is a period centered on November when temperatures are moderate. This period is long enough to consider the production of temperate zone crops.

The period of lowest temperatures coincides with the period of the highest rate of vegetable growth. This affects the growth and development of several crop species and varieties. One approach to this problem has been to select cold-resistant varieties, which is being done for rice.

It is important to recognize that dates for various cultivation practices may overlap. When double-cropping or triple-cropping is contemplated, little time is available between seasons for completing the

necessary operations including harvesting, seedbed preparation, and planting. Many things can happen which cause problems: lengthening of the growing season due to low temperatures, difficulty of traveling over the soil when unexpected rains do occur, mechanical breakdowns, or sickness of the farmer. Thus, embarking on a program of double- or triple-cropping requires careful planning.

D. Surface Water

1. Senegal River Floods. The typical annual volume of flow of the Senegal River is 25 billion cubic meters. The maximum flow rate varies widely from year to year, from a low of 310 m^3/sec in 1944-45 to a peak of 1300 m^3/sec in the 1924-25 flood season at Bakel (ALIC/OALS 1980).

The micro-relief of the natural levee system plays an important role in the submersion of the riverbed and adjacent lands during the floods which occur each year in varying magnitude. During the first crest of the flood, the water fills the principal channel and the floodplain along the river. Erosion occurs in certain areas, deposition in others. The extent of flooded land varies from one year to the next as a function of crest height and duration of flooding.

Flow velocities are generally very low or the water is almost stagnant in the flooded areas along the principal channel. The water remains for a length of time dictated by the crest height and shape of the terrain. The highest parts of the valley, reahced only by the highest flood crests, are flooded only briefly. Low areas, on the other hand, remain flooded for four to ten weeks.

At the end of flood stage, ocean waters enter the river channel, because parts of its bed are actually below sea level up to a threshold between Podor and Boghe. The salt water has reached as far as 200 kilometers upstream from the mouth. As soon as the first flood crest arrives at the delta area, only water can be pumped from the main river during much of the year. The upstream penetration of salt water occurs over a period of about nine months.

2. Water Quality for Irrigation. Generally speaking, salinity levels in the Senegal River are low. The salt content begins to increase at Dagana due to intrusion of ocean water during the dry season. Water downstream from this point cannot be used for irrigation during the dry season (until the downstream dam at Diama is operating).

Upstream from Dagana, river water is suitable for irrigation (Table 59). Total salinity varies from 56 to 82 micromhos at 25°C, and the ph ranges from 7.2 to 9.6.

There are problems with the water in the Boghe and Kaedi regions, where it contains what Eaton (1950) calls "residual sodium carbonate." The sum of carbonate and bicarbonate contents exceeds the amount of calcium plus magnesium thus the conditions are right to form alkaline carbonate, starting with bicarbonate in the water and sodium and potassium in the soil.
Use of this water for irrigation could lead to alkalization of the soil and dispersion of clays, rendering the soils impermeable. The degree to which these problems exist could not be determined.

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Table 59- Analysis of Water from the Senegal River. Samples were taken at Kaedi on 19/03/64, at Bagne-Bodj on 21/02/64 and at Diama on 15/03/69.

Parameter	Location		
	Kaedi	M Bagne-Bodj	Diama
Conductivity (micrombos)	69	82	21,830
pH	7.6	9.6	—
Dry Residue (mg/l)	69	59	--
Ca	0.27	0.23	7.4
Mg	0.46	0.31	44.1
K	0.03	0.03	5.69
Na	0.08	0.14	186
CO_3H	0.90	0.55	1.5
Cl	0.24	0.38	217.8
SO_4	trace	0.15	22.59

Source: Gannett et al., Inc. (1979).

There are advantages to the water chemistry of the region as well. The weak acid, bicarbonate, in the water should dissolve rock phosphate, which is available in the region. Use of the locally available phosphate as fertilizer would decrease the need to import triple super phosphate as is now done. In sum, the quality of the available surface water does not present insurmountable problems to its use in irrigation.

3. Ground Water

This section is based on Illy (1973) and UNDP (1977).

The two main aquifers in the Senegal River Basin are the alluvial water table aquifer "nappe Continentale Terminale" and the artesian aquifer "nappe Maestrichtienne." In the upper valley these two aquifers are in contact. This zone is the recharge area for the artesian aquifer.

The alluvial water table aquifer, can usually be exploited by shallow wells ranging in depth from 10 to 120 m depending on the ground evaluation.

The quality of the water is good (100 to 300 mg/l TDS) in the valley upstream of Boghe. Downstream from Boghe the TDS content increases gradually except in perched aquifers away from the river. At Richard Toll the TDS is around 5000 mg/l. In the delta area downstream from Dagana, even the artesian aquifer has salinities in the order of 2000-3000 mg/l near the river where the piezometric head is approximately 1-2 m below mean sea level, indicating a leaky aquitard.

No information was found about ground water conditions in the region of Kayes and Samé in Mali. Because the region is in the upper valley, one woule except the quality of the water to be good. However, wells at the Samé station yield water which is corrosive and not recommended for domestic use. Efforts to obtain water quality analyses were unsuccessful.

The mean annual recharge to the alluvial water table up to Bakel is estimated at 200 million cubic meters and is mainly due to infiltration from flooded areas. The ground water resources between Bakel and Boghe are important, and it is estimated that about 50 million cubic meters per annum could be pumped for irrigation without appreciable impact on the environment. Large scale utilization, however, would require wells that are in general 40 m or more in depth, penetrating at least 10 m below the water table. These wells can yield about 100 m^3/hr. Shallower hand-dug wells with casing would be possible in certain areas, but unless the penetration below the water table is substantial (in the order of 4-5m), the yield will be small, about 2 m^3/hr.

Animal and wind power are about 10 times less costly than internal combustion engines for pumping ground water from wells. Both are infrequently used in the SRB.

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From Fanaye upstream to Boghe it is possible to use hand-dug wells in the upland areas to supply water for domestic use and for livestock. In addition to supplying water for ON-FARM research activities, shallow hand-dug wells with animal-powered pumping will be experimented with at each research station to determine their feasibility for irrigation. Evaluation of technical and economic feasibility of ground water utilization for irrigation in the SRB with and without the dams will be part of the research program.

F. Soils

1. General Description. A number of soil surveys for various purposes have been made in the Senegal River Basin. In 1973 FAO sponsored a soil and land classification study. This was carried out by SEDAGRAI, which produced a series of maps at the scale of 1:50,000 for the river basin from Saint Louis to Bakel.

Based on the work of SEDAGRI, Groupement Manantali evaluated soil suitability for irrigation according to the U.S. Bureau of Reclamation system of classification (Gannett et al., Inc. 1979). The results of this work were published in 1977. A more recent document was published in 1978 by FAO, based on the work of T. G. Boyadgiev (FAO 1978).

Farmers have their own classification system for soils based on their experience, and which takes into account inherent soil properties and water regime (see Appendix I.A.) Soil characteristics are determined by the hydrology of the basin, particularly the annual cycle of flooding of the major river. The periodic flooding which is common to most rivers flowing through the delta areas or areas with negligible slope produces a natural levee along the bank of the flow channel made up of sandy material and little silt or clay. The soils found in the levees range in clay content from 12 to 15 per cent.

The soils along the banks of the river bed which are subject to high flow volocities are extremely sandy. Adjacent to the natural levees, one finds depressions containing pools with stagnant water or slow drainage. The water here has already lost most of its coarse material. The silt and clay settle out during the long periods that the water stands. Thus heavy textured soils (45 to 70% clay) are found at these sites. Farther from the river, beyond its flood plain, the soils are older, formed during earlier geologic times. These soils are very sandy, with less than 15 per cent clay.

OMVS has identified the following groups of soils in the SRB as those on which soil survey work must be pursued (OMVS 1977):

- slightly evolved soils
- hydromorphic soils
- vertisols
- brown subarid soils
- halmorphic soils.

With the exception of halomorphic soils, all the other groups of soils are common at the OMVS agricultural research stations.

The occurence of alluvial hydromorphic and vertic soils increases upstream in the vicinity of the flood plain. The relative proportion of alluvial hydromorphs (AH) is higher in the upstream locations.

The indigenous terminology has been used as a basis for classification of soils and evaluation of their potential for irrigation by Groupement Manatali (1977). Eighteen zones (three in Mali, six in Mauritania, and nine in Senegal) were designated as areas for future regionwide development based on suitability of relief, soils, and water availability. Zones were divided into UNE's (Unite Naturelle d'Equipment) for which the gross area was defined, and the clay-rich soils were measured and totaled to establish the irrigable area. The totals for all 72 UNE's were: gross are = 504,245 hectares, net irrigable ù 371,444 (CID 1980). Local names for soils are used to indicate their textural and management properties, while technical classifications are based on chemical and evolutionary considerations (Gannett et al. Inc. 1979).

OMVS (1977) commenced on the nutrient status of soils in the basin, noting that soil studies have shown a clear deficiency in nitrogen and a serious deficiency in phosphorus for all soils in the valley. There are potassium deficiencies in certain areas.

2. Soils of the Research Stations, Kaedi. The Mauritania research center has two experimental stations, Rindiao and Belinabe. Soils of these stations can be divided into two groups: alluvial soils, which are modium-textured and stratified, characteristic of Rindio; and alluvial soils with heavy texture (vertic), representing the soils in Belinabe.

(a) Alluvial soils with medium texture, stratified (Ustic Fine Loamy Torrifluvents)

Recommendation (based on field observations, analytic data, and other descriptions of the soils in cited documents):

Shallow plowing of these soils (10 cm) has been practiced so far. Texture and structure can easily allow plowing at a deeper depth (25-30 cm). This should make the use of organic fertilizer more advantageous. However, there are some limitations: a pronounced hydromorphy and low mineral content. For these reasons, plowing depth should be increased carefully and progressively on fallow land. Fertilization, especially organic, is highly recommended.

Considering the increasing salinization of the surface soil layer, use of KCl potassium fertilizer should be abandoned. Notice that potassium fertilizer was used even though the root zone horizon had an adequate potassium content. Nitrogen and phosphorus fertilizers are required to correct soil deficiencies and fulfill plant requirements; potassium is indicated only in the case of highly demanding crops (for example, rice). The CNRADA

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has recommended the use of "completely balanced" fertilizer formula for their vegetable crops.

The soils at Rindiao are highly suitable for irrigation. There can be 52 mm of available water in 50 cm of soil. Three times this amount (180 mm) would generally be sufficient to leach any salts accummulated in the top meter of soil.

(b) Alluvial soils, medium to heavy textured, vertic (Fine Loamy Ustertic Torrifluvents)

Physical and chemical characteristics of these soils can be summarized as follows:

Texture: silt loam, 38 cm depth (clay content 22%); clay, 38-114 cm depth (clay content 46%); silty-clay loam, below 114 cm (clay content 28-36%).

Available water: 62 mm depth of water in 50 cm depth of soil and 162 mm depth of water in 100 cm depth of soil.

Permeability: medium in the Ap horizon, almost null in the B horizon. Smum of exchangeable cations: average in the surface layer, higher at depth.

Dominant cations: calcium first, magnesium second. Sodium increases with depth.

Porosity: very poor throughout the profile.

Salinity: low.

PH: slightly acidic up to 114 cm depth; neutral further down.

Organic matter: very low.

Total N, total and exchangeable P, exchangeable K: all very low.

With such poor soils one should expect a very good plant response to fertilizers. However, some fertilizer experiments on rice (Dingle et al. 1975) revealed a clear response of plants to nitrogen by limited response to phosphorus and potassium. Further investigations in this area are needed.

Soil samples from the Kaedi research center have been analyzed by the Soil, Plant and Water Testing Laboratory, University of Arizona. Samples were collected from experimental plots under irrigation and from fallow plots with similar soil types. Other soil analysis (DeBon 1980, IMPHOS 1980) indicate at low organic matter content for most of the soils of the area. This points ups the need for encouraging use of organic fertilizers.

3. Samé. The research station in Mali has two experimental irrigated areas (perimeters): Casia perimeter in Samé (20 km from Kayes); Kamankole perimeter (6 km from Kayes).

Casia Perimeter, Samé

(a) Soils reddish-brown, subaridic developed on alluvial deposits (Fine Loamy Typic Ustropepts).

(b) Poorly developed soils, nonclimatic, alluvial deposits, steppic (Fine Loamy Fluventic Ustropepts).

Although they developed on different materials, these two types of soils have similar physical and chemical properties. Both have a light texture in the upper layer (7 to 17% clay) and a medium texture at depth (20 to 34 % clay). Perhaps a noticeable difference in the two textures is the coarse sand content, which is high in materials transformed in situ and low in transported materials. In spite of this difference, the two types of soil have a similar available water content: about 0.4 mm/cm in the surface layer and 0.8 mm/cm at depth. Permeability (Henin method) is low in the surface layer and poor at depth. Field measurements gave 1.2 mm/mn.

Cation exchange capacity is average, with calcium dominant. The pH is neutral and increases slightly with depth. Neither of the two profiles is affected by soluble salts. The soils from both sites are low in organic matter, total nitrogen, both total and available phosphorus, and in exchangeable potassium.

Recommendations. Both types of soils are good for irrigation. A 50 cm depth of soil can store up to 40 mm of available water. Water supplied at each irrigation should be on the order of 300-600 m^3/hectare.

Kamankole Perimeter

Two types of soils dominate in this perimeter:

(a) Poorly developed alluvial soils, Steppic (Fine Loamy Torrifluventic Haplustolls). One of the specific characteristics of this soil is its relatively high organic matter and nitrogen content. Total phosphorus is also higher than in other soils of the valley, but available phosphorus is still very low. Kamankole soils are among the best in the valley. They are good for cultivation of all crops except perhaps for rice. The quantities of water applied per irrigation should be 500-600 m^3/ha for 50 cm soil depth.

(b) Hydromorphic soils with surface pseudo gley, Vertic (Fine Clayey Vertic Ustifluvents). Texture is heavy and uniform along the profile (clay content 53-58%).

Permeability is very low in upper layer, almost nil at depth.

Porosity is very low in general, low in horizon Ap.

Cation exchange capacity is high in Ap horizon, and very high in the lower depth.

pH is highly acidic at the surface, slightly acidic at depth.

These soils are not affected by soluble salts.

Recommendations. Physical properties of the soils need to be improved. Good soil management is needed to improve structure and porosity and to make soils less affected by hydromorphy. The quantity of water added at each irrigation should be about 600 m^3/hectare to satisfy crop requirements.

Soil samples from Samé and Kamankole have been collected and sent to the University of Arizona. The Samé analyses show a low available phosphorus level and medium total phosphorus. More details are available from different surveys (U of A 1980, DeBon 1980, IMPHOS 1980, ORSTOM 1980).

4. Fanaye. For a complete description of the soils of Fanaye, refer to Sonko (1973), UNDP/FAO (1976). Starting from the road to Richard Toll, over one-third of the station soils are classified as red-brown subarid soils over old sand dunes beyond the flood area. A small strip about 75 meters long over the width of the station is made up of regosols with hydromorph spots over colluvial sands. An adjacent area over twice as big is covered by hydromorph soils on clayey sands. Next lies an area of vertisols over sedimentary clay. An irrigular area of hydromorph soils extends across the station and generally along the river. A hydromorph soil area with silty clay over clayey silt covers the rest of the station.

G. Environmental Impacts

At the small scale of the proposed agricultural research project, it is unlikely that environmental impacts of the project will be significant. However, if technology developed under the project is adopted widely, there are several potential adverse affects which should be noted and monitored.

1. More extensive use of surface and ground water for irrigation could lead to declining water levels and deterioration of water quality (increased salinity).

2. Each dug well that is installed presents another opportunity for pollution/contamination and accompanying water-borne diseases such as malaria, schistosomiasis, and guinea worm.

3. Mismanagement of agricultural chemicals could result in pollution or runoff to the river and the shallow water table in area adjacent to the river and the shallow water table in areas adjacent to the

river. This could result in local health problems, algae blooms, fish kills, and other effects.

4. Deep plowing could lead to increasing the erosion potential of soil on the research stations or at ON-FARM research sites. If adopted extensively, other areas could be affected.

5. Increased use of animal traction will put increasing pressure on local grazing resources, exacerbating existing problems of vegetation depletion.

6. Establishment of many more small irrigation projects will further compound the land use problem by elimination of grazing sites and including brush and trees.

VI. Other Donor Programs in the SRB

Many other countries are providing technical assistance in the SRB. Also several other USAID funded activities are now operating or were recently completed. In addition there are multilateral donors providing assistance to one or more of the OMVS member states. Capsule summaries of the various project activities are given in this section.

Potential for cooperation between AR II and these other donor activities is indicated in the summaries. Commitment to cooperate and/or letters of agreement as necessary will be obtained after the CID field team is in place.

A. Bilateral Assistance

The following relevant bilateral assistance programs are now operating or were recently completed in the SRB.

Donor	: Belgium
Project Title	: None
Activity Sites	: Fanaye, Richard Toll (Senegal)
Brief Description	: Pays salaries and expenses of three scientists engaged in rice research (with WARDA and ISRA)
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through avoidance of duplication, exchange of ideas about programs, interaction of scientists, joint use of research facilities, and provision of assistance in scientific specialty (possibility observed in field, discussed with scientists).

Donor	: Canada (IDRC)
Project Title	: Vegetable production
Activity Sites:	: Samé and Kayes area villages (Mali)
Brief Description	: Introduce vegetable production and/or improve it by working closely with village dwellers (mainly women)
Status (1981)	: Continuing

Cooperation with this Project	: Cooperate through exchange of ideas about programs, interaction of scientists, provision of assistance in scientific specialties (possibility observed in field, discussed with personnel)

Donor	: Canada IDRC/CIDA
Project Title	: Rural Development of Noro du Rip
Activity Site	: Large area in Noro du Rip region (near Kayes and Samé, Mali)
Brief Description	: Integrated rural development including literacy training and mechanization of agriculture
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, provision of assistance in scientific specialties. (Administrators of project in Ottawa and Bamako expressed interest in full cooperation whenever possible.)

Donor	: England
Project Title	: None
Activity Sites	: Fanaye, Richard Toll (Senegal)
Brief Description	: Conducting weed science research plus planned soil scientist
Status (1981)	: Continuing, some expansion planned.
Cooperation with this Project	: Cooperate through exchange of ideas about programs, interaction of scientists, provision of assistance in scientific specialties (possibility observed in field, discussed with scientist, administrators in Dakar and London)

Donor	: France (FAC)
Title of Project	: General assistance agreement
Activity Sites	: Richard Toll, Fanaye (Senegal), Kaedi (Mauritania), Sotuba, Bamako (Mali)

Brief Description	: Scientists provided but have limited or no financial support, construction of houses, laboratories, storage at Kaedi
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through avoidance of duplication, exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties. (Cereal specialist in Kaedi willing to cooperate. FAC officials in Mauritania, Mali, and Senegal are open to all kinds of cooperation.)

Donor	: France (FAC, CCCE)
Project Title	: School for irrigation technicians (CNAPTI)
Activity Site	: Ndiaye (Senegal)
Brief Description	: Center to train 60 technicians in practical irrigation techniques
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, provision of training for project personnel (possibility recognized)

Donor	: France (FAC/CCE)
Project Title	: Secondary center for training
Activity Sites	: Matam and Aere-Lao (Senegal)
Brief Description	: Upgrading and refresher classes for technicians on small perimeter projects
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, provision of training for project personnel (possibility recognized)

Donor	: France (GERDAT)
Project Title	:
Activity Sites	: Kaedi to Bakel (Senegal, Mauritania)

Brief Description	: Master planning for irrigation development
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of information and ideas about programs, interaction of scientists, provision of assistance in scientific or technical specialty (possibility recognized)

Donor	: France (IRAT)
Project Title	: None
Activity Site	: SRB and other Senegal locations
Brief Description	: Provides horticulturist (contract ends late summer, 1982) with budget to conduct research (with GERDAT)
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through avoidance of duplication, exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties. (Horticulturist willing to cooperate with CID team.)

Donor	: Holland
Project Title	: Extension of Small Perimeters
Activity Site	: River Region, Senegal
Brief Description	: Reach and include more locations and villages in the small perimeter irrigation program (funding level is $2.0 million U.S.)
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, provision of assistance in scientific specialties (possibility recognized)

Donors	: Saudi Arabia (83%), France (FAC) (17%)
Project Title	: Water Resources and Livestock Production
Activity Site	: Kayes area, Mali

Brief Description	: Development of ranches and watering points plus building of slaughter houses and cold storage rooms
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, provision of assistance in scientific specialties (possibility observed, discussed with scientist)

Donor	: Switzerland
Project Title	: None
Activity Site	: 20 km N of St. Louis on road to Richard Toll
Brief Description	: Research on forages (experimental farm)
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas and information about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialty (possibility observed in field)

Donor	: Switzerland (SENDA)
Project Title	: None
Activity Site	: Guiere Lake (Senegal)
Brief Description	: Assistance in corn production
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through avoidance of duplication, exchange of ideas and information about programs, interaction of scientists, provision of assistance in scientific or technical specialty (possibility observed in field)

Donor	: USAID
Project Title	: Agricultural Research and Planning
Activity Site	: Senegal
Brief Description	: Assist ISRA in developing an agricultural economics study unit within agricultural research stations and a national team headquarters in St. Louis

Status (1981)	: In planning stage (Michigan State University is contractor)
Cooperation with this Project	: Cooperation discussed with MSU team leader and USAID (Dakar) director and agreed upon.

Donor	: USAID
Project Title	: Village Development (AIP)
Activity Sites	: Reo and Ross-Bethio, River Region (Senegal)
Brief Description	: Project has been underway since 1960 and since 1976 primary theme has been creation of self-run groups for advancement of women. Groups have several projects; e.g., agriculture, livestock, crafts, health, nutrition, literacy, and all projects are managed by women themselves working with village leaders.
Status (1981)	: Continuing
Cooperation with this Project	: This is a very important project with which our activities should be coordinated. Data will be exchanged, advice on OMVS program activities requested. Program could present model for future activities involving women in agriculture in Senegal River area.

Donor	: USAID and Peace Corps
Project Title	: Vegetable Projection
Activity Sites	: 3rd, 5th, 6th regions of Mauritania
Brief Description	: Nutritionist and PCV home economists train village women in vegetable food preparation techniques. Especially relevant for newly settled people. Program may be expanded to include preparation of weaning foods, food preservation, and processing. Female counterparts will be identified.
Status (1981)	: Funded FY 78-81
Cooperation with this Project	: Exchange of ideas about programs. Data exchange on women's role in vegetable production.

Donor	: USAID/Mali
Project Title	:
Activity Sites	: Kayes area (Mali)
Brief Description	: Financial assistance to OPI/API activities.
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, provision of assistance in scientific specialties (possibility recognized)

Donor	: USAID (PL 480 funds)
Project Title	:
Activity Sites	: Fanaye and Richard Toll, Senegal
Brief Description	: Construction of offices, 1 working room for agronomist (200 m^2) and 2 houses in Fanaye, crop research
Status (1981)	: Proposed
Cooperation with this Project	: Cooperate through avoidance of duplication, exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties (possibility recognized)

Donor	: USAID ($6 M U.S.)
Project Title	: Community Development Center
Activity Sites	: Seven locations in SRB (Senegal)
Brief Description	: Basic and literacy training and day care centers in villages
Status (1981)	:
Cooperation with this Project	: Cooperate through exchange of ideas about programs (possibility recognized)

Donor	: USAID ($2 M U.S.)
Project Title	: SAED Training
Activity Sites	: Richard Toll, Ross Bethio (Senegal)

Brief Description	: Maintenance and repair of heavy machinery (Richard Toll) and small light machinery (Ross Bethio) plus training 300 workers and 42 new extension agents
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through avoidance of duplication, training for project personnel, provision of assistance in technical specialty (possibility recognized)

Donor	: USAID/Mali
Project Title	: Samé school upgrading
Activity Sites	: Samé, Mali
Brief Description	: Rebuilding of school dormitory and classroom facilities to serve 160 students in vocational agriculture
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, training for project personnel, joint use of facilities, provision of assistance in scientific specialties (possibility observed in field)

Donor	: USAID/Senegal
Project Title	: Integrated Rural Development
Activity Sites	: SRB
Brief Description	: Develop irrigation projects (5000 ha), plan for political, social, and economic reform
Status (1981)	: Being designed
Cooperation with this Project	: Depends on use of our results for its success (possibility discussed with administrators)

Donor	: USAID/OMVS
Project Title	: Environmental Assessment
Activity Sites	: Entire SRB, headquarters Dakar
Brief Description	: Comprehensive study of environmental impact of dam construction on SRB

Status (1981)	: Completed, final report submitted by contractor
Cooperation with this Project	: Using their information

Donor	: USAID/OMVS
Project Title	: Data and Institutional Development
Activity Sites	: Entire SRB, headquarters in Dakar
Brief Description	: Assist OMVS in improving planning and management capability. Includes fiscal and groundwater monitoring components.
Status (1981)	: Continuing
Cooperation with this Project	: Use of their results (discussed, agreed upon)

Donor	: USAID
Project Title	: Cooperatives for the Use of Agricultural Machinery (CUMA)
Activity Sites	: SRB
Brief Description	: OMVS requested AID to finance establishment of more CUMA's modeled on two successful co-operatives established by SAED.
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, provision of assistance in scientific specialties (possibility recognized)

Donor	: USAID
Project Title	: Cereal Production, Phase II
Activity Sites	: Senegal
Brief Description	: Women's component to be added to extension unit within SODEVA. Village level training program initiated. Village women will be trained to provide extension services for millet and groundnut production to women in 28 villages.

Status (1981)	: Funded FY 80-84
Cooperation with this Project	: SODEVA's approach to integration of women farmers may serve as model for small scale irrigation projects

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Donor	: USAID
Project Title	: Integrated Rural Development Project
Activity Site	: Guidimake region, Mauritania
Brief Description	: Increase food production in Guidimake region. The project has a female agriculturalist developing specific activities to increase the involvement of women in the project.
Status (1981)	: Funded FY 1979-82
Cooperation with this Project	: Contact will be made with this project and discussions will be held with the female agriculturalist to gain insights as to how to integrate women into the OMVS project activities.

Donor	: USAID
Project Title	: Casamance Regional Development
Activity Sites	: Lower Casamance, Senegal
Brief Description	: Women's unit has been established in the Regional Development Agency. This unit is responsible for ensuring that women farmers receive extension assistance in rice, vegetable, fruit, and livestock production. The unit also is responsible for assisting women's groups in gaining access to existing agricultural credit and providing training to rural women's groups in income producing activities.
Status (1981)	: Funded FY 1978-84
Cooperation with this Project	: Contact will be made with Women's Unit in the Regional Development Agency. Relevance for OMVS area will be assessed.

Donor	: USAID
Project Title	: Oasis Development
Activity Sites	: 6 oasis areas in Mauritania
Brief Description	: Project will assist Mauritania to increase food production in oasis agriculture. Efforts will be directed to increase women's agricultural production in these areas.
Status (1981)	: Funded FY 1980-85
Cooperation with this	: Exchange of information on small scale irrigation development

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Donor	: West Germany (GTZ)
Project Title	: Forestry
Activity Site	: Kayes area
Brief Description	: Reforestation and development of nursery (5000 seedlings)
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties (possibility observed in field)

Donor	: West Germany (GTZ)
Project Title	: Rangeland, Forestry and Entomology
Activity Sites	: St. Louis and Fanaye (Senegal)
Brief Description	: Concentrated projects. Entomology labs constructed in Fanaye
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties. (Scientist is willing to cooperate whenever possible.)

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B. Multilateral Assistance

The following multilateral assistance projects are operating in the SRB:

Donor	: CILSS
Project Title	:
Activity Sites	: Richard Toll, Fanaye (Senegal)
Brief Description	: Entomology and weed research for crops other than rice, plus construction of two houses--Richard Toll
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties (possibility observed in field)

Donor	: FAO/UNDP
Project Title	: Agronomic Research
Activity Sites	: Mainly in Guede, Fanaye, St. Louis (Senegal), some activity in Kaedi (Mauritania), and Samé (Mali)
Brief Description	: Cultivar testing and selection of wheat, triticale, corn, rice, cowpeas, and soybeans plus cultivation practices such as date of seeding, use of fertilizers, seed bed preparation, and weed control; seed production farm (Samé)
Status (1981)	: Operating, but greatly reduced
Cooperation with this Project	: Will cooperate through use of results of research conducted since 1969 by that project, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties. (UNDP and FAO officials indicated interest in cooperating with CID team.)

Donor	: FED
Project Title	: Gorgol irrigation districts development

Activity Site	: Kaedi area, Mauritania
Brief Description	: Development of small irrigated areas (about 400 ha already prepared, 175 ha under cultivation in 1979)
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, interaction of scientists, provision of assistance in scientific specialties (Director expressed willingness to cooperate with CID team)

Donor	: IBRD (World Bank)
Project Title	: Commodity and farming systems research
Activity Sites	: Fanaye, Richard Toll (plus other Senegal locations)
Brief Description	: 78 ha prepared, proposes 6 houses plus guest house in Richard Toll, 1 dike (1,300 m), 1 drain (2,700 m), 23 houses, infirmary and club house in Fanaye, upgrading and restructuring of agricultural research institutions and capabilities in Senegal (with ISRA)
Status (1981)	: Planned
Cooperation with this	: Cooperate through avoidance of duplication, exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties (possibility discussed with planners, administrators)

Donor	IMPHOS (World Phosphate Institute)
Project Title	: Phosphate trials
Activity Sites	: Fanaye (Senegal), Rindiao, Belinabe stations (Mauritania)
Brief Description	: Study of phosphate deficiency in tropical soils (part of a worldwide study)
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of

	assistance in scientific specialties (possibility observed in field)
Donors	: IRRI/ICRISAT/(including AID funds)
Project Title	: Variety Trials (Semi-Arid Tropics Research)
Activity Site	: Samé, Mali
Brief Description	: Pre-packaged trials for rice (IRRI), wheat, triticale and corn (CIMMYT), sorghum and millet (ICRISAT) followed by statistical analysis
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through avoidance of duplication, exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties (possibility observed in field)

Donors	: Saudi Arabia, Kuwait, West Germany (KWI), Canada and others
Project Title	: Building of dams
Activity Sites	: Diama (Senegal), Manantali (Mali)
Brief Description	: Over 750 million dollars available. Canada pledged $10 M additional for study
Status (1o81)	: Completion projected for Diama dam in 1986 and Manantali in 1989
Cooperation with this Project	: Essential for future use of the project results (possibility recognized)

Donor	: UNDP
Project Title	: None
Activity Site	: Matam, Bakel, Aere-Lao (Senegal)
Brief Description	: Machine shop and facilities to maintain agricultural equipment for small irrigation projects. It also will train pump mechanics and other maintenance personnel plus providing spare parts (68.8 M CFA. Senegal contribution)
Status (1981)	: Continuing

Cooperation with this Project	: Cooperate through exchange of ideas about programs, training of project personnel, provision of assistance in technical specialties (possibility recognized)

Donor	: UNDP
Project Title	: None
Activity Sites	: Matam, Bakel (Senegal)
Brief Description	: Centers for farmer training, literacy training plus training in office methods and organization ($20,000 and 63.8 M CFA, Senegal contribution)
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through exchange of ideas about programs, training for project personnel, provision of assistance in technical specialties (possibility observed in field)

Donor	: UNICEF
Project Title	: Village and rangeland water system
Activity Site	: River Region and Eastern Region (Senegal)
Brief Description	: 35 wells to be dug and equipped with simple water lifting devices (over $2 M U.S.)
Status (1981)	: Proposed
Cooperation with this Project	: Cooperate through exchange of ideas about programs, provision of assistance in scientific specialties (possibility recognized)

Donor	: USAID, African Development Fund, IBRD
Project Title	: Rice and sorghum production
Activity Sites	: 7th Region of Mali
Brief Description	: Project introduces technology to prepare land and eradicate rice-eating fish. Women constitute 15% of participants in project. Project will improve rice production in two areas through introduction of improved seeds and better agricultural practices.

Status (1981)	: Funded FY 76-80; extended through FY 84
Cooperatin with this Project	: Gain ideas from this project on methods of involving women in improving agricultural techniques

Donor	: WARDA
Project Title	: Rice production improvement
Activity Sites	: SRB in Mali, Mauritania, and Senegal
Brief Description	: Selection of adapted cultivars, weed control, plant pathology, and entomology studies plus seed production
Status (1981)	: Continuing
Cooperation with this Project	: Cooperate through avoidance of duplication, exchange of ideas about programs, interaction of scientists, joint use of research facilities, provision of assistance in scientific specialties (possibility observed in field)

In addition to USAID projects detailed above there are many others being conducted or proposed as part of the individual country and Sahel region programs which have some relevance to this project (AID 1981). They include:

Mali

Millet Operation - increasing millet production and general rural development

Rice-Sorghum Action I, II - increase cereal production through small scale irrigation

Agricultural Officers Training - 60 technicians annually

High Valley Operation - assistance in growing corn, sorghum and rice

Kayes - Nioro Road

Wheat Action - increase irrigated wheat production (Niger River)

Rural Water (PVO) - constructing wells

Training Center for Rural Women - establish in cooperation with Mali National Women's Union

Development Leadership Training - 60 Malians to U.S. universities

Mauritania

Integrated Rural Development (Guidimaka) - agricultural interventions

Rural Land Reclamation (Brakna, Gorgol) - rebuild dams, protect irrigated areas from shifting sand

Oasis Development (Assaba) - increase production of crops and livestock, stabilize dunes

Environmental Restoration - stabilize sand dunes

Agricultural and Human Resources Development (Kaedi) - strengthen capacity to train rural development workers in extension and adaptive research

Senegal

Small Irrigated Perimeters (Bakel) - work on 24 small-scale village irrigation projects

Cereals Production I, II

Agricultural Sector Grant - finance imports to increase agricultural production

Information Management of Research

Sahel Regional

West Africa Major Cereals

Sahel (Regional Food) Crop Protection

Sahel Water Data Network and Management I, II - rainfall data

Sahel Fertilizer Development - use and production of phosphate rock

Planning, Management and Research - preliminary studies and project design

Institution Building Socioeconomic Development - CRS (PVO) - water, natural resources, agricultural production and small-scale rural development

PVO Sahel

Sahel Manpower Development

Sahel AIP - rural wells, millet processing, land tenure policy, rural radio

Improved Rural Technology - small village water supplies, food processing, energy, construction

Environmental Training and Management

Monitoring Renewable Resources

CEAO Management Training Center (Dakar) - post graduate training in cooperation with Senegal School of Management Studies (ESGE)

Strengthening Agricultural Research Programs

Food Production and Distribution Support

Sahel Operational Program Grant (OPG) - irrigated agriculture, rural development and resource regeneration

VII. Organizations Relevant to Research and Development in the SRB

English	French	Other	Explanation
ABEDA	BADEA		Arab Bank for Economic Development in Africa
ADB			African Development Bank
AFD	FAD		African Fund for Development
	AGCD		Administration General de la Cooperation au Developpement (Belgium)
AID			Agency for International Development (United States)
	BCEAO		Banque Centrale des Etats de l'Afrique de l'Ouest
	BNDS		Banque Nationale de Developpement du Senegal (National Development Bank)
	BRGM		Bureau de Reserches Géologique et Minieres (France
	CAA		Centre d'Apprentissage Agricole, Samé, Mali
	CEEMAT		Centres d'Etudes et d'Experimentation du Machinisme Agricole (France)
CGIAR			Consultative Group on Internationa Agricultural Research
CID			Consortium for International Development (United States)
CIDA	ACDI		Canadian International Development Agency
	CILSS		Comite Inter-Etat de Lutte Contre la Sechéresse Sahelienne (Sahelian Intergovernmental Drought Committee)
		CIMMYT	Centro Internacional de Majoramiento de Maiz & Trigo (International Center for Maize and Wheat Improvement) (Mexico)

English	French	Other	Explanation
	CNRA		Centre National de Recherche Agricole (National Agricultural Research Center) (Senegal)
	CNRADA		Centre National pour la Recherche Agronomique et le Developpement Agricole (Mauritania)
	CNRF		Centre National de Recherches Forestieres (National Forestry Research Center) (Senegal)
	CREA		Centre de Recherche d'Economie Applique, Universite de Dakar
	CTFT		Centre Technique Forestier Tropical (Tropical Forest Research Center) (France)
	DGRST		Delegation Generale de la Recherche Scientifique et Technique (Senegal)
ECOWAS	CEAO		Economic Community of West African States
EEC			European Economic Community
	EISMV		Ecole Inter-Etats des Sciences et Médicine Veterinaire de Dakar, University of Dakar
	ENEA		Ecole National d'Economie Applique, Dakar
	ENFVA		Ecole National de Formation et de Vulgarisation Agricole, Kaedi, Mauritania (National Agricultural Training School)
	FAC		Fond d'Aide et de Cooperation (France)
FAO			Food and Agriculture Organization of the UN
	FED		Fonds European de Developpement (European Development Fund)

English	French	Other	Explanation
	GERDAT		Groupement d'Etudes et de Réchecheres pour le Developpement de l'Agronomie Tropicale (France)
	GERSAR		Groupement d'Etudes et de Realisations des Societes d'Amenagement Regional (France)
GIRM, GOM, GOS			Government of Islamic Republic of Mauritania; Government of Mali; Government of Senegal
IADS			International Agriculture Development Service (United States)
IBRD	BIRD		International Bank for Reconstruction and Development (World Bank) (Banque International pour la Reconstruction et le Developpement, Banque Mondiole)
ICRISAT			International Crops Research Institute for the Semi-Arid Tropics (India)
IDRC	CRDI		International Development Research Center (Canada)
	IEMVT		Institut d'Elevage et de Médicine Veterinaire pour les Pays Tropicaux (Animal Production and Health Research Institute for Tropical Countries) (France)
	IER		Institut d'Economie Rurale (Bamako, Mali)
	INR		Institut de Developpement Rurale, Senegal (National Rural Development College)
IMPHOS			International Phosphate Institute
	IRAT		Institut de Recherches Agronomique (France) Tropicales et des Cultures Vivrieres (Research Institute for Tropical Agriculture)

English	French	Other	Explanation
IRRI			International Rice Research Institute, Los Baños, Philippines
	ISRA		Institut Senegalais de Recherche Agricoles, Senegal (Senegalese Agricultural Research Institute)
	ITA		Institut de Technologie Alimentaire (Senegal) (Food Technology Institute)
	LNERV		Laboratoire National d'Elevage et de Recherche Veterinaires, Senegal (National Animal Production and Health Research Laboratory)
	OACV		Operation Arachide et Cultures Vivrieres (Mali) (Peanut and Staple Food Crops Organization)
	OERS		Organization of Senegal River States (forerunner of OMVS)
	OMBEVI		Office Malien du Betail et de la Viande
	OMC		Office Mauritanian pour les Cereales (Mauritanian Agency for Cereals)
	OMVS		Organisation pour la Mise en Valeur du Fleuve, Senegal (Senegal Valley Development Organization)
	ONCAD		Office National de Cooperation et d'Assistance pour le Developpement (National Cooperatives Organization) (Senegal)
	OPAM		Office des Produits Alimentaires du Mali (Food Products Agency)
	OPI/API		Operation de perimeter Irrigués/ Action de perimeter Irrigués (Mali)
	ORSTOM		Office de Recherche Scientifique et Technique Outre-Mer (France) (Institute for Overseas Scientific and Technical Research)

English	French	Other	Explanation
	OVSTM		Operation Senegal River Valley, Terekole River, Lake Magui (Mali)
	SAED		Societe d'Amenagement et d'Exploitation des Terres du Delta du Fleuve (Senegal) (Senegal River Valley Development Agency)
	SATEC		Societe d'Assistance Technique et de Credit (Government Development Company) (France)
	SCET		Societe Centrale pour l'Equipment du Territoire (French company)
	SEDAGRI		Societe d'Etudes et de Developpement Agricole
	SOCAS		Societe de Conserves Agricoles du Senegal (Tomato canning company)
	SODESP		Societe de Developpement de l'Elevage dans la Zone Sylvo-Pastorale (Senegal) (Livestock Development Agency)
	SOGREAH		Societe Grenobloise pour les Etudes Agricoles et Hydrauliques (France)
	SONACOS		Societe Nationale de Commercialisation des Oleagineaux du Senegal (National Oil-Seed Commercialization Agency)
	SONADER		Societe National pour le Developpement Rural, Mauritania
	SONED		Societe Nationale des Etudes pour le Developpement (National Consulting Company)
	SONEPI		Society Nationale d'Etudes et de Promotion Industrielle (Senegal)
UNDP	PNUD		U.N. Development Program
USAID			U.S. Agency for International Development (missions)
WARDA	ADRAO		West African Rice Development Assn.