SENEGAL

AGRICULTURAL RESEARCH PROJECT

July 1979

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MAPS

ABBREVIATIONS

CIMMYT - International Maize and Wheat Improvement Center

CNRA - Centre National de la Recherche Agronomique

CTFT - Centre Technique Forestier Tropical

GERDAT - Grouppement d'Etudes and de Recherches pour le Developpement d'Agronomie Tropicale

IADS - International Agricultural Development Service

ICRISAT - International Crops Research Institute for the Semi-Arid Tropics

IDRC - International Development Research Centre

IEMVT - Institut d'Elevage et de Medecine Veterinaire des Pays Tropicaux

IITA - International Institute for Tropical Agriculture

INDR - Institut National de Developpement Rural

IRAT - Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres

IRRI - International Rice Research Institute

ISRA - Institut Senegalais de Recherche Agricole

ITA - Institut de Technologie Alimentaire

LNERV - Laboratoire National d'Elevage et de Recherches Veterinaires

OMVS - l'Organization pour la Mise en Valeur de la Vallee de Senegal

ONCAD - Office National de Cooperation et d'Assistance au Developpement

ORSTOM - Office de Recherche Scientifique et Technique Outre-Mer

PAPEM - Point d'Appui Pratique et Experimentation Multilocale

SAED - Societe d'Amenagement et d'Exploitation du Delta

SERST - Secretaire d'Etat a la Recherche Scientifique et Technique

SODEFITEX - Societe pour le Developpement des Fibres Textiles

SODESP - Societe de Developpement de l'Elevage dans la zone sylvo-pastorale

SODEVA - Societe de Developpement et de Vulgarisation Agricole

SOMIVAC - Societe pour la Mise en Valeur de la Casamance

TSU - Technical Support Unit

UE - Unite Experimentale

USAID - United States Agency for International Development

WARDA - West Africa Rice Development Association

CURRENCY EQUIVALENTS

Currency Unit = CFAF, Communaute Financiere Africaine Franc

U. S. $1 = CFAF 220

CFAF 1 = U. S. $0.0455

I. INTRODUCTION

The Government of Senegal, over a period of several months, has conducted an extensive review of its agricultural research and has decided to reorient the nature of the research effort. Research is to be made more problem oriented--that is, more applicable to the problems of the farmer--and the communication between research workers and the development and extension staff of the development societies and the Ministry of Rural Development will be intensified.

As a part of the review process, the Secretaire d'Etat a la Recherche Scientifique et Technique (SERST), the highest administrative planning body for scientific and technical research, requested the International Agricultural Development Service (IADS) to assist the Institut Senegalais de Recherche Agricole (ISRA) in developing a master plan for national agricultural research. The Joint Senegalese-IADS team report was finalized in December 1978.

In February 1979, the SERST requested further IADS assistance in preparing a project in support of certain segments of agricultural research for submission to the World Bank for possible financing. Basically this project would: (1) strengthen the national research capabilities through developing a more efficient organization and supporting services for ISRA headquarters, (2) create and support multidisciplined teams conducting research on the basic food crops (millet, sorghum, maize, rice, and cowpeas, vegetables and groundnuts), (3) strengthen the farming systems research programs (including animal production systems), and (4) provide for close and effective communications between research and the development authorities.

This report, submitted to the SERST is the result of the collaborative work of Senegalese scientists and IADS consultants. In preparing this proposal two documents were used extensively. These were the "Plan Indicatif National de la Recherche Agricole (1979-1984)," prepared in February, 1979, by officers of SERST and the earlier joint team report, "Senegal: Agricultural Research Review."

Members of the IADS team were Bill Wright (leader), Thomas E. Daves, Asrat Felleke, Dwight C. Finfrock, David Shoesmith, and Albert E. Sollod.

II. THE ROLE OF AGRICULTURE IN SENEGAL

Agriculture is dominant in Senegal's economy. Seventy percent of the population is rural and almost totally dependent on agriculture. Agriculture, along with livestock and fishing, contributed 25 to 30% of the Gross Domestic Product in recent years. Millet is the staple grain crop (along with sorghum), but rice is also important in Casamance, and maize is increasing in the wetter areas. Groundnut is the major cash crop. Senegal has been the leading exporter of groundnut oil in the world. Cotton is also grown as a cash crop in southern Senegal.

Cattle, sheep, and goats are important animals in almost all of Senegal, although only a small proportion of the national herd is marketed each year. Poor nutrition and diseases, as well as supplies of drinking water, are serious constraints to animal production.

Senegal is a net importer of food; food imports account for about 25% of all imports. Rice and sugar are the leading import items, but wheat and fruits are imported in substantial quantities. For the period 1971-74 Senegal imported 37% of its total cereals requirements. Agricultural and fishery products in 1976 accounted for 67% of all exports. In some years groundnut products account for more than 50% of Senegal's total exports.

Annex 1 gives more details of Senegal's agricultural economy.

III. CURRENT STATUS OF AGRICULTURAL RESEARCH

A. Beginnings of Agricultural Research

Senegal has a relatively long history of agricultural research, beginning in Bambey in 1921 when a research station was established to produce improved varieties of groundnuts and to study cultural methods. In 1933 this research on groundnuts was expanded to include other crops which are grown in association with groundnuts: millet, sorghum, and cowpeas. Later, in 1936, a chemistry laboratory was established and soil pedology investigations began. In 1938 Bambey became the Federal station for agronomic research in French West Africa. When Senegal became independent in 1960, Bambey became the chief agronomic research station in Senegal but, by bi-lateral agreement, the administration was placed in the hands of the French assistance organization, Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres (IRAT). When the Institut Senegalais de Recherches Agricoles (ISRA) was created in 1975, the management passed to Senegalese authorities, and the station became the Centre National de la Recherche Agronomique (CNRA). IRAT continued to assist in staffing and in financial support.

Similarly, animal research began with the establishment of the Laboratoire National d'Elevage et de Recherches Veterinaires (LNERV) at Hann near Dakar in 1935. This research station, like Bambey, had a federal responsibility for all of French West Africa until Senegalese independence in 1960 when it became the Senegalese institute under the management of the French organization, Institut d'Elevage et de Medecine Veterinaire des Pays Tropicaux (IEMVT). With the creation of ISRA in 1975 it too came under Senegalese management with the support of IEMVT staff and funding. Throughout its history the main activities of this laboratory have been directed toward animal health, the production of vaccines, and animal nutrition.

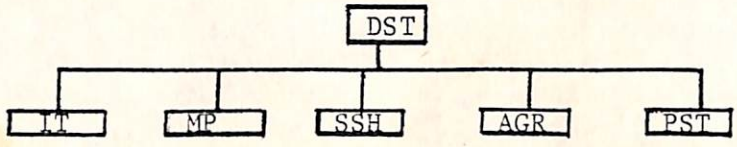
Oceanographic research in Senegal dates from 1961, when ORSTOM (Office de Recherche Scientifique et Technique Outre-Mer) began research in oceanography in Senegal. Later this research was transferred to ISRA. Oceanographic research has been confined mainly to population and ecological studies with the goal of developing the country's fishing industry and at the same time protecting Senegal's oceans and rivers from being depleted by over-fishing.

Forestry research was initiated in 1965 with the creation of CNRF whose management rested with the Centre Technique Forestier Tropical (CTFT) until ISRA came into being in 1975. Much of the forestry research has been concerned with forest conservation and reforestation.

B. Le Secretaire d'Etat a la Recherche Scientifique et Technique

In 1973 the Government of Senegal created the Delegation Generale a la Recherche Scientifique et Technique (DGRST) with broad authority for the administration of research. The DGRST was transformed to the SERST in 1979. The SERST is responsible directly to the Prime Minister and

has responsibility for planning, administering, coordinating, and evaluating nearly all research in the country. The SERST has four main divisions which are the Scientific and Technical Directorate, the External Relations Directorate, the Administrative and Financial Directorate, and the National Center for Scientific and Technical Documentation. The Scientific and Technical Directorate administers the Senegalese research organizations as shown in the following organogram:



DST = Scientific and Technical Directorate
IT = Division for industry, energy and mineral research
MP = Division of medical and pharmaceutical research
SSH = Division of social and humanitary research
AGR = Division of agricultural and oceanographic research
PST = Division of scientific and technical planning

There are two principal institutions in the division of agricultural and oceanographic research: ISRA, comprising almost all crop, animal, and oceanographic research in Senegal, and the Institut de Technologie Alimentaire (ITA).

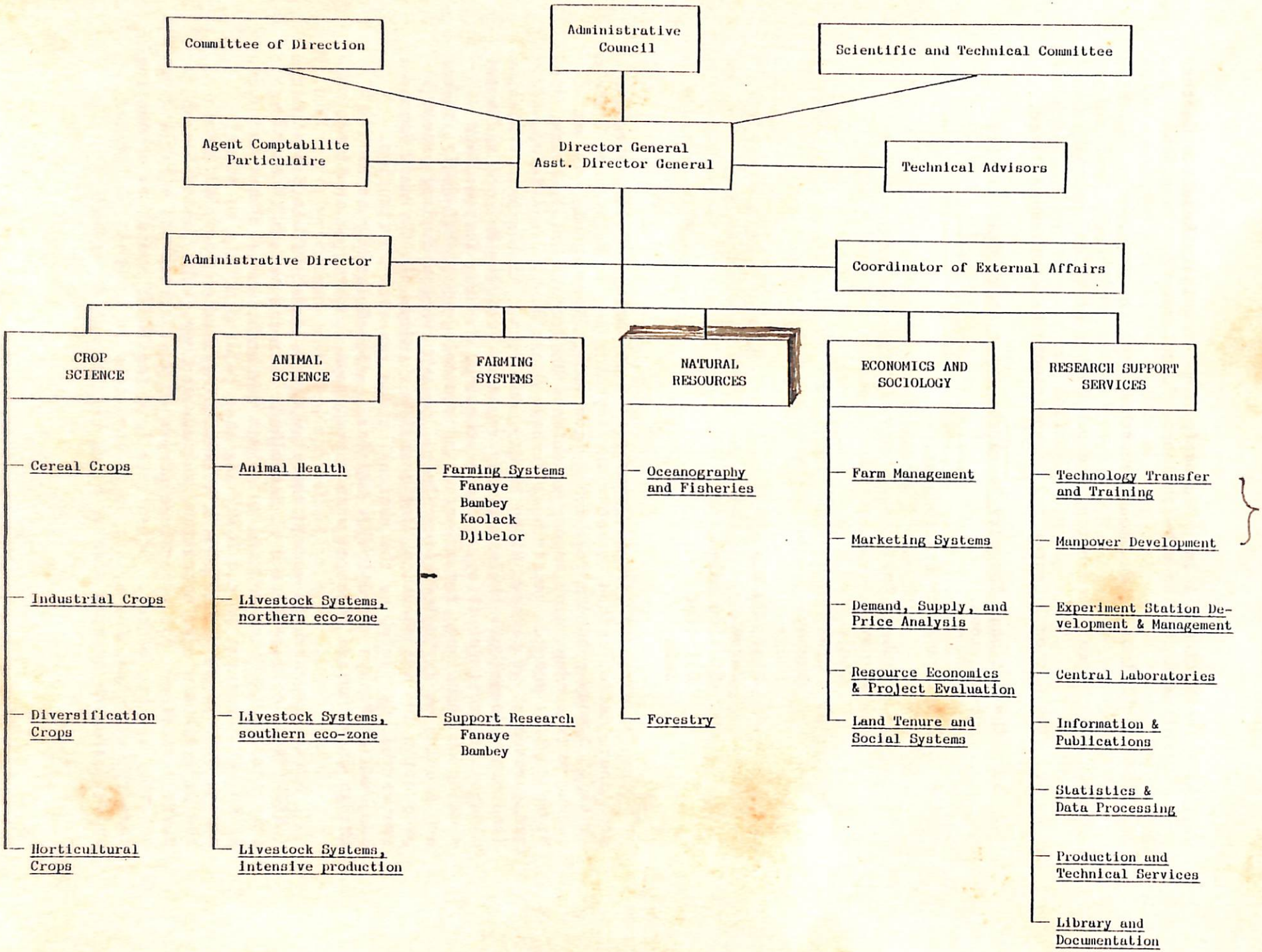
C. Institut Senegalais De Recherches Agricoles (ISRA)

The Institut Senegalais de Recherches Agricoles (ISRA), created in 1975, was charged with overall responsibility for agricultural (both crops and animals) and oceanographic research in the country. The organization for ISRA is given in Figure 3.1. The direction of ISRA is vested in the Council for Administration headed by a person named by the Prime Minister and having eighteen voting members and five consulting members. The Committee for Direction is concerned with financial and administrative oversight. The Scientific and Technical Committee oversees the plans and progress of ISRA's research operations.

Currently, ISRA has seven scientific departments: agronomy and bioclimatology, agricultural economics and sociology, forestry and hydrobiology, veterinary medicine and animal science, oceanography, agricultural machinery and equipment, and soil science. Because of lack of sufficient personnel one of these departments has no chief and two are being headed by the Director General of ISRA.

Under ISRA's direction are a number of research stations in various regions of Senegal (see Map 2, following Annex 23, for location of ISRA center). The important research stations are:

Figure 3.1. Proposed Organization of ISRA Headquarters



1. The National Animal Production and Veterinary Research Center at Hann and its sub-station at Sangalkam.

2. The Animal Production Research Center at Dahra.

3. The Animal Production Research Center at Kolda.

4. The National Center for Oceanographic Research near Dakar.

5. The National Forestry Research Center near Dakar and its sub-stations.

6. Crops research stations at:

    Richard Toll
    Fanaye
    Guede
    Ndiol
    Bambey
    Louga
    Nioro du Rip
    Darou
    Sintiou Malem
    Djibelor
    Sefa

Crop research in ISRA is concentrated at Bambey (millet, sorghum, groundnut, maize, cotton, cowpea, and soybean) and at Fanaye and Djibelor (rice). Bambey conducts research nation-wide. For example, millet research is conducted by Bambey scientists at Bambey, Ndiol, Louga, and Nioro du Rip; sorghum research at Bambey, Nioru du Rip, and Sefa; and maize research at Bambey, Nioro du Rip, and Sefa. At the Bambey station (and other locations) there are also research programs on soil and water management, soil fertility, plant protection, farming systems, and studies of techniques for transferring technology. Additionally, there are studies on agricultural machinery, post-harvest technology, seed production and introduction, and animal husbandry. In the past Bambey has served, de facto, as the national crops research institution. Research at Fanaye and Djibelor has been confined largely to rice although some limited research with other crops is going on at Fanaye.

Animal research is concentrated at the National Laboratory at Hann (LNERV) and its sub-station at Sangalkam. Outside the LNERV there are only three scientists working on animal research; one at Dahra and two at Kolda. Research at the LNERV has been related mostly to animal health (virology, bacteriology, helminthology, entomology, and protozoology), physiology, nutrition, and agrostology. The production of various vaccines (for several countries in West Africa) is a large activity of this center. Scientists from the IEMVT assist in conducting research at Dahra, Kolda, and other locations in Senegal. A limited animal research program also is being carried out at Bambey.

The Centre National de Recherche Forestiere (CNFR), located in Hann near Dakar, is a part of the activity of the department of forestry and hydrobiology of ISRA. It has a number of outlying field stations throughout the country, but most of these are nurseries and tree plantations. Although the center employs some 75 people, only three have full professional training; the remainder are technicians and laborers.

The principal activity of the center is to introduce and test fast-growing exotic forest trees that are drought tolerant. Most of the work is in the southern half of Senegal where rainfall exceeds 700 mm annually. In the lower Casamance, however, there is some work with silviculture and forest management.

The hydrobiological work is concerned with inland fisheries and the study of the shrimp population in the mangrove swamps of the lower Casamance River basin.

ISRA Manpower

Table 3.1 gives the approximate scientific staff of ISRA in December 1978 and indicates the numbers of Senegalese and foreign staff.

In the preceeding paragraphs it was pointed out that the CNRA at Bambey and the LNERV at Hann are the oldest and best developed research stations in Senegal. In fact, a very high proportion of Senegal's agricultural scientists are attached to these two stations: 59 out of a total of 99 scientists, or 60% of the total. Seven research stations have no staff at the scientific level residing at the station.

Of the total of 99 scientific staff, 36, or about 36% are Senegalese. Foreign scientists in ISRA are supplied mostly by French assistance organizations under bi-lateral agreements.

Another important point is that at ISRA Headquarters there are only five scientific staff. These are the Director General, Assistant Director General, and three foreign Technical Advisors (Conseilleur Technique). Moreover, these few people have other major additional responsibilities. For example, the Assistant Director General is additionally in charge of the Dahra experiment station, and one Conseilleur Technique is additionally head of a research section at Bambey. It is clear that the ISRA Headquarters staff is much too small to adequately supervise an expanded national research system.

ISRA Financing

ISRA is financed from two principal sources: the budget of the Government of Senegal and by French Assistance through bi-lateral conventions. Also other countries (Belgium, Germany, United States) assist in financing agricultural research in Senegal. Table 3.2 shows the level of funding for 1977/78 and, provisionally, for 1978/79, for the experiment stations. Table 3.3 gives the finalized budget for 78/79 according to source of funds and research area.

Table 3.1 Approximate number and distribution of ISRA scientific staff, December, 1978

Location	Senegalese Scientists	Foreign Scientists	Total
Richard Toll	5*	3	8
Fanaye	0	0	0
Ndiol	0	0	0
Guede	0	0	0
Dahra	1	0	1
Louga	0	0	0
Bambey	16	25	41**
Nioro du Rip	0	0	0
Darou	0	3	3
Djibelor	2	3	5
Sefa	0	0	0
Kolda	1	1	2
Sintiou Malem	0	0	0
ISRA Headquarters	2	3	5
LNERV	6	12	18
CRODT	4	11	15
CNRF	0	1	1
	37	62	99

* 3 Senegalese scientists are employed by WARDA

** 2 Senegalese and 3 foreign scientists are located at Kaolack

Table 3.2 Provisional Budgets for ISRA Research Stations

Center	(thousands of CFAF) 1977/78	1978/79
CNRA, Bambey	572,559	528,500
LNERV, Hann	308,791	294,750
Central (Sine-Saloum)	198,789	178,673
CRODT	83,546	88,990
ISRA Headquarters	80,050	85,350
Dahra	80,728	84,900
Richard Toll	85,209	77,278
Djibelor	61,122	66,125
Kolda	49,422	53,600
CNRF	41,342	45,485
Sefa	51,165	38,594
Total	1,612,723	1,542,245

Table 3.3 ISRA Budget 78/79

		1000's CFAF
Agronomic research		
Convention Generale (Senegal and French funds)		575,700
UNDP/ICRISAT		18,000
IDRC (WARDA)		80,000
FED		96,641
SAED		29,604
USAID		20,000
Senegal (national budget)		41,725
ISRA (sales)		56,000
	1000's CFAF	917,670
(GERDAT personnel	270,000*)	
Zootechnique research		
Convention Generale		308,000
(GERDAT personnel	150,000*)	
Forestry research		
Convention Generale		44,000
(GERDAT personnel	30,000*)	
Oceanographic research		
Convention Generale		87,000
(ORSTOM personnel	168,800*)	
ISRA Headquarters		84,500
Totals	(618,800*)	1,441,170

*Funded by France

IV. CURRENT STATUS OF AGRICULTURAL EDUCATION

A. Formal Education

The formal education system in Senegal is modeled after the French system. Primary education is a six-year program leading to a primary school certificate. About 20% of primary school graduates are admitted to the lower secondary schools ("college d'enseignement moyen general" or "technique") which offer a four-year program leading to a terminal diploma (brevet d'etudes du premier cycle).

The upper secondary schools (lycees) follow a seven-year program and confer the "baccalaureat" degree. Students finishing the upper secondary schools are automatically admitted to the University if they choose to go.

B. Technical Training

Technical training in agriculture is offered at a number of institutes. The National School for Rural Officers (Ecole Nationale des Cadres Ruraux, ENCR) at Bambey accepts students with a secondary degree for a 4-year study program that leads to careers in crop farming, animal production, agricultural engineering, water and forestry resources, and fisheries. This school, which has a capacity of 150 students, supplies many of ISRA senior technicians.

Other technical schools in various parts of the country offer training in agriculture, horticulture, livestock and veterinary medicine, and fisheries.

C. Higher Education

Until 1979 there was no Faculty of Agriculture in Senegal and, to date, Senegalese agriculturists have been trained at Western European, North American, and Soviet universities where training programs are not usually oriented to Senegal's needs.

With World Bank support a National College of Agriculture (Institut National de Developpement Rural - INDR) is being established at Thies. The college will have a capacity of 200 students, with an annual output of 40 graduates, and be located in Thies, about 40 km from Dakar. Students will be recruited at the baccalaureate level for a five-year program--a first preparatory year at the Department of Science of the University of Dakar, followed by four years at the INDR. The first two years will be used to strengthen the students' science background and provide basic training in agriculture. Main specializations will be offered from the third year onward in general agronomy, animal production, and agricultural engineering. Optional courses will also be available in forestry, horticulture, and agro-industrial sciences. The training program will be practical and oriented toward the needs of the rural development agencies, which will employ many of the graduates. This practical orientation of the program will be reinforced by supervised

field training periods. In 1979 the first group of students was admitted for the initial year at the Faculty of Science of the University of Dakar.

D. The Inter-State School of Science and Veterinary Medicine

The Ecole Inter-Etats des Sciences et Medecine Veterinaires de Dakar of the University of Dakar was founded in 1968 and graduated its first class in 1974. The school is a regional facility which can accept students from 14 African francophone countries.

Students having completed a baccalaureat du second degre or equivalent are considered for admission. The course work includes one preveterinary year of basic sciences and mathematics followed by four years of classroom instruction in veterinary medicine. The following percentages represent approximate relative emphasis on the various types of subject matter of the four-year program: veterinary medical arts and sciences, 66%; animal husbandry and agronomy, 19%; jurisprudence and economics, 10%; food technology and hygiene, 5%. After successful completion of the course work, students are allowed to continue for one year in a thesis program after which they are awarded the degree Docteur Veterinaire d'Etat.

The program, although intensive, does not provide in-depth speciality training nor does it allow extensive exposure to research methodology (other than the non-course work thesis year). Therefore, graduates wishing to pursue a career in research usually require additional, post-graduate training.

The school is currently graduating four to five Senegalese veterinarians each year. Beginning in 1981, the number of Senegalese graduates will double, making available additional candidates for graduate studies. Graduates of the veterinary school would be excellent candidates to pursue further studies in the animal health sciences, animal husbandry, or forage agronomy.

The school does not have funds for research so that faculty members wishing to pursue research have to do so in cooperation with another institution. The school has been granted land at Rufisque for an experimental farm but there is no money for its development. If funds could be obtained, the faculty are interested in pursuing research on alflatoxin, animal feeding technology, and infectious diseases.

E. Responsibility for Education

Responsibility for education is shared by three ministries:

(a) Ministry of National Education, responsible for general education, technical education, and vocational training up to the secondary level.

(b) Secretariate of State for Human Resources Development, attached to the Ministry of National Education and responsible for non-formal education and training, including literacy, farmer training, and rural youth training centers.

(c) Ministry of Higher Education, responsible for education and training at the post-secondary level.

In addition, several other ministries are responsible for training institutions in their own fields and several private enterprises operate their own vocational training and upgrading centers.

V. CURRENT STATUS OF AGRICULTURAL EXTENSION

Currently the extension functions in Senegal are the responsibility of several regional development societies, covering most of the country. These development societies are: SODEVA in the groundnut basin, SODEFITEX in Eastern Senegal, SOMIVAC in Casamance, SAED in the Senegal River Valley, and SODESP, a society to promote livestock production in the sylvo-pastoral zone. These societies were originally organized to promote a specific enterprise (SODEFITEX for cotton production, for example), but recently they have been given the responsibility for rural development in the general sense in their region.

The older of these organizations are established and reasonably functional. SODEVA, for example, employs around 1800 personnel, of whom about 900 are extension agents. SODEVA also has 80 training personnel located in three regions. These development societies are in all stages of evolution, from fairly mature to recently born and, consequently, their ability to function in the extension role varies considerably.

Although the development societies are under the Ministry of Rural Development, they all have their own Board of Management and Director, and they all receive a large share of their funding from external sources. Thus the societies, to varying levels, operate with some degree of autonomy.

Within the Ministry of Rural Development two organizations provide extension services to some extent. The Department of Livestock and Animal Industries has a responsibility for national livestock health programs. This department has a number of veterinarians, livestock officers, and veterinary assistants in seven regions (200 veterinary posts). It is responsible for free vaccinations, supervision of meat and milk processing operations, and animal production aspects, but its work is almost entirely oriented toward veterinary medicine.

The Centre Expansion Rurale Polyvalent in the Ministry of Rural Development functions in eight regions, 27 departments, and 93 arrondisements with about 270 staff. These teams are not focused only on agriculture but work in all aspects of rural development.

Although coniderable efforts have been made to create an effective interchange between the extension services of the agriculture development societies and the research organization, this linkage needs to be improved and strengthened further. One of the reasons for the lack of communication between ISRA and the development societies is that ISRA and the development societies are fairly new organizations and their roles and modes of operations are still evolving. Another reason is that the development societies operate with a large degree of autonomy and there is no central coordinating body for all the societies. In mid-1979 a research-liaison officer was appointed in the Ministry of Rural Development to serve as a link between the development societies and ISRA. This officer, a former research scientist, has the responsibility for keeping ISRA informed of research needs as perceived by the development societies.

Another cause of the lack of communication between research and extension is that the research scientists believe that the extension agents have too little training and are not in a position to fully appreciate the research being conducted by the research organization. As the training level of the extension services is increased, communications between the two groups should improve.

VI. THE PROJECT

A. The Project Area

This project would function in essentially all parts of the country of Senegal. Senegal is the westernmost country of Africa lying roughly between 12°N and 16.5°N lattitude and between 11.5°W and 17.5°W longitude. There is little physical relief in the country, much of it being relatively flat. Only in the extreme Southeast are there significant topographical features. The highest point in Senegal, 564m, is in the Southeast on the Guinean border.

The climate is varied with rainfall ranging from 350 mm in the extreme north to over 1600 mm on the southern border. Mean monthly temperatures range from 18° to 31°C. Most of the country is semi-arid with a realtively short rainy period and a long, hot dry season. Much of the country lies within what is commonly called the Sahel.

More details of the project area are given in Annex 2.

B. Brief Description

Research on the principal food crops (millet, sorghum, maize, rice, and cowpeas) and groundnuts would be strengthened by establishing multi-disciplined, coordinated, national research programs on these crops. Vegetable research is currently being carried out in the Ministry of Rural Development with assistance from an FAO/Belgium project. Vegetable research is not included in this project because it is already receiving adequate attention. Farming systems and livestock systems research teams would be strenghtened or initiated in six ecological regions of the country. ISRA Headquarters would be reorganized and strengthened to permit the efficient management of the enlarged research effort. A cadre of subject matter specialists is proposed to enhance the transfer of technology from the research organization to the farmers, through the extension activities of the production societies. This project would support these research programs through:

a. Training of Senegalese scientists to carry out the research;
b. Provision of funds for operating costs of the research programs;
c. Construction and equipment of improved research facilities at important research stations and ISRA Headquarters;
d. Provision of internationally recruited scientists on long and short term assignments;
e. Technical cooperation with international agriculture research institutes and outstanding national research programs of other countries.

These research programs would focus strongly on research needed to increase crop and livestock production throughout the country. The crop research programs would be mainly varietal improvement research programs. The farming systems research teams, backstopped by supporting research, would conduct research to: (1) better understand the present farming system and the economic and social constraints influencing farmers'

activities, (2) improve the farming system to make it more productive and profitable, (3) verify in farmers' fields that the experimental system is in fact more productive and profitable, and (4) study the effects on the farmer and the environment brought about by the adoption of the new technology. Because animals are an important facet of farming systems throughout Senegal, all the farming systems research would have a livestock component.

The livestock production systems teams would conduct a similar program focusing on livestock production rather than crop production.

The farming systems team at Kaolack would concentrate on the integrated crop/livestock production system conducting research to determine how best to maximize crop and livestock production in the same area.

Currently Senegalese scientists comprise a relatively small portion of ISRA's scientific staff and it is necessary to mount a strong training program to upgrade Senegalese staff to fill newly created posts and to replace foreign scientists. Under the fellowship program, about 63 Senegalese personnel would study abroad. Additionally, funds for technical cooperation are provided, part of which could be used to cover the costs of Senegalese attending training courses at some of the International Agricultural Research Institutes. At the time this project was prepared, there was not sufficient information regarding the number of qualified Senegalese available for fellowships to permit the planning of fellowship phasing. Total training costs are estimated to be $2,825,000.

Internationally recruited scientists, both long and short term, would be provided, totaling 475 man-months, at a cost of $3,846,000.

Construction of research facilities at seven experiment stations, ISRA's Headquarters buildings, and housing is estimated to cost $22,683,000.

Provision of field equipment, vehicles, and experimental land development to support the proposed research programs totals is estimated to cost $2,828,000 over a six-year project period.

Total operating costs, including salaries and field and laboratory expenses, are $18,001,000.

The total project cost, disbursed over a six-year period, would be $50,183,000.

C. Detailed Features

This project proposes the reorientation of ISRA's research toward multidisciplined teams conducting research to improve the principal food crops, farming systems in four regions of the country, and livestock production systems in two regions. Strengthening of ISRA Headquarters is proposed to enable it to adequately supervise and administer the accelerated research effort. A stronger linkage between the research and extension activities is also proposed.

Coordinated Crop Research Programs

Multidisciplined crop research teams are proposed for millet, maize, sorghum, rice, cowpeas, and groundnuts. These teams would consist of plant pathologists, entomologists, and sometimes plant physiologists whose responsibility would be to identify or create new varieties which are high-yielding, well adapted, have adequate resistance to prevalent diseases (and, hopefully, insects), and which have grain quality acceptable to the consumers.

These research programs would be led by a coordinator, an active scientist, located at a research station in an area of the country where that crop is most important. Research would be conducted on experiment stations, PAPEM's, and farmers' fields in all areas of the country in which the crop is important.

The following table indicates the proposed location of the coordinating centers and main research locations:

Location	Millet	Sorghum	Maize	Rice	Cowpeas	Groundnuts
Fanaye		x	x	o		
Ndiol	x					
Guede		x	x	x		
Bambey	o	x			o	o
Louga	x				x	
Kaolack	x	o	o		x	x
Nioro du Rip	x	x	x		x	x
Darou	x	x	x		x	x
Sintiou Malem	x	x	x		x	x
Djibelor				o		
Sefa	x		x			x

o indicates coordinating center
x indicates research location

A total of 32 scientists are proposed for these crop research programs. Currently approximately twenty scientists, both Senegalese and foreign, are at work on these crops research activities in ISRA. Of these twenty scientists, only approximately eight or nine are Senegalese. Thus, the full research activity in these programs cannot get under way until at least PY4.

Total training and operating costs for these crop improvement programs are estimated to be $8,497,000; $1,171,000 for training costs and $7,326,000 for operating costs.

The details of these coordinated crop improvement programs are given in Annexes 5, 6, 7, 8, 9, and 10. Also see Map 2, following Annex 23, for locations of ISRA experiment stations.

Farming Systems Research Programs

Multidisciplined farming systems research teams would be provided for irrigated conditions (Fanaye), low rainfall conditions (Bambey), moderate rainfall conditions (Kaolack), and moderate rainfall, rice-based conditions (Djibelor). These teams, consisting of agronomists, entomologists, animal scientists, economists, and sociologists would be responsible for studying the present farming systems and the farmer, conducting research aimed at modifying the present system to make it more productive and efficient, and testing the modified system under farmer conditions to make certain that it is productive and efficient. These farming systems teams, especially at Kaolack, would also determine how best to integrate livestock production into the overall farming system.

In addition to the farming systems teams, a number of scientists conducting research in support of the farming systems teams are proposed. Most of these would be located at Bambey and would do research which could be used by all the farming systems teams. The weed scientist at Bambey, for example, would screen and test herbicides and cultural techniques for controlling weeds which might be used by any of the farming systems teams.

The total number of scientists required to staff the farming system program, including supporting research, is 34. Currently in ISRA, there are approximately sixteen scientists conducting research that could be classified as farming systems or supporting research. About twelve of these are Senegalese, but some of them may require further training.

The estimated cost of training is $944,000 for the farming systems and support research programs. Operational costs are estimated at $7,167,000 for a total of $8,111,000.

Annex 11 details the farming systems research program.

Livestock Production Systems Programs

Two research teams are proposed for two regions which are predominantly oriented toward livestock production. One is the northern ecosystem, or the sylvo-pastoral region around Dahra and to the north. The other is the southern ecosystem of Middle and Upper Casamance, and Senegal Oriental. These teams, consisting of animal scientists, agronomists, economists, and sociologists, would study the present production system and the herders to fully understand what the herder does with his animals and why he does it. They would conduct research to find out how to change the system to make it more productive and profitable.

Once a new or modified system had been developed through research, the team would test it under existing range conditions to verify that it was, indeed, workable and profitable to the herdsmen.

A total of fifteen scientists would be required to staff the two livestock systems research programs. Currently at Dahra and Kolda, only one person at the scientist level is conducting research which perhaps

could be classified as livestock systems research. However, it is possible that some of the scientists at the IEMVT at Hann could redirect their research activity and shift to Dahra or Kolda to function as a member of the livestock systems team.

To assist in the initiation of these livestock systems programs, two internationally recruited scientists would be provided, one at Dahra and one at Kolda, in PY4, PY5, and PY6.

The estimated costs of the livestock systems programs are $622,000 for training and $2,846,000 for operating costs over the six-year project period, totaling $3,468,000.

Details of the livestock systems research programs are given in Annex 12.

Extension-Research Linkage

At each research station it is proposed to locate a subject matter specialist whose job would be to convey research results to extension personnel in the development societies and to help keep the researchers informed of the kind of research needed by the development societies. The subject matter specialist would be located with the farming systems or livestock systems team at the research station, but he would be a staff member of a development society assigned to the research station. Funds have been proposed in this project to train the subject matter specialist to the M.Sc. level, to support his operating costs, and to pay his salary.

The subject matter specialist would prepare publications describing latest research results for the use of the extension agents in the development societies. He would conduct training sessions for these agents. He would also organize field days for farmers to visit the experiment station. He would be the principal contact between research and extension personnel and would assist in arranging appropriate locations for experimental work on farmers' fields.

Training and operating costs for the subject matter specialists are included in the farming systems and livestock systems programs.

Annex 19 details the proposed subject matter specialists' roles.

ISRA Headquarters

ISRA Headquarters would be strengthened by the construction of new, adequate headquarters buildings. Apparently, ISRA Headquarters will be shifted to St. Louis from Dakar, a decision which may require careful review.

A new organization for ISRA has been proposed which would provide better management of the multidisciplined research programs and necessary support services. See Annex 3 for further details of ISRA organization.

Internationally Recruited Scientists

Five international scientists would be provided to assist ISRA in the transition from its present research activities to the multidisciplined team programs. These international scientists would be provided to assist in establishing the following activities: (1) farming systems research, (2) livestock systems research, (3) economics research, (4) experiment station development and operations, (5) research planning, management, and evaluation. Job descriptions for these posts are given in Annex 14.

In addition to these internationally recruited staff, two additional international scientists are proposed to assist the livestock systems teams at Dahra and Kolda, beginning in PY4, which is the year Senegalese scientists are expected to return to Senegal to take up their posts after post-graduate training.

The six-year estimated costs of long-term internationally recruited scientists is $3,444,000.

A total of 67 man-months of short-term consultants has been proposed, costing $402,000.

Annex 14 gives the cost details of the internationally recruited scientists.

Civil Works

The construction projects which would form the civil works component of the proposed research project are:

(1) Administrative headquarters for ISRA together with houses for senior staff.
(2) Further development of the research centers at Fanaye, Kaolack, Kolda, and Dahra.
(3) A new library and documentation center and storage facilities for experimental seed at Bambey together with renovation work in the laboratories.
(4) New houses, a barn, and renovation work at Nioro du Rip.
(5) Renovation work at Sefa.

ISRA Headquarters apparently are to be shifted from Dakar to St. Louis. The location of ISRA Headquarters is discussed more fully in Annex 3.

A major unresolved problem is the best location for staff housing for the researchers at Fanaye. A good case can be made for building a complete research facility at the research site itself, including staff housing and necessary social facilities. Alternatives are to locate housing in Richard Toll or, perhaps, Dagana. In any case it appears that the present site of ISRA offices, laboratories, and some housing is unsatisfactory for future construction. The location of housing in the Senegal River Valley must be studied with care by future Bank missions. This subject is discussed further in Annex 15.

Total projected costs for the civil works program are $22,683,000 disbursed over approximately 3.5 project years.

Further experiment station development is proposed at Fanaye and Dahra with estimated total costs of $912,000. The details are given in Annex 21.

Field equipment, research plot equipment, and vehicles have been proposed. Costs of these proposed items are: field equipment, $683,000; research plot equipment, $345,000; and vehicles, $888,000. Details of this proposed equipment are given in Annex 22.

Small Purchases Fund

A small purchase fund ($380,000) would be provided to enable the project to purchase experimental animals and other necessary inputs and to cover the costs of other small unforeseen expenses.

Cost Summary

Costs for the proposed project are summarized in Tables 6.1, 6.2, and 6.3. Of the total costs ($50,183,000), approximately $18 million (CFAF 3,960 million) would be disbursed as CFAF and the remainder ($32 million) as foreign exchange.

Details of the costs are given in the individual annexes relating to that segment of the project.

Table 6.1 Summary of Project Costs

	1000's U.S. $							Total Millions
	PY1	PY2	PY3	PY4	PY5	PY6	Total	CFAF
Development Costs								
Civil Works	1,641	4,545	12,727	3,770	-	-	22,683	4,990
Experiment Station Development	300	300	312	-	-	-	912	201
Field Equipment	365	188	130	-	-	-	683	150
Vehicles	310	303	275	-	-	-	888	195
Research Plot Equipment	105	105	100	20	15	-	345	76
	2,721	5,441	13,544	3,790	15	-	25,511	5,612
International Scientists								
International Scientists, Long Term	328	361	478	689	757	831	3,444	758
Consultants, Short Term	42	42	66	84	84	84	402	88
	370	403	544	773	841	915	3,846	846
Training								
Fellowships	878	878	878	-	-	-	2,634	579
Technical Cooperation	17	27	27	40	40	40	191	42
	895	905	905	40	40	40	2,825	621
Operating Costs								
Field and Laboratory Operations	645	721	842	1,937	2,071	2,278	8,494	1,869
Salaries	520	587	667	2,222	2,443	2,688	9,127	2,008
Small Purchase Fund	10	20	50	100	100	100	380	84
	1,175	1,328	1,559	4,259	4,614	5,066	18,001	3,961
Total	5,161	8,077	16,552	8,862	5,510	6,021	50,183	11,040

Table 6.2 Summary of Operations Costs

Research Program	1000's CFAF PY1	PY2	PY3	PY4	PY5	PY6	Total	Total $ 1000's
Millet								
Salaries	14,675	16,146	17,763	39,418	43,362	47,837	179,201	815
Field and Lab Opns.	23,100	25,300	27,720	43,032	47,335	52,068	218,555	993
Total	37,775	41,446	45,483	82,450	90,697	99,905	397,756	1,808
Sorghum								
Salaries	5,316	5,849	6,434	18,249	20,073	22,083	78,004	355
Field and Lab Opns.	12,100	13,200	14,410	28,391	18,150	19,966	106,217	483
Total	17,416	19,049	20,844	46,640	38,223	42,049	184,221	838
Maize								
Salaries	5,275	5,803	6,384	19,122	21,036	23,143	80,763	367
Field and Lab Opns.	7,150	7,700	8,305	19,250	21,175	23,294	86,874	395
Total	12,425	13,503	14,689	38,372	42,211	46,437	167,637	762
Rice								
Salaries	11,643	12,811	14,091	39,145	43,062	47,372	168,124	764
Field and Lab Opns.	11,000	12,100	13,310	31,141	34,255	37,681	139,487	634
Total	22,643	24,911	27,401	70,286	77,317	85,053	307,611	1,398
Cowpeas								
Salaries	2,025	2,228	2,451	21,772	23,951	26,349	78,776	358
Field and Lab Opns.	1,100	1,100	1,100	22,000	24,200	26,620	76,120	346
Total	3,125	3,328	3,551	43,772	48,151	52,969	154,896	704
Groundnuts								
Salaries	6,152	6,768	7,447	38,969	42,867	47,158	149,361	679
Field and Lab Opns.	28,050	30,800	33,825	47,603	52,363	57,600	250,241	1,137
Total	34,202	37,568	41,272	86,572	95,230	104,758	399,602	1,816
Farming Systems								
Salaries	38,325	42,158	46,376	155,020	170,536	187,601	640,016	2,909
Field and Lab Opns.	28,600	31,460	34,606	107,368	118,105	129,914	450,053	2,046
Total	66,925	73,618	80,982	262,388	288,641	317,515	1,090,069	4,955
Supporting Research								
Salaries	15,825	19,434	23,405	47,780	52,560	57,818	216,822	986
Field and Lab Opns.	27,500	30,250	33,275	53,105	58,415	64,255	266,800	1,213
Total	43,325	49,684	56,680	100,885	110,975	122,073	483,622	2,199
Livestock Systems								
Salaries	15,187	18,022	22,446	102,761	112,863	124,148	395,427	1,797
Field and Lab Opns.	3,300	6,600	13,200	62,700	68,970	75,867	230,637	1,048
Total	18,487	24,622	35,646	165,461	181,833	200,015	626,064	2,845
Economics								
Salaries	-	-	-	6,500	7,150	7,865	21,515	98
Field and Lab Opns.	-	-	5,500	11,500	12,705	13,976	43,731	199
	-	-	5,500	18,050	19,855	21,841	65,246	297
TOTAL	256,323	287,729	332,048	914,876	993,133	1,092,615	3,876,724	17,622
Salary Total	114,423	129,219	146,797	488,736	537,460	591,374	2,008,009	9,127
Field and Lab Opns	141,900	158,510	185,251	426,140	455,673	501,241	1,868,715	8,494

Table 6.3 Summary of Training Costs

Research Program	U.S. $							Total Millions CFAF
	PY1	PY2	PY3	PY4	PY5	PY6	Total	
Millet								
Fellowships	60,750	60,750	60,750	-	-	-	182,250	40.1
Tech Coop.	-	5,000	5,000	5,000	5,000	5,000	25,000	5.5
Total	60,750	65,750	65,750	5,000	5,000	5,000	207,250	45.6
Sorghum								
Fellowships	40,500	40,500	40,500	-	-	-	121,500	26.7
Tech Coop.	-	2,500	2,500	2,500	2,500	2,500	12,500	2.8
Total	40,500	43,000	43,000	2,500	2,500	2,500	134,000	29.5
Maize								
Fellowships	33,750	33,750	33,750	-	-	-	101,250	22.3
Tech Coop.	-	2,500	2,500	2,500	2,500	2,500	12,500	2.8
Total	33,750	36,250	36,250	2,500	2,500	2,500	113,750	25.1
Rice								
Fellowships	67,500	67,500	67,500	-	-	-	202,500	44.6
Tech Coop.	5,000	5,000	5,000	5,000	5,000	5,000	30,000	6.6
Total	72,500	72,500	72,500	5,000	5,000	5,000	232,500	51.2
Cowpeas								
Fellowships	54,000	54,000	54,000	-	-	-	162,000	35.6
Tech. Coop.	-	-	-	2,500	2,500	2,500	7,500	1.7
	54,000	54,000	54,000	2,500	2,500	2,500	169,500	37.3
Groundnuts								
Fellowships	94,500	94,500	94,500	-	-	-	283,500	62.4
Tech. Coop.	5,000	5,000	5,000	5,000	5,000	5,000	30,000	6.6
Total	99,500	99,500	99,500	5,000	5,000	5,000	313,500	69.0
Farming Systems								
Fellowships	229,500	229,500	229,500	-	-	-	688,500	151.5
Tech. Coop.	5,000	5,000	5,000	5,000	5,000	5,000	30,000	6.6
Total	234,500	234,500	234,500	5,000	5,000	5,000	718,500	158.1
Support Research								
Fellowships	67,500	67,500	67,500	-	-	-	202,500	44.6
Tech. Coop.	2,500	2,500	2,500	5,000	5,000	5,000	22,500	5.0
Total	70,000	70,700	70,000	5,000	5,000	5,000	225,000	49.6
Livestock Systems								
Fellowships	202,500	202,500	202,500	-	-	-	607,500	133.7
Tech. Coop.	-	-	-	5,000	5,000	5,000	15,000	3.3
Total	202,500	202,500	202,500	5,000	5,000	5,000	622,500	137.0
Economics								
Fellowships	27,000	27,000	27,000	-	-	-	81,000	17.8
Tech. Coop.	-	-	-	2,500	2,500	2,500	7,500	1.7
Total	27,000	27,000	27,000	2,500	2,500	2,500	88,500	19.5
TOTAL	895,000	905,000	905,000	40,000	40,000	40,000	2,825,000	621.5
Fellowship Total	877,500	877,500	877,500	-	-	-	2,632,500	579.2
Tech. Coop. Total	17,500	27,500	27,500	40,000	40,000	40,000	192,500	42.4

VII. PROJECT IMPLEMENTATION

A. Organization and Management

ISRA Headquarters

ISRA would be responsible for the execution of this project. The responsibility for each of the research programs would lie with the appropriate Department Head in ISRA Headquarters and the coordinator or leader of each of the multidisciplinary items.

A new organizational structure has been proposed for ISRA (Annex 3). In this structure the Director General and Assistant Director General would be the chief administrative officers. They would be assisted by Technical Advisors and the Administrative Director and his staff. A Coordinator of External Relations on the Director General's staff would coordinate the activities of the several donor organizations.

The Director General would also have the advice of the Committee of Direction and the Scientific and Technical Committee. The Administrative council would give overall guidance to ISRA.

Six departments are proposed, five with research functions and one with responsibility for supporting services. These department heads would function largely as administrators because research plans would be formulated by the multidisciplined research teams, led by the coordinator, in annual workshops (Annex 4).

To implement the civil works program and to provide general architectural and engineering service to ISRA, a Technical Support Unit (TSU) is proposed for ISRA Headquarters (Annex 17). The TSU would be staffed by an architect, an engineer with experience in irrigation and experiment station development, and supporting staff.

B. Phasing

This proposed project is for a period of six years, which is relatively short term for agricultural research. The time required to produce a new crop variety, for example, can easily require 10-15 years from the time the cross is made until the variety reaches the farmers' hands. This time span can be reduced significantly if more than one crop per year can be grown, but still the process takes time. A project of six years is particularly short in view of the paucity of well-trained Senegalese scientists and the necessity for a large training program. The slowness of construction in the remote areas of Senegal is also a factor. At the very outset consideration should be given to extending the length of this project by adding a Phase II at the end of the first six years.

The first three years of this project will be devoted mainly to: (1) strengthening the research programs that are now in place in ISRA, (2) training of Senegalese scientists to man the new research programs, and (3) construction of offices, laboratories, and housing at several

research stations, and procurement of vehicles and equipment. There is a sizeable research effort in ISRA at the present time. If these efforts are organized into multidisciplinary teams and reinforced by funds and equipment supplied through this project, a great deal of research progress can be made in the first three project years. However, some of the programs would very likely not be able to begin significant research until PY4 because of the lack of sufficiently well-trained staff.

C. Staff Development Program

General requirements for scientific and technical staff have been estimated and specified under each multidisciplined research program. The total number of scientific staff in the proposed project is 81. Currently there are approximately 100 scientific staff in ISRA, of which approximately 60 are conducting research on agronomic or animal science problems. Many of these 60 scientists could be assigned to the proposed research programs. A high proportion of these scientists now in ISRA are foreign scientists, and Senegalese would have to be trained to take their place. In preparing this project it has been assumed that foreign scientists now in ISRA will continue in their jobs until Senegalese scientists have been trained. In fact, one year of overlap, when both the expatriate and the Senegalese scientists are on the job, has been planned.

It is essential that ISRA scientists be payed sufficiently well to maintain a core of long-term scientific talent. In this project current pay scales have been upgraded by 25%. The salaries are elevated by 10% each year to account for inflation. At the very remote posts of Fanaye, Dahra, and Kolda a 25% incentive has been added to salaries.

D. Training

The training needs for the project are incorporated in the individual research programs. Fellowship requirements total to 63 for advanced degree study (to M.Sc. level). If this project should be extended to a second phase, fellowships for Ph.D. study should be included in Phase II.

Funds for scholarships are available to ISRA from a number of other sources, notably France and other bi-lateral donors. There is certain to be competition for qualified Senegalese to fill all the various fellowships. It has not been possible to accurately determine how many Senegalese are available for training to fill the posts in this project. For budgetary calculations it has been assumed that all fellowships could be utilized in the first three years of the project. This assumption is very likely not correct and this subject should be studied carefully by future Bank teams.

Funds have been provided in each of the research programs to finance international travel of Senegalese scientists to visit outstanding national research programs in other countries, to travel to international agricultural research institutes, or to attend international scientific meetings. This kind of interchange of ideas and first-hand knowledge of

the leading research activities is necessary to move Senegalese agricultural research into the mainstream of international agricultural research and development.

E. Internationally Recruited Staff

Seven long term internationally recruited posts have been provided in this project. Five of these would be located at ISRA Headquarters and would work on a nation-wide basis, assisting and giving leadership to programs in all parts of the country. The five positions at ISRA Headquarters are: a farming systems scientist, a livestock systems scientist, an economist (probably a farm management specialist), an experiment station development and management specialist, and a research program management specialist. The job descriptions for these posts are in Annex 14.

These specialists would help organize the multidisciplinary teams and help to orient their programs of research. In PY1-PY3 the research at some stations would be done by senior and junior technicians because the scientific personnel would be undergoing training. In such a case the international scientist would be required to give special attention to planning and overseeing the work at that location.

Two livestock systems specialists are provided for PY4-PY6 to be located at Dahra and Kolda. Because of the almost complete absence of livestock production scientists in Senegal the two livestock systems programs will not be able to function effectively until PY4. However, in PY1-PY3 both senior and junior technicians have been provided for both Dahra and Kolda, and these technicians, aided by the animal scientist stationed at ISRA Headquarters, would be able to lay the groundwork for the research programs. A number of short-term consultancies have been provided in this project to permit access to a specialized field of knowledge when this is necessary and to provide for outside review and evaluation of the progress of the research programs.

F. Civil Works

Site Acquisition

All sites at which construction is proposed are in Government ownership and additional land can be acquired without difficulty. The Government would undertake to provide utility services, as required, to the site boundaries without charge to the project.

Professional Services

The architectural problem would be defined in more detail in the form of an architectural brief for each station. This would be prepared by consultants financed by the project preparation facility. Architectural and engineering services would be provided by a national professional firm selected on the basis of procedures acceptable to the World Bank. Terms of reference are included as Annex 18.

Construction Supervision

This would be undertaken by the executive architects and would be verified by VERITAS.

Procurement

Civil Works contracts would be aggregated to be attractive to major contractors; contracts would be awarded on the basis of international competitive bidding, although recent experience has demonstrated little interest on the part of overseas contractors. Bidders would be pre-qualified and both the bidding and prequalifying procedures would be undertaken according to the Bank guidelines.

Equipment and furniture would be procured on the basis of prudent shopping. The award of contract for laboratory equipment would take into account the availability of service after sales and an adequate stockpile of spare parts in Senegal.

Maintenance of Buildings and Equipment

Hitherto ISRA buildings and laboratory equipment have suffered and their life expectancy has been reduced by lack of maintenance. To rectify this situation, the Government would enter into a covenant to provide funds for maintenance to the extent of 1% per annum of replacement cost of buildings for the first four years and 1½% per annum thereafter; for equipment, the allowance would be 5% per annum of replacement cost.

Technical Support Unit (TSU)

This would be established with ISRA to administer the implementation not only of the Bank financed projects but other projects with civil works components which are likely to arise. The TSU would be staffed by an architect, an engineer with experience in irrigation and experimental field development and supporting staff. In view of the importance of early selection and specification of laboratory equipment and preparation of pre-ordering schedules, this responsibility would rest with the TSU. For this purpose staff would be co-opted from other departments of ISRA or an equipment specialist would be appointed. The terms of reference for the TSU are included as Annex 17.

Progress Schedule

This has been included as Annex 16. The schedule indicates that the research centers will be available for use from early to late 1984 (project year 4) according to the magnitude of construction at each site. The protracted Government procedures for approving larger construction contracts, sometimes requiring 12-13 months for bidding and award, have been reflected in this schedule.

VIII. BENEFITS AND JUSTIFICATION

Estimation of the past or potential economic returns to agricultural research expenditures in Senegal would itself entail research study, for which neither time nor, quite likely, adequate data are available in the context of this report. In any case, the probable pay-off to research that would be initiated and supported by the proposed agricultural research project cannot be assessed until the project itself has been well specified. However, a considerable amount of research that assesses the economic returns to agricultural research in general and on numerous agricultural commodities has been done in other countries.

As shown in Table 8.1, rates of return on agricultural research have been found to be high in all of the studies completed. (The list is undoubtedly not complete, but it does represent the bulk of the research on research productivity that has been done.) That is, the estimated internal rates of return on agricultural research are, in virtually all cases, higher than interest rates in most countries and higher than the rates of return estimated for most development projects funded by national governments and/or international agencies. Moreover, it is apparent that probable returns to agricultural research are higher in general in developing countries than in developed countries. Because absolute levels of research expenditures as well as yields generally are higher in the developed than in the underdeveloped countries, this relationship probably reflects diminishing returns as research expenditures increase and as the inherent potentials of traditional resources and general resource combinations are approached.

Agricultural research expenditures in Senegal totaled about 1.36 billion CFAF ($6.2 million) in fiscal year 1978, about one percent of the value of agricultural production. In comparison to other countries, this level of commitment is quite high in percentage terms. The 1976 World Bank evaluation of agricultural research in Spain (Spain--Second Agricultural Research Project, Annex 5.16, page 2) reports agricultural research expenditures relative to value of agricultural product ranging from 0.23 to 2.33% in nine developed countries, in 1965. Nevertheless, Senegal's agricultural research expenditure is not large in absolute terms and because much of the expenditure is concentrated on a few commodities, the possibilities for high pay-off from broadening the research program, and staffing and funding it better are probably quite good.

Those crops to which considerable research commitment has been made, e.g., groundnuts and, to a lesser extent, millet, yield well in Senegal relative to international norms (Table 8.2). However, dramatic increases in yields for even these crops may be possible, as can be seen in the comparisons of Table 8.2. Yields of crops that have not received major research emphasis in Senegal, e.g., rice, lag far behind yields in most of the world's major producing countries. This is true also of the livestock subsector, for which very little production oriented research has been done in Senegal. The potential for advance in this subsector is great: the production take-off per animal unit (cattle) is in Senegal only about one-fifth as high as it is in some developed countries.

The above discussion should not be taken to suggest that all agricultural research that might be undertaken in Senegal would have a high economic return. But even one research project that is a major success could finance or justify the total agricultural research effort for years. From a national perspective, the projects that fail are part of the cost that must be borne by those that are productive. Minimization of the cost can be achieved through careful design of the research organization, staff development, constructively critical project evaluation, ex ante and ex post program and project monitoring and adequate funding.

It is also essential to have good extension programs using research results. A recent study of extension activities for several farm commodities in the United States shows that extension contributes between 60 and 78% of the effectiveness of research. That is, without extension activities only 22 to 40% of the potential increased benefits of research to society are realized. Extension, in fact, plays a dual role with respect to research. By definition, it is the vehicle for transmission of research results from researcher to all producers. However, it is also an important means to identify problems that are of importance to agricultural producers.

Table 8.1 Estimated Internal Rates of Return to Agricultural Research Expenditures

Commodity	Country	Study Commodity Studies	Time Period	Internal Rate of Return (%)
Maize	U.S.A.	Griliches (1958)	1940-55	35-40
Sorghum	U.S.A.	Griliches (1958)	1940-57	20
Poultry	U.S.A.	Peterson (1966)	1915-60	21-25
Sugarcane	S. Africa	Evenson (1969)	1945-58	40
Sugarcane	Australia	Evenson (1969)	1945-58	50
Sugarcane	India	Evenson (1969)		60
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
Maize & cultivation package	Peru	Hines (1972)	1954-67	50-55
Soybeans	Columbia	Montes (1973)	1960-71	76-96
Rice	Columbia	Ardila (1973)	1957-72	58-82
Rice	Japan	Hayamic & Akino (1975)	1930-61	73-75
Rice	Columbia	Scobie (1978)	1957-74	79-101
Rice	Asia	Evenson (1978)	1960-75	75-102
		Aggregate Studies		
All agriculture	Japan	Tang (1963)	1880-1938	35
All agriculture	U.S.A.	Griliches (1964)	1949-59	35-40
All agriculture	U.S.A.	Evenson (1968)	1949-59	47
All agriculture	India	Jha & Evenson (1970)	1953-71	40
Crops	Mexico	Ardito-Barletta (1970)	--	45-93
	International	Kislev & Evenson (1973)	1955-1968	
Applied Res	LDCs			42
	DCs			21
Ag. Scientific Res	LDCs			60
	DCs			36

1/ This study includes expenditures for extension programs in the internal rate of return calculations.

Sources: World Bank, Annex 5.16, Spain--Second Agricultural Research Project, Report 1153-SP, March 1976;
IADS, Appendix 4, SENEGAL--Agricultural Research Reviews, December 1978;
IRRI, Economic Consequences of the New Rice Technology, 1978, pp. 256,274.

Table 8.2 Comparisons of Groundnut, Millet and Rice Yields in Senegal with World and Africa Averages and Selected Major Producers

	Yields Kg/Ha	
Groundnuts	1969-1971	1978
World Ave.	925	968
Africa Ave.	786	787
Nigeria	900	313
China	1216	1174
India	797	847
Indonesia	1230	1334
Zaire	688	732
Mali	561	1094
U.S.A.	2182	2943
Senegal	789	1031
Millet		
World AVe.	661	641
Africa Ave.	623	598
Niger	421	333
Nigeria	556	610
Sudan	566	350
Upper Volta	418	389
China	766	689
India	519	545
U.S.S.R.	878	893
Senegal	540	605
Rice (Paddy)		
World Ave.	2320	2623
Africa Ave.	1866	1739
China	3223	3595
India	1668	2010
Bangladesh	1681	2000
Thailand	1947	1875
U.S.A.	5087	4538
Liberia	1194	1250
Nigeria	1293	1765
Tanzania	1190	1500
Senegal	812 (1968-72)	1383 (1976)

Sources: Table 4 (i.e., Tab le 4 from descriptive section); Monthly Bulletin of Statistics, Sept. 1978 and Jan. 1979.

ANNEXES

ANNEX 1

THE ROLE OF AGRICULTURE IN SENEGAL

A. Demographics and Income Level

In Senegal 70% of the population is rural (Annex Table 1.1) and is almost totally dependent on agriculture for family incomes. The proportion rural ranges from 70% to more than 90% in all of Senegal's administrative regions except Cap Vert (Dakar and suburbs) which is 84% urban. In the predominately rural regions population density ranges from 5 persons per square kilometer in Senegal Oriental to 98 in Diourbel and 107 in Thies. The national average density is about 26 persons per square kilometer. The population growth rate is estimated to be 2.65% per year, and despite a strong rural-to-urban migration, the rural population continues to grow.

Of the 1976 population of 5.1 million, about 2 million were employed, of which slightly over one-third were women. About 70% of these workers were employed in agriculture. A small proportion of the rural work force is engaged in commerce, forestry, or fishing, usually in conjunction with farming.

The standard of living of most Senegalese is quite low, regardless of how it is measured. Per capita income was only about U.S. $225 in 1977 and has not increased in real terms since the early 1960's (Annex Table 1.2). Both total agricultural and food output per capita have stagnated over the same period. The U.S. Department of Agriculture estimates that the indices of agricultural and food output on a 1961-65 base were 107 and 101, respectively, in 1977, and averaged 139 and 135 over the 1974-1976 period.[1] On a per capita basis the 1976 indices were 72 for agriculture in total, and 68 for food production. Only in one year since 1968 was food production per capita as high as the 1961-65 average.

Despite food imports, food availability is inadequate for a large part of the population. It is estimated that children of less than 6 years receive only about 70% and adults about 90% of their food needs. These averages cover up some major variations, however; 5 to 15% of all adults obtain only 70% of their nutritional needs. The period of the "Soudure" from July to October, just before harvest, is particularly food short for many families in subsistence agriculture. There are also regional differences with food availability being lowest in Senegal Oriental.

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[1] Indices of Agricultural Production in Africa and the Near East, 1968-77, Statistical Bulletin No. 610, ESES/USDA, July 1978.

In rural areas mortality is 20% for children up to 1 year of age. For the group 1 to 4 years, it is even higher--35%. Senegal also scores poorly on the Oversees Development Council's Physical Quality of Life Index (PQLI) that aggregates three indicators--infant mortality, life expectancy, and literacy. Individual countries rank from 1 to 100. In 1977 Sweden was highest with 100; Senegal was at 22.

B. Agricultural Characteristics

Agriculture, livestock, fishing, and forestry contributed 25 to 30% of the Gross Domestic Product (GDP) of the Senegalese economy in recent years (Annex Table 1.2). Of this contribution from agriculture over 70% came from crop and livestock products, about 19% came from the fishing industry, and 9% from forestry products. The fishing industry has been a bright spot in the economy, showing a growth of 15% per year between 1970 and 1974. During that period its share of the primary sector grew from 11 to 19%.

Crops

Two crops account for almost 90% of all cultivated crops in Senegal: millet at 38% of the cultivated area and groundnut at 51% (Annex Table 1.3). Millet is the staple subsistence food product in most rural areas and groundnut is the major cash crop. Cotton has been introduced in the southern part of the country and is emerging as another important cash crop. Millet and groundnut are produced in all regions of the country but are concentrated in central Senegal, particularly Diourbel and Sine-Saloum. Cotton is grown only in Casamance, Senegal Oriental and southern Sine-Saloum. New varieties, expanded use of fertilizer and other agricultural chemicals, and land development programs have resulted in increased production of the major crops (Annex Table 1.4). Groundnut production in 1976 was 48% greater than in 1968; rice production was 90% greater. Both areas and yields of rice, groundnut, and cotton have expanded; however, considerably more increase is needed to meet domestic food needs. The Senegal River Development scheme and irrigation plans for the Casamance should considerably expand production capacity for rice and, possibly, wheat.

Livestock

In 1975 there were 2.4 million cattle and 2.7 million sheep and goats in Senegal (Annex Table 1.6). Production appears to be important for all regions of the country except Cap Vert. Hog production is concentrated in Casamance and near Dakar. Though livestock numbers are large relative to the human population, meat consumption per capita is quite low, no more than 10 to 15 kg. For cattle the estimated annual off-take is only 10%. The estimated off-take is 25% for sheep and goats. The low rates of production occur because of high death rates among young animals and low rates of fecundity due to poor nutrition, inadequate disease control, and sub-optimal management practices.

Trade

Agricultural and food products are very important in Senegal's foreign trade activities. In total, Senegal is a net importer. Exports covered only 54 to 80% of the value of imports for the years 1972 through 1976 (Annex Table 1.7). Agricultural and fishery products are among Senegal's major exports, accounting for 67% of all exports in 1976. Groundnut oil and groundnut products are, by far, the most important single export product group, usually accounting for from 35 to more than 50% of total exports. Imports of food contribute substantially to Senegal's deficit balance of trade. About one-fourth of all imports are food products. In value terms rice and sugar are the leading imported foods, but substantial quantities of wheat and of fruits and vegetables are also imported. For all cereals, 37% of total requirements were imported during the period 1971-74 and in 1976 (Annex Table 1.5). However, cereals imports were reduced to only 43% of the total supply in 1977. Throughout the period since 1971 virtually all of the wheat and 75 to 80% of the rice has been imported. The development strategy for the 5th Plan calls for a reduction of cereal imports to 17% of total use through increased domestic production. France is still Senegal's dominant trade partner. It was the market for about 45% of all exports and the source of 40% of all imports in 1976. France is the major buyer of groundnut oil and groundnut products.

C. Objectives and Strategies for Agricultural Development

Senegal is now operating under its fifth four-year development plan, and hopes to create a semi-industrial society by the year 2001. The level of rural Gross Domestic Product (GNP) is projected to increase by about six times between 1977 and 2001. Given the expected population growth rate, such an increase would result in a tripling of real income per person (Annex Table 1.1). The annual growth rates of the economy needed to achieve these goals are 5.8% until 1985 and 8.9% thereafter. The extremely high projected growth rate after 1985 is based on expectations that many of the large capital projects now underway (industrial and water development) will be coming into production after 1985. These rates appear to be very optimistic.

The 5th Plan recognizes that the directly productive sectors of the economy, industry and agriculture, need to be diversified and modernized. Other sectors such as transport, communications, education, research, and health need to be improved not only to provide the technical and management needs for increased production but also to improve the well-being of the population. Foreign trade should be modified through expansion and diversification of exports and through reduction of food imports. Because agriculture accounts for such a large part of economic activity, (70% of employment, 23% of the Gross Domestic Product, and 45% or more of total export earnings) and will continue to do so into the foreseeable future, agricultural development will inevitably be a major part of any improvement in the quality of life in Senegal. Agricultural growth is needed to provide for increased food consumption and nutrition, to increase the income of rural people, to provide savings to finance the necessary investments in all sectors.

Objectives for the agricultural (crops) subsector in the 5th Plan are to reduce deficits in food crops, to increase the output of industrial crops (groundnut, cotton, and sugarcane), and to expand the domestic processing of agricultural products. For the livestock subsector, herds and their productivity are to be increased. For the fishing subsector, the output of the modern fleet is to be expanded. In the forestry subsector reforestation, protection of forests, and management to expand production will be emphasized. The projected annual growth rates to 1981 for each of these subsectors are:

Crops	4.3%
Livestock	3.0
Forestry	2.9
Fishing	5.6
For the primary sector	4.1%

Development objectives or targets have been specified for each of these subsectors during the 5th Plan.

Crops

Crops subsector objectives include stabilization of production of groundnuts for oil at about 1,200,000 tons annually; diversification and expansion of food production and, by 1985, limitation of rice and wheat imports to 75,000 tons annually. Annual growth rate targets for individual crops are: 11.7% for millet and sorghum, 26% for rice, 7.6% for cotton, 38.3% for maize, and 12.9% for confectionary groundnuts. Increases in domestic cereal production are planned to cover 83% of domestic demand in 1981 as compared to 58% in 1975.

Fruit and vegetable production is to be expanded to enable per capita annual consumption of 15 kg and 25 kg, respectively; and to reduce imports, particularly of citrus, bananas, potatoes, and onions. Part of the expansion will come from off-season vegetable production. Exports of mangoes and avocadoes are to be increased. Farm mechanization is to be encouraged, primarily with animal drawn equipment, and fertilizer use is to be expanded by 12% per year.

Livestock

Livestock subsector objectives are to achieve a growth rate of 3 to 5% in meat production; increase use of crop by-products; increase forage production in the Senegal River Valley; develop feedlots for cattle fattening; increase milk production in Cap Vert; expand goat milk production; and increase poultry production as a substitute for beef.

Forestry

Objectives for the forestry subsector include reforestation of 30,000 hectares; tree plantings for the protection of soils and to provide windbreaks for growing crops and livestock; increased lumber and charcoal production, and better protection for wild animals.

Fishing

Among the 5th Plan objectives for the fishing subsector are co-operation with countries of the region to improve productivity of the coastal fishery; modernization of the traditional fishing sector; development of new foreign markets; and expansion of the fish processing industry. A specific Plan target is to expand the production of the modern industrial fishing fleet by 11.8% per year.

Annex Table 1.1: Population, Percent Rural, and Population Density by Region in Senegal, July 1976

Region	Population	Percent Rural	Area	Population Density
	1000's	%	Km^2	Persons/Km^2
Cap Vert	990.3	16	550	1,801
Casamance	740.8	83	28,491	26
Diourbel	427.6	80	4,363	98
Fleuve	531.5	79	44,292	12
Louga	420.1	92	30,010	14
Senegal Oriental	287.8	91	57,558	5
Sine-Saloum	1,013.5	87	24,132	42
Thies	703.0	75	6,570	107
Total	5,114.6	70	196,000	26

Source: 5^{eme} Plan, Ministere du Plan

Annex Table 1.2: Economic Accounts of Senegal Estimates and Projections for Selected Years and Periods, 1961-2001

	1961-65	1966-70	1971-75	1976	1977[1/]	Projections 1981	1985	2001
Gross Domestic Product[2/] (current prices)				Billion CFAF				
Primary Sector	46.8 (25.8)[3/]	53.4 (24.6)	77.1 (25.0)	138.8 (30.2)	130.6 (23.5)	---	---	---
Secondary Sector	33.5 (18.4)	44.9 (20.7)	68.5 (22.2)	101.4 (22.1)	144.9 (26.1)	---	---	---
Tertiary Sector	101.2 (55.8)	118.6 (54.7)	163.2 (52.8)	219.9 (47.7)	279.9 (50.4)	---	---	---
Total	181.5	216.9	308.9	459.3	555.4	---	---	---
Gross Domestic Product (1971 prices)	213.5	236.3	252.0	264.0	295.4	367.2	460.1	1,803.2
Population (millions)	3.55	4.33	4.71	5.12	5.25	5.89	6.56	9.73
GDP Per Capita								
CFAF, 1971 prices	60,140	54,570	53,500	51,560	56,260	62,340	70,140	185,320
$US, 1$ = 250 CFAF	240	218	214	206	225	249	280	741

1/ Preliminary

2/ Primary Sector--agriculture, livestock, fishing, forestry; Secondary Sector--manufacturing, construction; Tertiary Sector--transportation, trade, services.

3/ Numbers in parentheses are the percentage contributions of the individual sectors to total GDP.

Sources: 5eme Plan, Ministere du Plan; Statistiques Economiques et Monetaires, No. 269 (February 1979) and No. 257 (January 1978), BCEAO; Indices of Agricultural Production in Africa and the Near East, 1968-1977, Statistical Bulletin No. 610, ESCS/U.S. Department of Agriculture, July 1978.

Annex Table 1.3: Areas Devoted to Crops by Region in Senegal, 1975-76
1000's of hectares

Region	Millet	Cowpea	Rice	Maize	Cassava	Potato	Vegetables	Groundnut	Cotton
Cap Vert	1.8	.1	---	.05	.1	---	3.4	2.5	---
Casamance	90.7	2.5	70.9	15.3	1.4	.5	.2	126.4	17.7
Diourbel	316.6	29.8	---	10.7	9.0	---	.3	374.2	---
Fleuve	93.6	10.7	10.5	---	---	1.9	1.5	6.8	---
Senegal Oriental	69.7	---	5.4	26.7	---	---	---	58.9	16.9
Sine-Saloum	262.2	---	---	2.9	7.2	.3	.02	537.7	5.6
Thies	128.5	---	.3	.7	10.3	---	1.4	195.8	---
SENEGAL	963.1	58.4	87.1	56.4	28.0	2.7	7.0	1302.3	39.7
Percentage of total cultivated area	38.0	2.3	3.4	2.2	1.1	.1	.1	51.4	1.6

Source: Situation Economique du Senegal, 1976, Direction de la Statistique, Ministere des Finances.

Annex Table 1.4: Area Planted, Yield Per Hectare, and Total Production for Selected Crops in Senegal: 1964, 1968, 1972, 1976 and Projections for 1980

	1st Plan 1964	2nd Plan 1968	3rd Plan 1972	4th plan 1976	5th Plan[1] 1980
Millet and Sorghum					
Area ('000 ha)	1010	1054	936	952	1080
Yield (kg/ha)	527	427	345	582	694
Production ('000 T)	532	450	323	554	750
Groundnut					
Area ('000 ha)	1050	1191	1071	1322	1254
Yield (kg/ha)	946	698	532	929	1004
Production ('000 T)	993	831	570	1228	1259
Maize					
Area ('000 ha)	47	36	32	47	87
Yield (kg/ha)	788	696	625	1000	1700
Production ('000 T)	37	25	20	47	148
Rice (Paddy)					
Area ('000 ha)	87	77	50	81	125
Yield (kg/ha)	1252	759	866	1383	2400
Production ('000 T)	109	59	44	112	300
Cotton					
Area ('000 ha)	2	7	20	44	55
Yield (kg/ha)	360	1459	1155	1082	1200
Production ('000 T)	1	10	24	47	66
Cowpeas					
Area ('000 ha)	NA	NA	88	58	79
Yield (kg/ha)	NA	NA	125	274	297
Production ('000 T)	15	17	11	16	23
Cassava					
Area ('000 ha)	NA	NA	73	36	44
Yield (kg/ha)	NA	NA	3688	3917	3900
Production ('000 T)	151	232	270	141	171
Wheat					
Area ('000 ha)	0	0	0	NA	NA
Yield (kg/ha)	0	0	0	NA	NA
Production ('000 T)	0	0	0	1	29

1/ Projections

Sources: 5eme Plan, Ministere du Plan; Indices of Agricultural Production in Africa and the Near East, 1968-77, Statistical Bulletin No. 610, ESCU/USDA, July 1978

Annex Table 1.5: Cereals Sector Supply Components, 1971-74 Average, 1976 and 1977

	1971-74		1976		1977 1/	
Millet and Sorghum	1000 MT	%	1000 MT	%	1000 MT	%
Production	470	95.5	555	-	459	100.0
Imports	22	4.5	NA	-	0	0.0
Total	492	100.0	-	-	459	100.0
Rice						
Production 2/	56	23.6	67	21.5	50	18.6
Imports	181	76.4	244	78.4	218	81.3
Total	237	99.0	311	99.9	268	99.9
Wheat						
Production	0	0	1	0.8	1	0.5
Imports	92	100.0	120	99.2	201	99.5
Total	92	100.0	121	100.0	202	100.0
Maize						
Production	34	53.1	47	-	45	100.0
Imports	30	46.9	NA	-	0	0.0
Total	64	100.0	-	-	45	100.0
All Cereals						
Production	560	63.3	670	63.4	555	57.0
Imports	325	36.7	387	36.6	419	43.0
Total	885	100.0	1057	100.0	974	100.0

1/ Preliminary estimates

2/ Paddy production estimates converted to rice equivalent using a coefficient of 0.6

Sources: FAO Monthly Bulletin of Statistics, Vol. 1, No. 9 FAO, September 1978; Indices of Agricultural Production in Africa and the Near East 1968-77, Statistical Bulletin No. 610, ESCS/USDA, July 1978; Statistiques Economiques et Monetaires, No. 269, BCEAO, February 1979

Annex Table 1.6: Livestock Numbers and Slaughter in Senegal, 1976

Region	Cattle		Sheep & Goats		Hogs		Horses	
	No. of Head 1000	%	No. of Head 1000	%	No. of Head 1000	%	No. of Head 1000	%
Livestock Numbers								
Cap Vert	13	0.5	17	0.6	19	11.2	neg	0.1
Casamance	485	19.9	422	15.8	125	75.1	1	0.6
Diourbel	112	4.6	98	3.7	1	0.5	33	15.0
Fleuve	501	20.5	721	27.1	2	1.3	20	9.3
Senegal Oriental	330	13.5	161	6.0	---	---	4	1.8
Sine-Saloum	494	20.3	457	17.2	7	4.1	70	32.3
Thies	127	5.2	292	11.1	13	7.8	29	13.2
Louga	378	15.5	495	18.6	---	---	60	27.5
Total	2439	100.0	2661	100.0	167	100.0	217	100.0
Livestock Slaughter	244	10.0	665	25.0	124	75.0	22	10.0

Source: Situation Economique du Senegal, 1976, Direction de la Statistique, Ministere des Finances.

Annex Table 1.7: Senegalese Exports, Imports and Trade Balance, 1972-1976

	1972		1973		1974		1975		1976	
	Million CFAF	%	Million CFAF	%	Million CFAF	%	Million CFAF	%	Million CFAF	%
EXPORTS										
Agricultural Products										
Groundnut Products	28,787	52.9	15,274	35.3	33,983	36.2	40,319	40.7	64,342	55.5
Fish Products	4,198	7.7	4,680	10.8	7,226	7.7	7,357	7.4	7,862	6.8
Fruits and Vegetables (fresh and processed)	479	0.9	697	1.6	772	0.8	1,069	1.1	677	0.6
Seed Cotton	868	1.6	1,032	2.4	2,266	2.4	1,308	1.3	2,788	2.4
Tobacco	613	1.1	676	1.6	736	0.8	842	0.8	587	0.5
Hides and Leather	408	0.7	810	1.9	464	0.5	327	0.3	418	0.4
Other Agricultural	869	1.6	1,048	2.4	1,995	2.1	674	0.7	492	0.4
Sub-total Agricultural	36,222	66.6	24,217	56.0	47,442	50.5	51,896	52.4	77,166	66.6
Phosphate Products	5,436	10.0	5,589	12.9	26,036	27.7	23,734	23.9	16,909	14.6
Petroleum Products	2,203	4.0	2,537	5.9	5,308	5.6	6,948	7.0	5,316	4.6
Other	10,551	19.4	10,894	25.2	15,197	16.2	16,253	16.4	16,534	14.3
Total Exports	54,412	100.0	43,237	100.0	93,983	100.0	99,101	99.7	115,925	100.1
IMPORTS										
Agricultural Products										
Fish and Meat Products	393	0.6	296	0.4	371	0.3	235	0.2	337	0.2
Dairy Products	2,151	3.1	1,781	2.2	1,986	1.7	2,411	1.9	2,145	1.4
Fruits and Vegetables (fresh and processed)	2,395	3.4	2,654	3.3	2,920	2.4	3,392	2.7	4,956	3.2
Rice	4,252	6.0	9,519	11.9	18,032	15.1	6,050	4.8	10,675	6.9
Wheat	2,125	3.0	2,619	3.3	2,858	2.4	4,623	3.7	5,372	3.5
Coarse Cereals	428	0.6	2,609	3.2	1,230	1.0	456	0.4	683	0.4
Sugar	4,503	6.4	5,374	6.7	9,294	7.8	7,831	6.3	10,132	6.6
Tobacco	574	0.8	686	0.8	754	0.6	1,047	0.8	1,626	1.0
Sub-total Agricultural	16,821	23.9	25,538	31.8	37,445	31.4	26,045	20.9	35,926	23.3

Annex Table 1.7 (Continued)

Fertilizers	207	0.3	286	0.4	639	0.5	2,114	1.7	1,158	0.8
Petroleum Products	3,963	5.6	5,233	6.5	15,479	13.0	14,785	11.9	19,011	12.4
Other	49,298	70.1	49,109	61.2	65,819	55.1	81,672	65.5	97,792	63.5
Total Exports	70,289	99.9	80,166	99.9	119,382	100.0	124,616	100.0	153,887	100.0
NET TRADE BALANCE	(-)15,877	-	(-)36,929	-	(-)25,399	-	(-)25,515	-	(-)37,962	-
PERCENT OF COVERAGE (Exports/Imports X 100)	77%		54%		79%		80%		75%	

Source: Statistiques Economiques et Monetaires, No. 269 (Feb 1979) and No. 257 (Jan 1978), BCEAO.

ANNEX 2

THE PROJECT AREA

Senegal, the most westerly country of Africa, has an area of about 196,000 square kilometers and a population of just over 5 million. To the south lie Guinea-Bissau and the Republic of Guinea, and to the east is Mali. The northern border follows the Senegal River, which separates the country from Mauritania. The Gambia is a separate nation along the Gambia River which forms a narrow wedge of land extending some 300 kilometers into Senegal, separating Senegal's southernmost region (the Casamance) from the central and northern regions.

The climate is varied, with mean monthly temperature ranging from 18° to 31° C. The mean annual rainfall varies from a low of 350 mm in the extreme north to over 1600 mm at the border with Guinea-Bissau. Most of the country is semi-arid with the annual rainfall averaging between 400 and 600 mm, concentrated in the 3-month period of July, August, and September. In the Casamance, the rainy season may last for five months. Unfortunately, droughts are common and in years of abnormally low rainfall crop yields are markedly depressed. Map 1, following Annex 23is a political map of Senegal on which rainfall isohyets are indicated.

Because of the great variations in climate, population density, and agriculture within Senegal, brief descriptions of the five principal ecological zones or regions are presented in the following sections. These regions and ISRA experiment station locations are shown on Map 2, following Annex 23.

Senegal River Valley

The Senegal River flows along the northern border of the country for a distance of over 600 kilometers. It arises in the high-rainfall areas of the Republic of Guinea, flows through Western Mali and enters Senegal above Bakel. It is the richest source of irrigation water in Senegal and could be developed to supply water to a maximum of 400,000 hectares. Now about 17,400 hectares are irrigated in the delta and the valley, of which only 10,600 hectares are under full water control.

There are two major problems in the Senegal River Basin. One is that the flow of water varies greatly from season to season, ranging from only a few cubic meters per second in June, to over 3,000 cubic meters in September, at the end of the rainy season. The other is that toward the end of the dry season, or earlier, the river water becomes saline up to Dagana, and thus is unfit for irrigation purposes. To remedy the situation two dams are being planned for the near future. The first one will be built in the delta at Maka-Diama and will reduce the intrusion of sea water in the dry season. The other will be built in Mali near Kayes. These dams are being financed by OMVS (l'Organization pour la mise en valeur de la Vallee du Senegal). Its membership includes Senegal, Mali, and Mauritania. The dam in Mali will reduce fluctuations in seasonal flow and will make it possible for small ships to reach

Kayes. The dam at Maka-Diama should be completed by 1982, and the one in Mali several years later. OMVS is obtaining the funds from various international aid agencies.

The soils of the valley are alluvial and fine textured, with clay contents going up to 70 or 80 percent. They are particularly suited for rice production, but other crops can be grown during the cool, dry months from November through February.

There are great seasonal variations in temperature for a region located well within the tropics. At Podor, for example, the mean minimum temperature in January is about 13° C, while the mean maximum in June is about 40° C. The diurnal variations are great, often being as much as 20° C.

In the delta and upstream for several hundred kilometers, the rainfall is low (350-450 mm), but it tends to increase as the river curves to the south, being about 600 mm at Matam and a little higher at Bakel.

Because of the low rainfall, the region of the Fleuve is sparsely populated. However, most of the people live in the valley itself and there, within this narrow belt, the population density is about 80 per square kilometer.

Although many crops can be grown in the Senegal River Valley under irrigated conditions, rice is the best adapted to the heavy soils and the imperfect water control that now exists on much of the area. On experimental plots, yields of over 9 t/ha have been obtained when the crop was planted in early March and harvested in June. Farm yields range from 2 to 8 t/ha during the same period, depending upon the management level. A second crop of rice can be grown between July and October with somewhat lower yields. There are serious problems on farmers' fields of weed and bird control, insect damage, and general cultural methods. These will be discussed in a later section of this report.

Other crops that appear suitable for growing during the cooler months from November to February are wheat, maize, tomatoes, and sorghum.

A large sugarcane plantation at Richard Toll appears to be successful.

When the irrigated area becomes more extensive, certain portions could be devoted to the production of irrigated forage crops, thus averting the heavy weight losses that cattle undergo during the dry season.

The installation of large irrigation systems in the Senegal River Basin is handled by the development society, Societe d'Amenagement et d' Equipment du Delta (SAED). As is true for all development societies in Senegal, it is under the authority of the Ministry of Rural Development. SAED has installed a number of large irrigation systems which operate with varying degrees of success, depending upon management levels. Planners project an expansion of the irrigated area from its present

level (17,400 ha) to nearly 50,000 hectares in the next six years. Some authorities estimate that this level will not be attained before 1990.

Without question, the crop production potential of the Senegal River Basin is enormous. Furthermore, the nation cannot expect to feed its people and increase the prosperity of its rural population unless the problems of irrigation and salinity in the Senegal River Basin are solved.

Central Region

This ecological region extends from the Senegal River valley where the rainfall is mostly between 350 mm and 400 mm annually, to the northern border of the Gambia where the annual rainfall reaches about 900-1000 mm. The rainy season in the north-central zone lasts about 90-100 days, with 20 to 40 rainy days. The variability in the annual rainfall in the north is 30 percent and that of the duration of the rainy period is 25 percent. Farther south in southern Sine-Saloum crop growing conditions are more favorable, with more than 700 mm of rain falling over a period of 3-4 months, with 35 to 65 rainy days.

In all of this region, soils are sandy, containing low amounts of clay (3 to 7 percent) and organic matter (less than 1 percent). Thus they have a low capacity for holding water and plant nutrients.

In the north part of the central region, livestock raising is the most important agricultural enterprise. The vegetation consists of annual grasses and scattered, drought-tolerant trees and shrubs. At the start of the rainy season, the grass springs up green and grows faster than the animal population can devour it. Then after the rains cease, the grass dies, the watering places (except for the man-made wells) dry up, and the herdsmen take their cattle farther south where the rainfall is higher and the wet season longer.

In the northeast, population density is low: less than five per square kilometer. But in the western edge of this region, the population density is much higher, exceeding 50 persons per square kilometer.

In the west of the region, then, crops are more important than animals. Groundnuts, millet, and sorghum are the most important cash crops grown.

The Central Region includes much of the so-called "groundnut basin," where population densities reach 80 per square kilometer. Lately, cotton production has increased greatly in this area, particularly south and east of Kaolack. The main food crops, as in most of the western part of Senegal, are groundnuts, millet, and sorghum, with groundnuts providing most of the cash and the other two crops used for food. In the southern part of the region, maize is increasing in importance as a food crop.

Limited studies of ground water supplies indicate that agriculture in the Central Region will continue to rely heavily on rainfall.

Throughout this region, even when farming is heavily oriented to cropping, cattle, sheep, and goat raising is of considerable importance.

Eastern Region

East and south of the Central Region described above, lies the Eastern Region, known as Senegal Oriental. The most northerly portion extends to the Senegal River near Bakel, and it is bordered by Mali on the east. To the south it extends to the border of the Republic of Guinea, and much of the western boundary is determined by the Gambia and Koulountou rivers. It is the most sparsely populated region of Senegal, containing less than 4 people per square kilometer. The only city of any size is Tambacounda.

The government, with the assistance of outside agencies, has started several resettlement projects, known as the "new lands operation." Although quite a few families have moved into these new areas, the projects are so recent that time alone will tell how successful they will be. Nevertheless, several additional areas will be opened up during the next few years, if present plans are carried out.

Two serious health problems in the wetter areas are river blindness (onchocerciasis) which affects humans and trypanosomiasis which affects animals.

The sparse population, relatively low rainfall, and poor communications will hold back this area for some time. Now the most important industry is cattle raising, which suffers from inadequate water supplies, poor range management, and lack of animal health facilities.

As is true for most of Senegal, the soils are sandy and infertile. Also in this region there are extensive areas of land with laterite near the surface which reduces soil productivity.

The rainfall ranges between 600 and 1000 mm over most of the area, being somewhat higher only in the extreme southern parts.

Although plans are still incomplete and no action has yet been taken, studies have been made of the irrigation potential of areas along the Gambia River and its tributaries. These studies have shown that if cooperation can be obtained among the three countries of Senegal, The Gambia, and the Republic of Guinea, several thousand hectares of irrigated land could be opened up. Some would be in the Eastern and Casamance regions of Senegal, and others would be in The Gambia and Guinea. A three-country organization has been formed which is equivalent to the OMVS for the Senegal Valley. When final agreement is reached and the appropriate dams are built, this area could become an important producer of rice, sugarcane, and tropical fruits, as well as other crops.

Casamance

This region, lying between the border of The Gambia and that of Guinea-Bissau, is favored with annual rainfall ranging between 1000 and 1700 mm. The rainy season lasts for 120 to 150 days, as compared with

about 90 days in the rest of the country. Temperatures are less variable than farther north, and the natural vegetation is typical of the semi-humid tropics.

The area of the Casamance region is about 28,000 square kilometers, and the population is about 720,000. The average population density is 22 per square kilometer. However, it is not evenly distributed, being denser in the west than in the east.

The Casamance River is shallow and sluggish. Salt water from the sea penetrates more than 120 kilometers inland, which makes the water unfit for irrigation. If dikes are built to hold back the water, rice can be grown during the rainy season. The terrain is undulating and the depressed areas are subject to annual flooding. Thus rice is a crop well suited to the region.

There are four types of rice culture practiced in the Casamance, as follows:

1. Mangrove swamp rice, where problems of saline water and highly acid soil prevail.

2. Lowland rice grown in the valleys, flooded with fresh water.

3. Rainfed rice where the water table is high throughout the growing season, sometimes flooding the rice for short periods.

4. Upland rice on the plateaus.

Casamance contributes 80 percent of the nation's entire rice production. Plans are on the drawing board for building dams on the Casamance River to permit expanded rice production but they have not yet been finally approved or financed.

Because of the higher rainfall and longer wet season, there are many possibilities for diversifying agriculture in the Casamance region. Among the more important crops, besides rice, now being grown are groundnuts, cotton, maize, cassava, sorghum, and millet. In addition, tropical fruits and vegetables and oil palms are grown and the amounts could be greatly expanded.

There are excellent opportunities to improve pastures for livestock and to grow forage crops that can be cut, dried, and fed to livestock during the dry season.

The presence of trypanosomiasis in this region limits the productivity of the livestock sector.

North Coast and Cap Vert Region

This region of Senegal is differentiated from other parts mainly because of its distinctive climate, topographic features, and the ready availability of ground water for irrigation.

It is not an administrative region, its boundaries being determined principally by the climate, soil, and groundwater conditions. The region consists of a narrow belt, no more than 30-40 kilometers wide extending along the northwest coast from Dakar to just south of St. Louis near the delta of the Senegal River.

Temperatures are more even and the air is more humid than farther inland, even though the rainfall averages only about 400 mm.

Large unstable sand dunes, some of them 30 meters high, occur just inland from the beaches. Farther inland, the dunes are smaller and more stable and the topography is mostly rolling. In the depressions, the soils may contain considerable clay. In any case, these low areas flood during the rainy season, and the water table comes fairly close to the surface in the upland areas.

The depressed spots are used for vegetable production during the cool, dry season. Simple dug wells provide a source of water for irrigation. Because the vegetable farms are very small, the water is transported from the wells to the vegetable fields by hand in sprinkling cans. Common vegetables being grown are tomatoes, green beans, eggplant, and various leafy vegetables.

Tropical fruits and nut trees do well in this region because their roots can reach the water table. Limited quantities of mangoes, cashew nuts, citrus fruits, papayas, and leafy vegetables are grown. It would appear that there is abundant opportunity for expanding the fruit industry, particularly citrus fruits which are now imported.

ISRA ORGANIZATION AND HEADQUARTERS

As a result of earlier reviews of ISRA's organization and programs, SERST has decided to reorient ISRA's research. Three decisions have been taken: (1) the research programs will be reorganized into commodity or factor-oriented research projects and farming systems research teams, (2) research will be decentralized and regional research stations (and programs) will be created or strengthened, and (3) ISRA headquarters will be reorganized and relocated from Dakar to St. Louis.

A. Research Programs

The research programs on the basic food crops, farming systems, and livestock systems are presented in Annexes 4 through 13. In these annexes the specific locations for research are presented, suggested organizational patterns for regional research stations are made, and proposals are made for strengthening the physical facilities at some of the regional research stations.

B. ISRA Organization

Administration

The organogram in Figure 3.1 is a proposed organizational chart for ISRA headquarters. The overall responsibility for ISRA would be in the Director General's hands. He would be assisted by an Assistant Director General. Technical advisors would be available to assist him in making decisions and an Administrative Director would take care of personnel, financial, and other administrative details.

The Administrative Council would be the chief body with responsibility to oversee ISRA's overall activities. This Council exists now but does not function effectively. A strong effort should be made to revive the Administrative Council. The Committee of Direction and the Scientific and Technical Committee would be advisory bodies constituted to advise the Director General on operating policies and scientific research programs.

Research Departments

Under the Director General are six major Departments with line responsibility administering the research programs and supporting services. Each commodity or factor-oriented research program would be organized into a coordinated research program (Annex 4) which means that the program coordinator and the program staff would be responsible for formulating plans for research and implementing these plans. The Department Head would function primarily as a coordinator of different research programs and as an administrator. The Departments proposed are Crop Science, Animal Science, Farming Systems, Natural Resources, Economics and Sociology, and Research Support Services. The Crop Science, Animal

Science, Farming Systems, and Economics and Sociology Departments and their research programs are discussed in Annexes 4 through 13.

Oceanography and Fisheries, and Forestry have been grouped together under one department. This was done to minimize the number of departments and because neither of the two organizations is large enough to justify a separate department at ISRA headquarters level.

Support Services

Under the Department of Research Support Services are grouped several necessary services which must be available to a productive research organization.

a. Technology transfer and training

Crop yields at research stations in Senegal are, in many cases, substantially higher than those obtained by farmers. This gap reflects a number of factors, including lack of effective use of available technology.

The transfer of technology from the research station to the extension organizations, farmers' associations, and other groups involved in the more widespread application of new materials and practices by farmers is difficult in Senegal because of limitations in transport and communications. The production societies in the different regions must be taken into account in developing procedures for transfer of technology and keeping them functioning effectively.

In order to ensure attention to the establishment of effective linkages between the research stations and the various production societies in different agricultural regions of Senegal, an office with a small but highly qualified staff would be set up at the ISRA headquarters.

b. Manpower development

To carry out the research programs outlined in this report will require an effort to identify, recruit, train, and post the necessary Senegalese staff. An office in ISRA headquarters would be established to perform these functions and to act as general coordinator for all staff training, both outside and inside Senegal. Currently a relatively low proportion of ISRA's staff members are Senegalese which means that many national scientists must be hired and trained over the next few years. In shifting from a disciplinary to a multidisciplinary approach and in developing national research teams on a problem-oriented basis, it will be necessary to work out carefully the scientific personnel requirements and to match these requirements with training opportunities. Timing or phasing of recruitment and training is critical if these proposed research programs are to be staffed in the shortest possible time.

A schedule should be set up for the systematic development of agricultural research manpower, including technicians. This schedule should include priorities for those disciplines of research most crucial to the acceleration of development programs.

Personnel management procedures should be improved, and a system for evaluating and promoting research personnel on the basis of their performance in a job should be established.

c. Experiment station development and management

ISRA has a number of research stations with reasonable experimental field areas, offices, and laboratories. The physical facilities--laboratories and equipment--have not been maintained properly at several of these stations, and they should be rehabilitated to an effective working level as rapidly as possible.

The expanded scope of ISRA, together with the demands for improved technology for regional development projects, will require the establishment of new research stations and facilities, particularly in Senegal Oriental.

Most of the research stations of ISRA should be multi-purpose in nature and provide for research on several crops, on non-commodity problems such as soil and water management, and in some cases, for integrated attention to crops and livestock. The stations, therefore, are a basic resource/service facility of ISRA that should be developed, operated, and maintained in a manner that will ensure the quality of experimentation essential for evolving dependable improved technology.

The intensification of ISRA's major agricultural research activites and the necessary structural changes will facilitate the establishment of a research support unit that will give attention to research station development, operation, and management. This subject is discussed further in Annex 20.

d. Central laboratories

In expanding and decentralizing ISRA reasearch activities it will not be necessary to duplicate expensive laboratory installations in each region, if central research laboratories are utilized. For example, it is proposed that all soil, water, and plant analyses be done by the central laboratories at Bambey. Small, functional laboratories would be necessary at each research location but these should be relatively simple and should be confined to analyzing only the most critical elements. For example, at Fanaye it would be necessary to have available locally equipment for determining irrigation water quality and soil moisture characteristics. More detailed soil physical and chemical characteristics could be obtained by sending soil samples to Bambey. An administrative section in ISRA headquarters would be necessary to administer these services.

e. Information and publication

Information and communication services and public relations must be improved throughout the ISRA system if an expanded research program is to be effective in solving problems of crop and animal production in Senegal. Good public relations is simply doing a thorough job in solving important problems and then letting the public know about it. The job

of the research scientist is not completed on any project until the results are made available for the use of farmers and others concerned with food production, processing, marketing, and distribution.

ISRA should prepare publications, visual aids, and radio and television scripts of its research activities to be used by development societies in their extension work. Moreover, scientific technical reports and the annual ISRA progress reports would be coordinated through this office.

f. Statistics and data processing

In the immediate future, much of ISRA's research will be adaptive, modifying and fitting materials and practices available from national and international sources to specific locations and farming systems in Senegal. Varied trials, or experiments with a few variables and interactions can be handled routinely by well-trained scientists.

There will be increasingly complex experiments as the ISRA program is expanded, as more intensive studies of interacting factors involved in decline of yields in present schemes are undertaken, and as integrated crops and livestock programs are activated.

An office with a small but highly competent staff should be set up at ISRA's headquarters to furnish guidance in the design of experiments and to provide data processing and analysis of the results of more complex experiments. Analyses of more routine experiments should be left to research team leaders and individual scientists.

In the future it is likely that ISRA would wish to acquire its own computer facilities. If ISRA headquarters is not located in Dakar, it would be unwise to locate computer facilities in ISRA headquarters.

g. Production and technical services

This section would handle the records and sales associated with ISRA's agricultural production, such as seed production. Also it would make the necessary contracting arrangements for all special services performed by ISRA on behalf of other organizations.

h. Library and documentation

As with all other research organizations, a good, up-to-date library is essential to ISRA's success. Each research station should have its own working collection of the important journals and texts in that station's area of interest, but a complete library at each station is too expensive. The best solution is to create a central library which can make loans or photocopies available to other stations. Currently the principal library is at Bambey and it should remain there if ISRA's headquarters are shifted to St. Louis. Dakar is, however, the best location for a central library because it is the easiest location for all the other ISRA stations to reach. If ISRA headquarters are to remain in Dakar, the central library should be at headquarters.

C. ISRA HEADQUARTERS LOCATION

Apparently the government of Senegal has taken the decision to shift ISRA headquarters from Dakar to St. Louis. This proposed move is in keeping with the government's commendable policy decision to encourage business and governmental institutions to locate their offices in cities other than Dakar. This seems a wise move to decentralize away from Dakar and to strengthen the development of the cities and provinces in other regions of Senegal. In locating ISRA headquarters in St. Louis, however, there are several disadvantages, some serious, and the government must be prepared to accept these disadvantags.

One disadvantage is the cost of construction at St. Louis as compared with Dakar. Construction costs are higher in St. Louis and, furthermore, some staff housing must be built in St. Louis which would not be necessary in Dakar. Construction costs are given in Annex 15.

Perhaps the chief drawback to St. Louis as a location for ISRA headquarters is that St. Louis is located in the extreme northwest corner of the country; it is not centrally located. ISRA is a national organization with research activities in all parts of the nation and needs to be centrally located to facilitate communication and transportation between the headquarters and the regional stations. ISRA scientists located in the central, eastern, and southern provinces will have considerably more difficulty traveling to St. Louis than Dakar. The same will be true for ISRA headquarters staff traveling to other research locations.

ISRA headquarters need to be in close contact with SERST and other institutions of government located in Dakar. If the headquarters are outside Dakar, the Director General and his staff will spend a lot of their time traveling to and from Dakar. It will probably be necessary to establish an ISRA headquarters office of some sort in Dakar.

It seems, then, that Dakar would be the best location for ISRA headquarters but, because of government policy, this may not be possible. If ISRA headquarters are not located in Dakar, perhaps the best site would be in Thies, a central location. More importantly, the new National College of Agriculture (Institut National de Developpement Rural) is located there and ISRA should be closely related to this college.

ANNEX 4

COORDINATED CROP RESEARCH PROGRAMS

Crops research would be organized into several different national multidisciplinary research teams. Each team would be led by a coordinator (an active research scientist) located at an experiment station where that crop is most important. The coordinator would be responsible to the Crop Science department head for planning the research, preparation of budgets, execution of the research, and reporting research findings.

Coordination means "organized cooperation." Coordination in research is not something imposed on compliant associates by dominating leaders; rather, it means directing and integrating research--on a commodity or a problem--in such a way as to ensure a balanced focus on the problems of production that face the farmer. Coordination requires leadership charged with the responsibility for seeing that the research planned jointly by the team is carried out on a timely basis and with a high degree of professionalism. The coordinator must be a scientist who is experienced in research and who commands the respect of the other scientists in the project. Because his role as coordinator requires priority attention, his involvement in research must be adjusted accordingly.

The coordinator is responsible for bringing together all the research information produced by the project and publishing these data in an annual progress report. He has further responsibility for calling and organizing annual meetings of all researchers in the team. At these meetings, literally the heart of a coordinated project, the past year's research is reviewed, recommendations for farmers and extension agents based on the results of the research are formulated, and the future research is planned. The research plans should be made in considerable detail so that, for example, breeders will know what yield trials will be planted, where they will be grown, which seed will be supplied by whom, which seeds will be multiplied, and where they will be planted. Physiologists, pathologists, and other scientists in the coordinated project should make their respective plans so that by the end of the annual meeting the research to be conducted as a team effort can be finalized.

The coordinator also has the responsibility of preparing the budget request for the entire project. To do this he asks for a budget estimate from each member of the research team and assembles these into a budget proposal for the entire national project, which is then submitted to the Director General through the Crops Science Department. When funds are made available to the coordinated project, they should be allocated to all levels at which the research is done: to the coordinator, to the research stations where the research is actually carried out, and to the individual scientist. In this situation there is a specified amount of money for research on a specific topic at each station. The scientist should initiate the expenditure of these funds, and the station director should ensure that they are expended properly.

It may be useful to discuss more fully an example of a coordinated crop research program. Because millet is the food crop most widely grown in Senegal and because ISRA already has a significant research program with this crop, it will be used as an example.

Basically the coordinated millet improvement project should have for its goal the production of millet varieties that are adapted to the different millet-growing areas, are high-yielding, have adequate resistance to prevailing diseases (and, if possible, insects), and have superior grain quality. The project would include plant breeders, plant physiologists, plant pathologists (and perhaps entomologists) and would have access to grain quality evaluation tests, perhaps through the cooperation of the Food Technology Institute.

It is recommended that the coordinator be located at Bambey and that all the actual crossing of hybridization be carried out there. Selecting from segretating germplasm and testing of varieties for yield and resistance to local diseases and pests would be done at several other research stations.

The plant pathologist and entomologist would assist the team to develop varieties having field resistance to the most important diseases and insects. The pathologist would be responsible for conducting disease surveys to establish the locations of the major diseases; for collecting and storing disease inoculum; for inoculating (if necessary) the breeding nurseries with the major diseases so that resistant lines can be identified; for making disease readings in the field and selecting resistant lines; and perhaps for developing breeding lines in which genes for disease resistance are accumulated. The entomologist, similarly, would work toward developing insect resistant varieties.

The plant physiologist would conduct research with the goal of characterizing the plant architecture and other factors associated with high-yielding varieties. This research should also try to discover discrete plant characteristics for which breeders could select in developing high-yielding varieties.

The agronomic research for millet would be done by the farming systems teams in each region where millet is an important crop. Research to determine the optimum cultivation methods (date and rate of planting, fertilizer use, pest management, harvesting and storing techniques, etc.) should be carried out by the farming systems teams. This team would also study the role of millet in the farming system and how it should be grown and managed in relation to other crops and animals in the total system.

ANNEX 5

MILLET RESEARCH PROGRAM

A. Importance of Millet in Senegalese Agriculture

Millet is the principal food grain of the Senegalese people, as is true in many areas of the world characterized by low, erratic rainfall. The short maturity period of the millet plant allows it to grow, mature, and produce grain during the brief rainy period of the Sahelian Zone, at least in most years. In the northern part of the country where rainfall is lowest, millet is the dominant grain, but farther to the south where rainfall is higher sorghum, maize, and rice become more important.

Unfortunately, agricultural statistics in Senegal often do not distinguish between millet and sorghum; therefore, the figures in Annex Table 5.1 are for the sums of the two crops.

Annex Table 5.1. Area, Yield, and Production of Millet (and Sorghum) in Senegal for the years 1974/75 and 1975/76.

	1974/75			1975/76		
Political Region	Area 000's Ha	Yield T/ha	Production 000's tons	Area 000's Ha	Yield T/Ha	Production 000's tons
Cap Vert	2.0	0.7	1.4	1.8	0.5	0.9
Casamance	95.5	1.1	101.9	90.7	0.9	79.0
Diourbel	318.7	0.6	185.8	316.6	0.5	162.7
Fleuve	120.5	0.4	53.2	93.6	0.4	41.1
Senegal Oriental	71.7	0.5	32.9	69.7	0.9	60.0
Sine Saloum	421.9	0.8	332.2	262.2	0.7	179.1
Thies	123.5	0.7	87.5	128.5	0.8	98.1
	1,153.9	0.7	794.9	963.1	0.8	620.9

Source: Situation Economique Du Senegal 1976

Although millet is the predominant cereal consumed in rural areas, increasingly the urban population is turning to rice and wheat, both largely imported. The Food Technology Institute has developed a technique for supplementing wheat flour with millet flour for bread making, but this procedure has not yet reduced the demand for wheat imports.

Little millet was traded commercially until recently. In 1978 ONCAD began to purchase millet from producers. Currently, there are about 100,000 tons of millet in government stores. Using 43 CFAF/kg as the price of millet, the 1975/76 crop was worth about 27 billion CFAF, roughly 5% of the Gross Domestic Product.

B. Current Status of Millet Research

Research in millet in Senegal began at Bambey in 1931 and has continued since that time. As with most agricultural research in Senegal, however, research on millet has been characterized by frequent changes in research staff and concomitant shifts in the direction of the research.

In the past the research has been conducted for all parts of Senegal by staff located in Bambey. These workers travel to Louga, Nioro du Rip, Sintiou Malem, Sefa, and other stations to supervise the research activities on millet at those locations.

Several years ago the research program was reorganized and the GAM (Groupe Amelioration Mil) program initiated. This program concentrated on short cycle millet (60 days) for the central-north, longer-cycle millet for the central-south (90 days), and on studying the architecture of the plant to determine which plant habit is more productive under different environmental and cultural conditions.

ISRA and ICRISAT have strong ties. A millet breeder and a sorghum pathologist are stationed at Bambey through a project financed by UNDP. Furthermore, ICRISAT's project director for this regional project is located in Dakar.

In May 1979, there were six scientific staff working on millet, all located at Bambey. In addition to three plant breeders, there was one entomologist, and one plant physiologist. Previously, in 1978, there had been six breeders and pathologists, one entomologist, and one agronomist conducting research on millet at Bambey.

C. Proposed Research Project

Basically the millet improvement project should have for its goal the production of millet varieties that are adapted to the different millet-growing areas, are high-yielding, have adequate resistance to prevailing diseases (and, if possible, insects), and have superior grain quality. This program would include plant breeders, plant physiologists, plant pathologists, and entomologists, and would have access to grain quality evaluation tests through cooperation of the Food Technology Institute.

The coordinator would be located in Bambey and all of the actual crossing or hybridization would be carried out there. Selecting from segregating germplasm and testing of varieties for yield and resistance to local diseases and pests would be done at several other research stations, PAPEM's, and in farmers' fields (in cooperation with personnel from the development societies). Ndiol, Louga, Nioro du Rip, Sintiou Malem, and Sefa would be the important stations for selection. To assist in conducting these trials and making selections, it is proposed to station a plant breeder at Kaolack to carry out research at Nioro du Rip and Sintiou Malem, and at Djibelor (half-time) to carry out research at Sefa.

The plant pathologist and entomologist, located at Bambey, would assist the team to develop varieties having field resistance to the most important diseases and, hopefully, insects. The pathologist would be responsible for conducting disease surveys to establish the locations of the major diseases in all of Senegal; for collecting and storing disease inoculum; for inoculating (if necessary) the breeding nurseries with the major diseases so that resistant lines could be identified; for making disease readings in the field and selecting resistant lines; and perhaps for developing breeding lines in which genes for disease resistance are accumulated. The entomologist, similarly, would work toward developing insect resistant varieties. He would also study the occurrence and biology of the major insects with the aim of developing measures for their control under field conditions.

The plant physiologist would conduct research to characterize the plant architecture and other physiological factors associated with high-yielding varieties. This research should also try to discover discrete plant characteristics for which breeders could select in developing high-yielding varieties.

The following table gives the proposed location of research workers in the millet program and indicates positions filled as of May 1979.

Location	Discipline	Name of Scientists
Bambey	1 plant breeder	Mme. NDoye
	1 plant breeder	A. Lambert (ICRISAT)
	1 plant physiologist	Mme. Lambert (IRAT)
	1 plant pathologist	vacant
	1 entomologist	M. B. NDoye
Kaolack	1.0 plant breeder	vacant
Djibelor	0.5 plant breeder	vacant
	6.5	

D. Training Requirements

Currently there are 2.5 vacant positions in the proposed millet program. Additionally, two scientists' positions are occupied by foreign scientists. This means that young Senegalese must be trained to fill these 4.5 positions. It is assumed that the foreign scientists assigned by ICRISAT and IRAT will be on duty until one year after the Senegalese plant breeders return to Senegal from their training programs. It is also suggested that some of the funds for technical cooperation be used in PY2 or PY3 by the Senegalese breeder and entomologist to travel to ICRISAT for a suitable period as visting scientists.

E. Linkage with External Organizations

Already the millet research workers in ISRA have strong ties with IRAT and ICRISAT, the two organizations most active in millet research internationally. These ties should be further developed and strengthened. Also, cooperation with SAFGRAD (Semi-Arid Food Grain Research and Development), a cereals research project in West Africa under the auspices of the Organization of African Unity and headquartered in Upper Volta, is beginning. Another possible source of information, germplasm, and training is Kansas State University in the United States, which receives funds from USAID to assist developing nations improve millet production.

F. Proposed Budget

Costs of the millet research program for the six year period total to CFAF 397,756,000 operating costs, and $207,205 training expenses. These budgets are detailed in Annex Tables 5.3 and 5.4.

To prepare these budgets an initial salary of CFAF 3,250,000, an annual operating cost of CFAF 5,500,000 per senior scientist, and a scholarship cost of $13,500 per student per year have been assumed. At research locations where no senior scientist is located but research is to be carried out, an arbitrary figure of 1/10 the annual operating costs has been assigned for each technician at that station. Funds for technical cooperation--scientific interchange between Senegal and other scientific institutions--were calculated using $2500 as the cost figure for the travel and subsistance for one scientists on a two week travel program.

Annex Table 5.2 Millet Research Program Staffing Pattern

LOCATION	Man-years PY1	PY2	PY3	PY4	PY5	PY6
Bambey						
Scientists						
breeder	1	1	1	1	1	1
breeder	1(f)[1]	1(f)	1(f)	2(1f)	1	1
pathologist	-	-	-	1	1	1
entomologist	1	1	1	1	1	1
physiologist	1(f)[2]	1(f)	1(f)	2(1f)	1	1
Senior technicians	3	3	3	5	5	5
Junior technicians	5	5	5	5	5	5
Kaolack						
Scientists						
breeder	-	-	-	1	1	1
Senior technicians	-	-	-	1	1	1
Junior technicians	1	1	1	1	1	1
Djibelor						
Scientists						
breeder	-	-	-	0.5	0.5	0.5
Senior technicians	-	-	-	0.5	0.5	0.5
Junior technicians	0.5	0.5	0.5	0.5	0.5	0.5

(f) indicates post filled by a non-Senegalese scientist
[1] supplied by ICRISAT
[2] supplied by IRAT

Annex Table 5.3 Millet Research Program Training Schedule and Costs

U.S. Dollars

LOCATION	NO.	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Scholarships								
Bambey								
breeder	1	13,500	13,500	13,500	-	-	-	40,500
pathologist	1	13,500	13,500	13,500	-	-	-	40,500
physiologist	1	13,500	13,500	13,500	-	-	-	40,500
Kaolack								
breeder	1	13,500	13,500	13,500	-	-	-	40,500
Djibelor								
breeder	0.5	6,750	6,750	6,750	-	-	-	20,250
Technical Cooperation[1]		-	5,000	5,000	5,000	5,000	5,000	25,000
Total		60,750	65,750	65,750	5,000	5,000	5,000	207,250

[1] funds to finance travel of project scientists for short-term visits to International Centers, outstanding national research programs, and international scientific meetings.

Annex Table 5.4 Millet Research Program Operational Costs

(1,000's CFAF)

Salaries LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Bambey							
Scientists							
breeder	3,250	3,575	3,933	4,326	4,759	5,235	25,078
breeder	-	-	-	3,250	3,575	3,933	10,758
pathologist	-	-	-	3,250	3,575	3,933	10,758
entomologist	3,250	3,575	3,933	4,326	4,759	5,235	25,078
physiologist	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	4,500	4,950	5,445	8,991	9,891	10,881	44,658
Junior technicians	2,625	2,890	3,180	3,500	3,850	4,370	20,415
	13,625	14,990	16,491	30,893	33,984	37,520	147,503
Kaolack							
Scientists							
breeder	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	-	-	-	1,500	1,650	1,815	4,965
Junior technicians	525	578	636	700	770	847	4,056
	525	578	636	5,450	5,995	6,595	19,779
Djibelor							
Scientists							
breeder	-	-	-	1,625	1,788	1,967	5,380
Senior technician	-	-	-	750	825	908	2,483
Junior technician	525	578	636	700	770	847	4,056
	525	578	636	3,075	3,383	3,722	11,919
	14,675	16,146	17,763	39,418	43,362	47,837	179,201
Field and Laboratory Operations							
Bambey	22,000	24,200	26,620	34,782	38,260	42,086	187,948
Kaolack	550	550	550	5,500	6,050	6,655	19,855
Djibelor	550	550	550	2,750	3,025	3,327	10,752
	23,100	25,300	27,720	43,032	47,335	52,068	218,756
Total	37,775	41,446	45,483	82,450	90,697	99,905	397,756

ANNEX 6

THE SORGHUM RESEARCH PROGRAM

A. Importance of Sorghum in Senegalese Agriculture

Sorghum is the crop next preferred to millet as a staple food in Senegal. Seldom are statistics given separately for millet and sorghum; it is, however, estimated that the millet area is about 1.5 times the sorghum area, and that these two major cereals presently occupy nearly 40% of the total cultivated area of Senegal. Because of their ability to grow in droughty areas, sorghum and millet will remain the dominant crops in the arid regions of Senegal. Average production of 470,000 T of millet and sorghum is well over 90% of all cereals (560,000 T) produced in Senegal.

Sorghum is mainly grown in the arid Central and more humid region north of The Gambia, and in Casamance. Its production along with millet and other drought resistant crops is likely to continue in the arid Central and North regions of Senegal. Maize is replacing sorghum in the wetter Casamance region of Senegal due to its advantages of resistance to bird attack and mold damage, higher yields, higher prices, and because it can be eaten before the grain matures. As a double crop, 120-145 day sorghum may continue to have a place there. Recent experiments in the Fleuve region have shown good potential under irrigated conditions.

Annex Table 6.1. Area, Yield, and Production of Sorghum (and Millet) in Senegal for the years 1974/75 and 1975/76.

	1974/75			1975/76		
Political Region	Area 000's Ha	Yield T/ha	Production 000's tons	Area 000's Ha	Yield T/Ha	Production 000's tons
Cap Vert	2.0	0.7	1.4	1.8	0.5	0.9
Casamance	95.5	1.1	101.9	90.7	0.9	79.0
Diourbel	318.7	0.6	185.8	316.6	0.5	162.7
Fleuve	120.5	0.4	53.2	93.6	0.4	41.1
Senegal Oriental	71.7	0.5	32.9	69.7	0.9	60.0
Sine Saloum	421.9	0.8	332.2	262.2	0.7	179.1
Thies	123.5	0.7	87.5	128.5	0.8	98.1
	1,153.9	0.7	794.9	963.1	0.8	620.9

Source: Situation Economique Du Senegal 1976

The 5th National Plan calls for an increase in millet and sorghum production of over 11%, a very optimistic increase. Although increased production may be achieved by expanding the area planted to these crops, the Plan hopes that research and extension efforts will contribute to an increase of yield per hectare.

B. Current Status of Research

Efforts to improve sorghum--an indigenous crop in Africa--began after work on groundnuts and millet had begun, about three decades ago. As a result of this earlier work, some improved varieties were produced which were adopted by a few farmers.

Currently sorghum research is centered at Bambey and is carried out as two breeding programs, one for North Senegal and one for South Senegal. The plant breeder of the northern program is supplied by IRAT. The principal aim is to produce high-yielding, adapted varieties of 90-105 days maturity for the dry areas around Bambey and northern Senegal. Sorghum is also being tested as a crop to grow in the irrigated Fleuve as a double crop with rice.

The sorghum program for South Senegal focuses on longer duration varieties and resistance to several diseases and insects. In this wetter part of Senegal, varieties that mature during the rainy period are subject to head molds; also insects and diseases are more severe. IDRC has supported this program for several years with funds for a foreign scientist, operating costs, and training. It is understood that this assistance will terminate in July 1979.

Agronomic research on sorghum in the Fleuve has been a component of an FAO project until recently when this activity was placed under an OMVS project. The agronomic techniques for growing irrigated upland crops (of which sorghum is one) is under study in this project.

C. Proposed Research Program

In general the proposed research program is a continuation of (1) introducing and screening of new germplasm from various regions of the world for entry into Senegalese yield trials, (2) creation of variability by crossing and selection with assistance from pathologists and entomologists, and (3) simultaneous testing for grain quality and market acceptability, in cooperation with the Food Technology Institute.

Two basic changes recommended in the current program are: (1) to end the separation of sorghum breeding as two programs and continue these under one breeder, and (2) move the principal research from Bambey to Kaolack. Since sorghum performs better in higher rainfall areas, as compared to millet, it seems reasonable to locate the main research site in the wetter areas, such as southern Sine-Saloum. The shift from Bambey to Kaolack would occur in PY4 after the building program had been completed at Kaolack and on the return of a Senegalese sorghum breeder from a post-graduate training program.

It is visualized that after PY3 all the crossing and hybridization would be done at Nioro du Rip by researchers stationed at Kaolack. Selection for yield, adaptability, and resistance to insects and diseases would be carried out at Fanaye, Bambey, Darou, Sintiou Malem and perhaps Sefa, and at PAPEM's and on farmers' fields in the sorghum growing regions. To assist in carrying out this research and in making selections, it is proposed to locate a half-time plant breeder at Fanaye.

The plant pathologist and entomologist located in Kaolack would function nation-wide, assisting the team to develop superior varieties with good resistance to prevailing diseases and insects.

The following table indicates the proposed location of research workers in the sorghum program and gives the status of the position as of May 1979.

Location	PY1-PY3 Discipline	Status	PY4-PY6 Discipline
Fanaye	0.5 breeder	vacant	0.5 breeder
Bambey	1 breeder	J. Chantereau (IRAT)	0.5 breeder
	0.5 entomologist	R. Gahukar (ICRISAT)	
	0.5 pathologist	vacant	
Kaolack	---		1 breeder
			0.5 entomologist
			0.5 pathologist

It is proposed that the breeder in the Fleuve would work half time each on sorghum and maize, as would the entomologist and pathologist at Kaolack in PY3-PY6.

D. Training Requirement

Currently, there are no Senegalese scientists in the sorghum research program which means that five (three are half time) Senegalese scientists must be trained for these posts. If this training is begun in PY1, the Senegalese scientists will be on the job by PY4. Table 6.3 gives the phasing and costs of such a training program. It has been assumed that the IRAT and ICRISAT scientists will be available through PY4 to provide for overlap with the young Senegalese returning from training after PY3. Funds have also been suggested for travel by sorghum program scientists to superior sorghum research centers and to international scientific centers.

E. Linkages with External Organizations

The principal organizations interested in sorghum research and development are ICRISAT and IRAT. That ISRA is closely connected with these organizations is obvious in that the sorghum breeder is supplied by IRAT and the sorghum entomologist by ICRISAT. SAFGRAD is another research institution which may be of value in the future. In the United States, a consortium of universities with headquarters at the University of Nebraska is receiving USAID funds to assist developing nations increase sorghum production.

F. Proposed Budget

Annex Tables 6.3 and 6.4 detail the proposed budget for the sorghum research program.

Costs of the sorghum research program for the six-year period total to CFAF 184,221,000 operating costs, and $134,000 training expenses. To prepare these budgets an initial salary of CFAF 3,250,000, an annual operating cost of CFAF 5,500,000 per senior scientist, and a scholarship cost of $13,500 per student per year have been assumed. An incentive pay of 25% has been added to salaries at Fanaye. At research locations where no senior scientist is located, but research is to be carried out, an arbitrary figure of 1/10 the annual operating costs has been assigned for each technician at that station. Funds for technical cooperation--scientific interchange between Senegal and other scientific institutions--were calculated using $2500 as the cost figure for the travel and subsistence for one scientist on a two-week travel program.

Annex Table 6.2 Sorghum Research Program Staffing Pattern

LOCATION	Man-years PY1	PY2	PY3	PY4	PY5	PY6
Fanaye						
Scientists						
breeder	-	-	-	0.5	0.5	0.5
Senior techncians	0.5	0.5	0.5	0.5	0.5	0.5
Junior technicians	0.5	0.5	0.5	0.5	0.5	0.5
Bambey						
Scientists						
breeder	1(f)	1(f)	1(f)	1.5(1f)	0.5	0.5
pathologist	0.5(f)*	0.5(f)	0.5(f)	0.5(f)	-	-
entomologist	0.5(f)**	0.5(f)	0.5(f)	0.5(f)	-	-
Senior technicians	2	2	2	0.5	0.5	0.5
Junior technicians	2	2	2	0.5	0.5	0.5
Kaolack						
Scientists						
pathologist	-	-	-	0.5	0.5	0.5
breeder	-	-	-	1	1	1
entomologist	-	-	-	0.5	0.5	0.5
Senior technicians	-	-	-	2	2	2
Junior technicians	-	-	-	2	2	2

(f) indicates non-Senegalese scientist
* supplied by IRAT
** supplied by ICRISAT/UNDP

Annex Table 6.3 Sorghum Research Program Training Schedule and Costs

U.S. Dollars

LOCATION	NO.	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Scholarships								
Fanaye								
Scientists								
breeder	0.5	6,750	6,750	6,750	-	-	-	20,250
Bambey								
Scientists								
breeder	0.5	6,750	6,570	6,750	-	-	-	20,250
Kaolack								
Scientists								
breeder	1	13,500	13,500	13,500	-	-	-	40,500
pathologist	0.5	6,750	6,750	6,750	-	-	-	20,250
entomologist	0.5	6,750	6,750	6,750	-	-	-	20,250
		40,500	40,500	40,500				121,500
Technical Cooperation		-	2,500	2,500	2,500	2,500	2,500	12,500
Total		40,500	43,000	43,000	2,500	2,500	2,500	134,000

Annex Table 6.4 Sorghum Research Program Operational Costs

(1,000's CFAF)

Salaries LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Fanaye							
Scientists breeder	-	-	-	2,032	2,235	2,458	6,725
Senior technicians	938	1,032	1,135	1,248	1,373	1,511	7,237
Junior technicians	328	361	397	437	480	528	2,531
	1,266	1,393	1,532	3,717	4,088	4,497	16,493
Bambey							
Scientists breeder	-	-	-	1,625	1,788	1,967	5,380
Senior technicians	3,000	3,300	3,630	750	825	908	12,413
Junior technicians	1,050	1,156	1,272	263	289	318	4,348
	4,050	4,456	4,902	2,638	2,902	3,193	22,141
Kaolack							
Scientists breeder	-	-	-	3,250	3,575	3,933	10,758
pathologist	-	-	-	1,625	1,787	1,966	5,378
entomologist	-	-	-	1,625	1,787	1,966	5,378
Senior technicians	-	-	-	3,994	4,394	4,834	13,222
Junior technicians	-	-	-	1,400	1,540	1,694	4,634
				11,894	13,083	14,393	39,370
	5,316	5,849	6,434	18,249	20,073	22,083	78,004
Field and Laboratory Operations							
Fanaye	550	550	550	2,750	3,025	3,328	10,753
Bambey	11,000	12,100	13,310	14,641	3,025	3,328	57,404
Kaolack	550	550	550	11,000	12,100	13,310	38,060
	12,100	13,200	14,410	28,391	18,150	19,966	106,217
Total	17,416	19,049	20,844	46,640	38,223	42,049	184,221

ANNEX 7

MAIZE RESEARCH PROGRAM

A. Importance of Maize in Senegalese Agriculture

Maize is rapidly becoming an important cereal crop in the higher rainfall areas of Senegal: Casamance, Senegal Oriental, and Sine-Saloum. It is potentially an important crop in the irrigated areas of the Senegal River Valley. An important characteristic is that green maize ears may be eaten very early in the rainy season when other food may be scarce.

Annex Table 7.1. Area, Yield, and Production of Maize in Senegal for the Years 1974/75 and 1975/76.

	1974/75			1975/76		
Region	Area 000's Ha	Yield T/HA	Production T	Area 000's Ha	Yield T/Ha	Production T
Cap Vert	-	-	-	.05	0.6	0.3
Casamance	15.3	1.1	16.5	15.3	1.1	16.5
Diourbel	-	-	-	-	-	-
Fleuve	7.7	0.7	5.7	10.7	0.4	4.2
Senegal Oriental	24.4	0.8	19.1	26.7	0.8	22.1
Sine-Saloum	1.2	1.7	2.0	2.9	1.9	5.6
Thies	-	-	-	0.7	0.7	0.7
Senegal	48.6	1.1	43.3	56.4	0.9	48.9

Source: Situation Economique du Senegal, 1976.

B. Current Status of Maize Research

Currently maize research is being conducted by a staff of one scientist, a plant breeder, located at Bambey. Research is aimed at producing hybrids and synthetic varieties as well as introducing and testing varieties from other areas of the world. A hybrid BDS-111 was released for production in 1970, but only a fraction of the required F_1 seed is produced and distributed each year (67.5 tons of F_1 in 1978 contrasted with 1740 tons required to plant 87,000 ha in a SODEVA production program). Until now diseases and insects have not been a serious problem in maize production and little research has been directed to insects and diseases.

C. The Proposed Program

Since the most important maize producing regions are the relatively high rainfall area surrounding The Gambia, it is proposed that maize research shift from Bambey, where maize is an unimportant crop, to Kaolack. From Kaolack it is much easier to reach the experiment stations

at Nioro du Rip, Darou, Sintiou Malem, and Sefa. A shift from Bambey to Kaolack would be delayed until offices, laboratories, and houses had been constructed. This should be accomplished by the beginning of PY3.

The proposed staffing pattern is given in the following table.

Location	Discipline	Current Status
Fanaye	0.5 plant breeder	vacant
Bambey	0.5 plant breeder	vacant
Kaolack	1 plant breeder	P.A. Camara (now at Bambey)
	0.5 pathologist	vacant
	0.5 entomologist	vacant
Djibelor	0.5 plant breeder	vacant
	3.5	

The principal goal of the maize project should be to identify or create varieties that are well adapted, high yielding, disease and insect resistant, and which have acceptable quality for consumption as green ears and dry grain. Research is now concentrating on producing synthetic varieties, not hybrids, and is emphasizing short cycle plants. These are commendable goals.

The initial introduction and testing of germplasm and all the hybridization should be done at Nioro du Rip after PY3. Further varietal yield testing, selection, and scoring for disease and insect resistance should be done at Darou, Sintiou Malem, Sefa, Bambey, at Fanaye under irrigation, at several PAPEM's, and in farmers' fields.

The pathologist and entomologist should concentrate their efforts on identifying the major pests and diseases in the various maize producing areas and in assisting the breeders to develop resistant varieties.

The scientists assigned one-half time to maize at Fanaye, Bambey and Kaolack would also be assigned to Sorghum one-half time. At Djibelor the scientist would work on maize and millet in the Casamance.

D. Training Requirements

Since only one of the proposed posts is currently filled, provision has been made for training of 2.5 Senegalese scientists in the maize program to the level of M.Sc. equivalent. Moreover some or all of these scientists should participate in CIMMYT's or IITA's training activities. Also it is highly desirable for Senegalese maize scientists to visit, for short periods, productive maize research programs in other countries.

E. Linkage with External Organizations

CIMMYT is the international center having worldwide obligation for maize research. Senegalese maize scientists should strengthen their contacts with CIMMYT by requesting training positions for the younger scientists, by exchanging germplasm and information, and by inviting CIMMYT maize scientists to Senegal to observe Senegal's maize research program. IITA is also active in maize research, but this center is primarily concerned with agriculture in the humid tropics. Nevertheless, close ties with IITA's maize research would be valuable.

F. Proposed Budget

Costs of the maize research program for the six year period total to CFAF 167,639,000 operating costs and $113,750 training expenses. These budgets are detailed in Annex Tables 7.3 and 7.4.

To prepare these budgets an initial salary of CFAF 3,250,000, an annual operating cost of CFAF 5,500,000 per senior scientist, and a scholarship cost of $13,500 per student per year have been assumed. Incentive pay of 25% has been added to salaries at Fanaye. At research locations where no senior scientist is located but research is to be carried out, an arbitrary figure of 1/10 the annual operating costs has been assigned for each technician at that station. Funds for technical cooperation--scientific interchange between Senegal and other scientific institutions--were calculated using $2500 as the cost figure for the travel and subsistence for one scientist on a two-week travel program.

Annex Table 7.2 Maize Research Program Staffing Pattern

LOCATION	Man-years PY1	PY2	PY3	PY4	PY5	PY6
Fanaye						
Scientists						
breeder	-	-	-	0.5	0.5	0.5
Senior technicians	-	-	-	0.5	0.5	0.5
Junior technicians	-	-	-	0.5	0.5	0.5
Bambey						
Scientists						
breeder	1	1	1	-	-	-
breeder	-	-	-	0.5	0.5	0.5
Senior technicians	1	1	1	0.5	0.5	0.5
Junior technicians	1	1	1	0.5	0.5	0.5
Kaolack						
Scientists						
breeder	-	-	-	1	1	1
pathologist	-	-	-	0.5	0.5	0.5
entomologist	-	-	-	0.5	0.5	0.5
Senior technicians	-	-	-	2	2	2
Junior technicians	-	-	-	2	2	2
Djibelor						
Scientists						
breeder	-	-	-	0.5	0.5	0.5
Senior technicians	-	-	-	0.5	0.5	0.5
Junior technicians	-	-	-	0.5	0.5	0.5

Annex Table 7.3 Maize Research Program Training Schedule and Costs

U.S. Dollars

LOCATION	NO.	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Scholarships								
Fanaye								
Scientists breeder	0.5	6,750	6,750	6,750	-	-	-	20,250
Bambey								
Scientists breeder	0.5	6,750	6,750	6,750	-	-	-	20,250
Kaolack								
Scientists pathologist	0.5	6,750	6,750	6,750	-	-	-	20,250
entomologist	0.5	6,750	6,750	6,750	-	-	-	20,250
Djibelor								
Scientists breeder	0.5	6,750	6,750	6,750	-	-	-	20,250
Technical Cooperation		-	2,500	2,500	2,500	2,500	2,500	12,500
Total		33,750	36,250	36,250	2,500	2,500	2,500	113,750

Annex Table 7.4 Maize Research Program Operational Costs

(1,000's CFAF)

Salaries LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Fanaye							
Scientists							
breeder	-	-	-	2,031	2,234	2,458	6,723
Senior technicians	-	-	-	937	1,032	1,134	3,103
Junior technicians	-	-	-	328	361	397	1,086
				3,296	3,627	3,989	10,912
Bambey							
Scientists							
breeder	3,250	3,575	3,933	-	-	-	10,758
breeder	-	-	-	1,625	1,788	1,967	5,380
Senior technicians	1,500	1,650	1,815	750	825	908	7,448
Junior technicians	525	578	636	263	289	318	2,609
	5,275	5,803	6,384	2,638	2,902	3,193	26,195
Kaolack							
Scientists							
breeder	-	-	-	3,250	3,575	3,933	10,758
pathologist	-	-	-	1,625	1,788	1,967	5,380
entomologist	-	-	-	1,625	1,788	1,967	5,380
Senior technicians	-	-	-	3,000	3,300	3,630	9,930
Junior technicians	-	-	-	1,050	1,155	1,272	3,477
				10,550	11,606	12,769	34,925
Djibelor							
Scientists							
breeder	-	-	-	1,625	1,788	1,967	5,380
Senior technicians	-	-	-	750	825	908	2,483
Junior technicians	-	-	-	263	289	318	870
				2,638	2,902	3,193	8,733
	5,275	5,803	6,384	19,122	21,037	23,144	80,765
Field and Laboratory Operations							
Fanaye	550	550	550	2,750	3,025	3,328	10,753
Bambey	5,500	6,050	6,655	2,750	3,025	3,328	27,528
Kaolack	550	550	550	11,000	12,100	13,310	38,060
Djibelor	550	550	550	2,750	3,025	3,328	10,753
	7,150	7,700	8,305	19,250	21,175	23,294	86,874
Total	12,425	13,503	14,689	38,372	42,212	46,438	167,639

ANNEX 8

THE RICE RESEARCH PROGRAM

A. Importance of Rice in Senegalese Agriculture

Rice is becoming an increasingly important food grain in Senegal. With the rapid rise in urban population, there has been a rising demand for rice. In the years 1971-74, 78% of the rice consumed in Senegal was imported. The policy of the government is to become self-sufficient in rice. Consequently, a concerted effort is being made to increase rice production in Casamance, which is the major rice producing area, and in the Senegal River Valley where large irrigated areas are being developed.

Table 8.1. Area, Yield, and Production of Rice in Senegal for the Years 1975-76.

	1974/75			1975/76		
Political Region	Area 000's Ha	Yield T/HA	Production 000's Tons	Area 000's Ha	Yield T/Ha	Production 000's Tons
Cap Vert	--	--	--	--	--	--
Casamance	63.8	1.4	86.4	70.9	1.4	97.4
Diourbel	--	--	--	--	--	--
Fleuve	9.4	1.8	17.2	10.5	1.3	12.9
Senegal Oriental	5.6	1.2	6.6	5.4	0.9	5.0
Sine-Saloum	6.6	1.0	6.6	--	--	--
Thies	0.2	1.0	0.2	0.3	1.3	0.4
Senegal	84.6	9.2	117.0	87.1	1.3	115.7

Source: Situation Economique du Senegal, 1976.

Senegal is a net importer of rice. In 1974, 207,195 tons of rice valued at 18,032 million CFAF were imported. In 1975, 102,125 tons of rice valued at 6,050 million CFAF were imported. In 1974 the amount spent on importing rice was 15% of the total amount spent on imports and would account for 71% of the export-import deficit. This situation eased substantially in 1975 when the import of rice was reduced by 105,000 tons. Only 5% of the total imports value was spent on rice, but still rice accounted for about 24% of the export-import deficit. Self-sufficiency in rice production would greatly reduce the foreign exchange drain from Senegal.

B. Current Status of Rice Research

There are two active rice research groups currently working in Senegal. One group is located in Casamance at the Djibelor Research Center. In this generally low-lying area of the Casamance River Delta, rice is grown under three conditions. Upland rice is grown under strictly

rainfed conditions at elevations of 20 to 40 meters above mean sea level, paddy rice is grown under controlled water conditions, and mangrove rice (swamp rice) is grown on the low-lying, deep-flooded areas of saline and acid sulfate soils. The paddy rice areas, on good soils with controlled water conditions, are situated mainly along tributary streams and rivers that are above the levels of salt water intrusion and consequently have a potential for high yields. The research group at Djibelor has developed or identified improved varieties of rice for the three types of rice culture practices in the Casamance region. They have also developed recommended levels of fertilizer for rice grown in the area.

Work at Djibelor is presently being devoted to the further development of varieties both for yield and disease resistance. There is also a program of study on the management of saline and acid sulfate soils. There is a large area of these soils in the Casamance River Delta that can be used for rice production if these management problems can be solved. Research on insect control and production agronomy is also being conducted. At present USAID is providing partial support for this research program.

In the Senegal River Valley, a team of researchers with support from WARDA is assisting with rice research. Rice in this area is grown under irrigated conditions and, because it is in a much lower rainfall area (300 to 400 mm compared to 1200 to 1400 for the Casamance area), disease and insect problems are fewer and of lower intensity. This group is currently engaged in screening for varieties that are adapted to sub-Saharan conditions of seasonal hot, dry winds and cool temperatures. A number of varieties have been identified which produce high yields during the rainy season and several promising selections have been identified which have superior cold tolerance when grown in the cool season. Agronomic studies have developed fertilizer recommendations that give economic increases in yield. Weed control research is also underway. The potential for very high yield of rice in this area is excellent and a major effort in rice research should be maintained. Rice research workers in Senegal have working contacts with WARDA and IRRI.

C. Proposed Research Program

The proposed research program would strengthen and fortify the existing rice research programs. Because the two major rice producing areas of Senegal are widely separated and are situated in different ecological zones, it is proposed that two distinct teams of researchers work on rice. Initially, the main thrust of the research by these teams would be the development of fertilizer responsive varieties of high yield potential with superior resistance to diseases and insects and with good grain quality. Soil fertility, soil and water management, and cultural practices research would be handled by the farming systems group at each of these locations.

The two rice research teams should have constant and close contacts through exchange of germplasm, visits by scientists at one location to

observe research in progress at the other location, and through interactions of scientists at the annual workshop of the rice research program.

The following table shows the proposed staffing pattern of the rice research program and the present status of each position.

Location	Discipline	Current Status
Fanaye	plant breeder	Coly*
	plant breeder	Dome*
	plant pathologist	vacant
	entomologist	T. Diop*
Djibelor	plant breeder	De May (f)** Alphonse Faye
	plant breeder	M. Dianger, Mme. Dianger
	plant pathologist	~~vacant~~ Yaman Mbaye
	entomologist	~~Vercambre~~ (f)** Ehrman

(f) indicates a non-Senegalese scientist
* all financed through WARDA
** supplied by IRAT

D. Training Requirements

The requirements for advanced training in the rice project are substantial, but the existence of training funds in both the WARDA/IDRC program and the AID program imply that part of the training expenses will be met by those sources. Precisely how much, should be determined by future review teams. For the purposes of this report, all training expenses have been estimated in Table 8.3. Fellowships have been provided only for a pathologist at Fanaye, but it is possible that some of the WARDA/IDRC financed staff need additional training which will not be available from the IDRC funds. At Djibelor, four fellowships are indicated, for two plant breeders, an entomologist, and a pathologist. It has been assumed that the foreign scientists will be at their post until these scholars have returned to Senegal and have been on the job for one year.

Funds have also been provided to permit one scientist from both the Fleuve and Djibelor to travel each year to an outstanding rice research program, either national or international each year, or to an international scientific meeting.

E. Linkage with External Organizations

WARDA, IITA, and IRRI are important regional or international institutions concerned with rice research and production. ISRA already has close and productive ties with these organizations.

F. Proposed Budget

Costs of the rice research program for the six year period total to CFAF 307,611,000 operating costs and $232,500 training expenses. These budgets are detailed in Annex Tables 8.3 and 8.4.

To prepare these budgets an initial salary of CFAF 3,250,000, an annual operating cost of CFAF 5,500,000 per senior scientist, and a scholarship cost of $13,500 per student per year have been assumed. Incentive pay of 25% has been added to salaries at Fanaye. At research locations where no senior scientist is located but research is to be carried out, an arbitrary figure of 1/10 the annual operating costs has been assigned for each technician at that station. Funds for technical cooperation--scientific interchange between Senegal and other scientific institutions--were calculated using $2500 as the cost figure for the travel and subsistence for one scientist on a two-week travel program.

The budget for Fanaye has been calculated assuming that WARDA will continue to supply the salaries and operating costs of the scientists presently funded through this organization. This should be verified by future review teams.

Annex Table 8.2 Rice Research Program Staffing Pattern

LOCATION	Man-years PY1	PY2	PY3	PY4	PY5	PY6
Fanaye						
Scientists						
breeder	1*	1	1	1	1	1
breeder	1*	1	1	1	1	1
pathologist	-	-	-	-	-	-
entomologist	1*	1	1	1	1	1
Senior technicians	3	3	3	4	4	4
Junior technicians	3	3	3	4	4	4
Djibelor						
Scientists						
breeder	1(f)**	1(f)	1(f)	2(1f)	1	1
breeder	-	-	-	1	1	1
pathologist	-	-	-	1	1	1
entomologist	1(f)**	1(f)	1(f)	2(1f)	1	1
Senior technicians	2	2	2	4	4	4
Junior technicians	2	2	2	4	4	4

(f) indicates post filled by a non-Senegalese scientist
* supplied by WARDA/IDRC
** supplied by IRAT

Annex Table 8.3 Rice Research Program Training Schedule and Costs

U.S. Dollars

LOCATION	NO.	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Scholarships								
Fanaye								
Scientists								
breeder		-	-	-	-	-	-	
breeder		-	-	-	-	-	-	
pathologist	1	13,500	13,500	13,500	-	-	-	40,500
entomologist		-	-	-	-	-	-	
Djibelor								
Scientists								
breeder	1	13,500	13,500	13,500	-	-	-	40,500
breeder	1	13,500	13,500	13,500	-	-	-	40,500
pathologist	1	13,500	13,500	13,500	-	-	-	40,500
entomologist	1	13,500	13,500	13,500	-	-	-	40,500
Technical Cooperation		5,000	5,000	5,000	5,000	5,000	5,000	30,000
Total		72,500	72,500	72,500	5,000	5,000	5,000	232,500

Annex Table 8.4 Rice Research Program Operational Costs

(1,000's CFAF)

Salaries LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Fanaye							
Scientists							
breeder	-	-	-	-	-	-	-
breeder	-	-	-	-	-	-	-
pathologist	-	-	-	4,063	4,469	4,916	13,448
entomologist	-	-	-	-	-	-	-
Senior technicians	5,625	6,789	6,807	9,363	10,301	11,332	49,617
Junior technicians	1,968	2,166	2,382	3,275	3,602	3,962	17,355
	7,593	8,355	9,189	16,701	18,372	20,210	80,420
Djibelor							
Scientists							
breeder	-	-	-	3,250	3,575	3,933	10,758
breeder	-	-	-	3,250	3,575	3,933	10,758
pathologist	-	-	-	3,250	3,575	3,933	10,758
entomologist	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	3,000	3,300	3,630	6,994	7,694	8,464	33,082
Junior technicians	1,050	1,156	1,272	2,450	2,696	2,966	11,590
	4,050	4,456	4,902	22,444	24,690	27,162	87,704
	11,643	12,811	14,091	39,145	43,062	47,372	168,124
Field and Laboratory Operations							
Fanaye	-	-	-	5,500	6,050	6,655	18,205
Djibelor	11,000	12,100	13,310	25,641	28,205	31,026	121,282
	11,000	12,100	13,310	31,141	34,255	37,681	139,487
Total	22,643	24,911	27,401	70,286	77,317	85,053	307,611

ANNEX 9

THE COWPEA RESEARCH PROGRAM

A. Importance of Cowpeas in Senegalese Agriculture

Cowpeas (or Niebe) have been grown since pre-historic times in tropical Africa which is considered to be the area of origin of cowpeas. This crop is the most important food legume grown in Senegal, occupying about 60,000 hectares. Most of the cowpeas in Senegal are grown in the Thies and Diourbel Regions, with significant amounts produced in the Fleuve and Casamance Regions. Small amounts are produced in other regions.

Annex Table 9.1 shows the area in production of cowpeas by regions in 1975-76.

Annex Table 9.1. Area, Yield and Production of Cowpeas for Four Areas for 1975-76.

	1974/75			1975/76		
Political Region	Area 000's Ha	Yield T/HA	Production 000's Tons	Area 000's Ha	Yield T/Ha	Production 000's Tons
Cap Vert	0.1	0.3	0.03	0.1	0.5	0.05
Casamance	1.7	0.6	1.0	2.5	0.4	1.1
Diourbel	25.8	0.4	10.8	29.8	0.5	13.6
Fleuve	15.8	0.2	3.4	10.7	0.4	4.2
Senegal Oriental	--	--	--	--	--	--
Sine-Saloum	--	--	--	--	--	--
Thies	15.9	0.4	6.8	--	--	5.5
	59.3	0.4	4.4	58.4	0.5	24.4

Source: Situation Economique du Senegal, 1976.

The major portion of the cowpeas produced in Senegal is consumed within the country and very small amounts, if any, are exported.

The dietary importance of this crop should not be underestimated. It not only makes a valuable addition to the protein nutrition of the people of Senegal, but the foliage is also used as a pot herb which contributes to vitamin and mineral nutrition.

B. Current Status of Research

In the past, a significant research program on cowpeas at Bambey resulted in several improved varieties which are being grown by farmers. In recent years, however, research on cowpeas has been at a low intensity, and currently only one scientist, a breeder in Bambey, works with this important crop.

C. Proposed Research Program

It is proposed that the cowpea research program be strengthened through the formation of a multi-disciplined team at Bambey, supported by a cowpea breeder stationed at Kaolack. This team would work to develop high-yielding varieties having adequate disease resistance, resistance to some insects and control measures for others, and quality acceptable to the consumers. This latter aspect would be through co-operation with the Food Technology Institute.

The proposed location and staffing pattern would consist of two plant breeders, a pathologist, and an entomologist. One plant breeder and the pathologist and entomologist would be located at Bambey; and one plant breeder at Kaolack. All the introduction of germplasm and hybridization would be done at Bambey, with plant selection and varietal testing being conducted at both Bambey and Kaolack as well as other experimental sites in the regions where cowpeas are grown.

The pathologist would assist in the identification of diseases and sources of disease resistance. He would also conduct disease surveys, collect inoculum, and inoculate the breeding nurseries, if necessary, to create disease epidemics to facilitate the identification of resistant lines.

The entomologist would survey the national cowpea crop to identify insects attacking the crop as well as beneficial insects present. He would work with the team to identify germplasm with resistance or tolerance to major insect pests, and would also devise methods of selective control by chemicals applicable under farmer conditions.

The following table indicates the proposed staffing and the current status.

Location	Discipline	Status
Bambey	1 plant breeder	B. Traore
	1 plant pathologist	vacant
	1 entomologist	vacant
Kaolack	1 plant breeder	vacant

D. Training Requirements

Training will be required for all personnel staffing this research program. The level of training of the current plant breeder at Bambey is not known, but a fellowship has been provided for this position. Funds have been provided to permit visits to outstanding cowpea research programs in other countries to IITA, and to international scientific meetings.

E. Linkage with External Organizations

IITA is the international center charged with international responsibilities for research with cowpeas, and a rigorous breeding program is being conducted there. ISRA should try to establish close ties with IITA by making use of that institute's training programs and by exchanging breeding materials and other information. The national research program at the Agricultural Research Institute at Samaroo in Nigeria might also be a source of materials and information.

F. Proposed Budget

The proposed budget for the cowpea research program is given in Annex Tables 9.3 and 9.4.

Costs of the cowpea research program for the six year period total to CFAF 154,896,000 operating costs and $169,500 training expenses.

To prepare these budgets an initial salary of CFAF 3,250,000, an annual operating cost of CFAF 5,500,000 per senior scientist, and a scholarship cost of $13,500 per student per year have been assumed. At research locations where no senior scientist is located but research is to be carried out, an arbitrary figure of 1/10 of the annual operating costs has been assigned for each technician at that station. Funds for technical cooperation--scientific interchange between Senegal and other scientific institutions--were calculated using $2500 as the cost figure for the travel and subsistence for one scientist on a two-week travel program.

Annex Table 9.2 Cowpea Research Program Staffing Pattern

	Man-years					
LOCATION	PY1	PY2	PY3	PY4	PY5	PY6
Bambey						
Scientists						
breeder	-	-	-	1	1	1
pathologist	-	-	-	1	1	1
entomologist	-	-	-	1	1	1
Senior technicians	1	1	1	3	3	3
Junior technicians	1	1	1	3	3	3
Kaolack						
Scientists						
breeder	-	-	-	1	1	1
Senior technicians	-	-	-	1	1	1
Junior technicians	-	-	-	1	1	1

Annex Table 9.3 Cowpea Research Program Training Schedule and Costs

		U.S. Dollars						
LOCATION	NO.	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Bambey								
Scientists								
breeder	1	13,500	13,500	13,500	-	-	-	40,500
pathologist	1	13,500	13,500	13,500	-	-	-	40,500
entomologist	1	13,500	13,500	13,500	-	-	-	40,500
Kaolack								
Scientists								
breeder	1	13,500	13,500	13,500	-	-	-	40,500
		54,000	54,000	54,000				162,000
Technical								
Cooperation		-	-	-	2,500	2,500	2,500	7,500
Total		54,000	54,000	54,000	2,500	2,500	2,500	169,500

Annex Table 9.4 Cowpea Research Program Operational Costs

(1,000's CFAF)

Salaries LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Bambey							
Scientists							
breeder	-	-	-	3,250	3,575	3,933	10,758
pathologist	-	-	-	3,250	3,575	3,933	10,758
entomologist	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	1,500	1,650	1,815	4,997	5,497	6,047	21,506
Junior technicians	525	578	636	1,750	1,926	2,119	7,534
	2,025	2,228	2,451	16,497	18,148	19,965	61,314
Kaolack							
Scientists							
breeder	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	-	-	-	1,500	1,650	1,815	4,965
Junior technicians	-	-	-	525	578	636	1,739
				5,275	5,803	6,384	17,462
	2,025	2,228	2,451	21,772	23,951	26,349	78,776
Field and Laboratory Operations							
Bambey	1,100	1,100	1,100	16,500	18,150	19,965	57,915
Kaolack	-	-	-	5,500	6,050	6,655	18,205
	1,100	1,100	1,100	22,000	24,200	26,620	76,120
Total	3,125	3,328	3,551	43,772	48,151	52,969	154,896

ANNEX 10

GROUNDNUT RESEARCH PROGRAM

A. Importance of Groundnuts in Senegalese Agriculture

Groundnut is by far the most important crop in Senegal. Senegal was already exporting groundnuts in the middle 1800's, and now this single crop occupies about half the total cultivated area (51% in 1976). The export sale of groundnut contributes about 10% of the gross national product. Groundnut is a major crop in the "groundnut basin" situated in the regions of Thies, Diourbel, and Sine-Saloum, but it is also important in Casamance and in some parts of Senegal Oriental. Only in the Senegal River Valley where cultivation is being discouraged by Government is groundnut a minor crop.

In 1976, Senegal grew 1.3 million hectares of groundnuts, producing 1.4 million tons with an average yield of 1.11 T/ha. In 1975 Senegal exported groundnut products valued at 40.3 billion CFAF which accounted for 40.7% of the country's total exports. Annex Table 10.1 gives the area, yield and production of groundnuts in Senegal for 1975 and 1976.

Annex Table 10.1. Area, Yield and Production of Groundnuts in Seven Regions of Senegal, 1975 and 1976.

	1974-1975			1975-1976		
Political Region	Area 000's Ha	Yield T/HA	Production 000's Tons	Area 000's Ha	Yield T/Ha	Production 000's Tons
Cap Vert	2.0	0.60	1.2	2.5	0.80	2.0
Casamance	122.2	1.20	146.1	126.4	1.10	139.6
Diourbel	296.2	0.90	265.7	374.2	1.10	411.6
Fleuve	5.9	0.64	3.8	6.8	0.75	5.1
Senegal Oriental	41.1	0.84	34.9	58.9	0.98	58.0
Sine-Saloum	430.0	0.93	398.1	537.7	1.18	636.4
Thies	154.8	0.93	144.4	195.8	0.98	191.3
SENEGAL	1152.1	0.86	994.2	1302.3	1.11	1444.0

Source: Situation Economique du Senegal, 1976.

As a part of the long-term agricultural strategy Senegal aims to stabilize groundnut production at about 1.2 million tons per year, and to emphasize alternative, diversified crops. Cotton has been introduced as one alternative cash crop and soybeans are being studied as a possibility. Cowpeas, cassava, and sugarcane are also considered to be crops of diversification.

B. Current Status of Groundnut Research

Groundnut was the first crop on which research was conducted in Senegal. Research was begun in 1921 at Bambey, then an agricultural training school, by a staff of two. The first objectives were to select better varieties of groundnut. Bambey has been a leading center for groundnut research for many years, producing some of the world's best varieties, such as 28-206.

Currently the research program has two principal thrusts: developing varieties for oil and for eating. Considerable attention is being given to alflatoxin production on the groundnut, a problem which could seriously limit Senegal's export of groundnut cake in some years. The research on groundnut for oil is concentrated at Bambey and at Darou for eating groundnut.

The research workers at Bambey have long and good contacts with other groundnut research programs in Africa, the United States, and the recently initiated program at ICRISAT.

C. Proposed Research Program

The proposed research program is essentially an extension of the current activities with heavier emphasis on the breeding aspect. The creation of well adapted, high-yielding, disease resistant varieties with superior quality is the basic goal of this research program. Serious attention is also given to reducing the alflatoxin contamination. Moreover, it is important to conduct plant physiological research to attempt to discover ways of augmenting production, such as searching for differential responses among lines to drought and selecting for tolerance to drier conditions.

The program coordinator would be located at Bambey and the research would be concentrated around Bambey and Kaolack. It is proposed to shift the three groundnut researchers from Darou, an isolated station with poor accessibility, to new facilities to be constructed near Kaolack. This would take place in PY4. Their field research would be conducted at Nioro du Rip, Darou, Sintiou Malem, and in the area surrounding these stations. A groundnut breeder is proposed to be located at Djibelor to supervise research conducted at Sefa, and other locations in Casamance. The following table shows the proposed staffing pattern.

Location	Disciplines	Current Status
Bambey	1 plant breeder	vacant (to be filled by IRAT/IRHO)
	1 pathologist	vacant
	1 plant physiologist	J. Gautreau
Kaolack	1 plant breeder	Meunier
	1 entomologist	Van den Berghe
	1 pathologist (alfatoxin)	Rouziere
Djibelor	1/7 plant breeder	vacant

The principal work of the groundnut research team should be toward introducing new germplasm, creating new lines and testing them in the field for adaptation to environment, yield, resistance to diseases and insects, and quality of the nut, both for oil production and for eating quality. Careful attention should be given to the alflatoxin problem: "What causes the fungus to develop?;" "How may it be prevented?;" and "Are there sources of resistance in the world collection of groundnut germplasm?;" are questions which should be answered. The plant physiologist should try to discover lines which may have some tolerance to drought and to investigate other avenues for increasing yield.

D. Training Requirements

In May, 1979, there were no Senegalese at the senior scientific level doing research on groundnuts. The proposed scientific staff of seven will all have to receive graduate training to enable them to qualify for the positions. Furthermore, participation in ICRISAT's training activities and relatively short visits to the outstanding groundnut research programs in other parts of the world are valuable to Senegalese scientists.

E. Linkage with External Organizations

Senegal now has good contacts with IRHO, ICRISAT, and research programs in Africa and the United States. However, to increase this beneficial exchange, a small amount of funds are proposed to finance occasional visits by Senegalese scientists to these institutions, to international scientific meetings, and to outstanding national research programs.

F. Proposed Budget

Costs of the groundnut research program for the six-year period total to CFAF 399,601,000 operating costs, and $313,500 training expenses. These budgets are detailed in Annex Tables 10.3 and 10.4.

To prepare these budgets an initial salary of CFAF 3,250,000, an annual operating cost of CFAF 5,500,000 per senior scientist, and a scholarship cost of $13,500 per student per year have been assumed. At research locations where no senior scientist is located but research is to be carried out, an arbitrary figure of 1/10 the annual operating costs has been assigned for each technician at that station. Funds for technical cooperation--scientific interchange between Senegal and other scientific institutions--were calculated using $2500 as the cost figure for the travel and subsistance for one scientist on a two-week travel program.

Annex Table 10.2 Groundnut Research Program Staffing Pattern

LOCATION	Man-years PY1	PY2	PY3	PY4	PY5	PY6
Bambey						
Scientists						
breeder	1(f)*	1(f)	1(f)	2(1f)	1	1
pathologist	-	-	-	1	1	1
physiologist	1(f)*	1(f)	1(f)	2(1f)	1	1
Senior technicians	2	2	2	3	3	3
Junior technicians	2	2	2	3	3	3
Kaolack						
Scientists						
breeder	1(f)*	1(f)	1(f)	2(1f)	1	1
entomologist	1(f)*	1(f)	1(f)	2(1f)	1	1
post harvest technologist	1(f)*	1(f)	1(f)	2(1f)	1	1
Senior technicians	-	-	-	3	3	3
Junior technicians	3	3	3	3	3	3
Djibelor						
Scientists						
breeder	-	-	-	1	1	1
Senior technicians	-	-	-	1	1	1
Junior technicians	1	1	1	1	1	1

(f) indicates a post filled by a non-Senegalese scientist
* supplied by IRHO

Annex Table 10.3 Groundnut Research Program Training Schedule and Costs

U.S. Dollars

LOCATION	NO.	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Bambey								
Scientists								
breeder	1	13,500	13,500	13,500	-	-	-	40,500
pathologist	1	13,500	13,500	13,500	-	-	-	40,500
physiologist	1	13,500	13,500	13,500	-	-	-	40,500
Kaolack								
Scientists								
breeder	1	13,500	13,500	13,500	-	-	-	40,500
entomologist	1	13,500	13,500	13,500	-	-	-	40,500
post harvest technologist	1	13,500	13,500	13,500	-	-	-	40,500
Djibelor								
Scientists								
breeder	1	13,500	13,500	13,500	-	-	-	40,500
Technical Cooperation		5,000	5,000	5,000	5,000	5,000	5,000	30,000
Total		99,500	99,500	99,500	5,000	5,000	5,000	313,500

Annex Table 10.4 Groundnut Research Program Operational Costs

(1,000's CFAF)

Salaries LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Bambey							
Scientists							
breeder	-	-	-	3,250	3,575	3,933	10,758
pathologist	-	-	-	3,250	3,575	3,933	10,758
physiologist	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	3,000	3,300	3,630	5,494	6,044	6,649	28,117
Junior technicians	1,052	1,156	1,272	1,925	2,118	2,330	9,853
	4,052	4,456	4,902	17,169	18,887	20,778	70,244
Kaolack							
Scientists							
breeder	-	-	-	3,250	3,575	3,933	10,758
entomologist	-	-	-	3,250	3,575	3,933	10,758
post harvest technologist	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	-	-	-	4,500	4,950	5,445	14,895
Junior technicians	1,575	1,734	1,908	2,100	2,310	2,541	12,168
	1,575	1,734	1,908	16,350	17,985	19,785	59,337
Djibelor							
Scientists							
breeder	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	-	-	-	1,500	1,650	1,815	4,965
Junior technicians	525	578	636	700	770	847	4,056
	525	578	636	5,450	5,995	6,595	19,779
	6,152	6,768	7,446	38,969	42,867	47,158	149,360
Field and Laboratory Operations							
Bambey	11,000	12,100	13,310	20,141	22,155	24,371	103,077
Kaolack	16.500	18,150	19,965	21,962	24,158	26,574	127,309
Djibelor	550	550	550	5,500	6,050	6,655	19,855
	28,050	30,800	33,825	47,603	52,363	57,600	250,241
Total	34,202	37,568	41,271	86,572	95,230	104,758	399,601

ANNEX 11

FARMING SYSTEMS RESEARCH PROGRAM

A. Need for Farming Systems Research

Farming Systems

Even though Senegal is a relatively small country, there is considerable diversity in its agricultural ecologies. The rainfall ranges from 300 mm/year in a 100 day rainy period to around 1600 mm/year in a 135 day rainy period. Substantial irrigated areas are found in the Senegal River Valley and in Casamance. The "niayes" of the north coast are a unique agricultural environment. Soils vary from heavy clays in the Senegal River Valley to sands in much of Senegal. Highly weathered ultisols and oxisols characterize much of Senegal Oriental and acid sulfate soils are found in the mangrove swamps of lower Casamance.

These ecological differences lead to considerable diversity in the farming systems in the country. Irrigated farming, for example, is markedly different from rainfed farming in low rainfall areas. In the low rainfall north-central parts millet, groundnuts, and cowpeas dominate the farming system. Farther north, crops are less important and livestock becomes the dominant enterprise. As one proceeds from the north-central area to the south, other crops replace millet and the farming systems become more complex. In Casamance, rice and other crops of the humid tropics are grown in the farming systems.

A farming system is not simply a collection of crops and animals to which one can supply this input or that and expect immediate results.[1] Rather it is a complicated, interwoven mesh of soils, plants, animals, implements, workers, other inputs and environmental influences with the strands held together and manipulated by a person called the farmer who, given his preferences and aspirations, attempts to produce crop and livestock products from the inputs and technology available to him. It is the farmer's unique understanding of his immediate environment, both natural and socioeconomic, that results in his farming system. Therefore, farming systems research must recognize that interdependencies and interrelationships exist among elements of the farm system, including environmental influences. Also the research should be aimed at enhancing the efficacy of farming systems by generating and testing improved technology.

Major activities of farming systems research would include:

(1) the collection and analysis of base data concerning existing farming systems and the social and physical environment,

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[1] This section borrows heavily from "Farming Systems Research at the International Agricultural Research Centers," 1978, CGIAR.

(2) the alteration of those systems or the design of new farming systems, and

(3) the evaluation and monitoring of new or altered farming systems.

Support Research

The farming systems research program is the point where research results from a number of disciplines and subject matter areas is brought together and melded into a workable, viable farming system. Information about crops, soils, water, fertilizers, herbicides, insecticides, agricultural equipment, farm management economics, and many other factors is required by those scientists researching and manipulating the farming system. Obviously it is not possible to have every one of these subject matter areas represented on a farming systems research team; the number of scientists needed would be prohibitive. It is equally obvious that the farming systems research teams need the support of research in fields such as soil fertility, bioclimatology, weed control, and agricultural engineering.

B. Current Status of Farming Systems Research

Farming Systems

Farming systems research has been going on in Senegal, principally at Bambey, for a number of years but as it is presently organized, the research is carried out by scientists from a number of different administrative departments. The basic approach is to develop technology to form a farming system "package" at experiment stations and PAPEM's, then to study the adoption of this technology (and to fine tune the package) at the Unites Experimentales. In creating the new technology, research scientists try to identify systems that are technically possible using research results and socioeconomic studies.

At the Unites Experimentales, the experimental system is recommended to farmers in rural cooperatives and the adoption process is stuided by sociologists and economists to determine why the technology was accepted or rejected by the farmer.

As it is currently organized at Bambey, it appears that farming systems research is being conducted by scientists in five departments: Utilisation Rationnelle des Resources en Eau, Etudes et Maintien de la Fertilite des Sols Exondes, Defense des Cultures, Techniques et Systemes, and Systemes de Production et d'Application de la Recherche. Other scientists from Bambey, stationed at Kaolack, manage the two Unites Experimentales.

At the present time, there is very little farming systems research at experiment stations other than Bambey.

Support Research

Currently five ISRA scientists are conducting research which could be classified as support research. These five scientists are all at Bambey, but they are located in three different scientific departments.

C. Proposed Research Programs

Farming Systems Research

Multidisciplined research teams are proposed for Fanaye, Bambey, Kaolack, and Djibelor. Each team would include agronomists, economists, sociologists, and animal scientists. Entomologists are also included in some of the teams.

The objective of the farming systems research would be to enable the farmer to produce more crop or livestock products more efficiently, more economically, and with less risk.

The research teams would have at least four main functions:

(1) to study the farmer and the present farming systems to learn what he is doing and why he is doing it;

(2) to conduct research to improve the present farming system or to devise a new system;

(3) to determine constraints the farmer faces as he attempts to increase his agricultural production and to make this information available to the Senegalese authorities capable of removing those constraints;

(4) to study the adoption of recommended technology by the farmer to learn why he accepts or rejects it.

a. Nature of Research

The economic and social scientists would take the lead in studying the farmer and his current farming systems to improve the scientist's understanding of the farmer. A special emphasis would be placed on learning what restricts the farmer from improving his production.

The agronomists, entomologist, and animal scientist would conduct research to determine how the present farming system can be altered to increase its productivity, keeping in mind any alteration must be socially acceptable, economically sound, and the changes must be physically possible under current conditions.

The farming systems scientists would also conduct research on various components of the farming system and sub-systems. Agronomists would study each new crop variety which emerges from the crop research programs to determine how best it could fit into the farming system. For example, experiments would be conducted with a new variety of millet

to determine the best planting dates, planting rates, spacings, fertilizer rates, and so on, before inserting it into the farming system. One agronomist should be knowledgeable about weed control chemicals and cultural methods so that suitable weed control practices could be recommended.

The entomologist would direct his research toward devising the best techniques to control insect damage in the farming system. Insecticides as well as biological control methods and crop management should be evaluated.

The animal scientist, as part of the team, should determine how best to utilize the crop residues as animal feed and how to manage the animals as part of the over-all farming systems. Forages, specifically grown for animals, should be a subject for research in cooperation with the agronomists and the economist. Herd health and reproduction would also be a part of his research.

The subject matter specialist has been placed with the farming systems team. This is logical because the research results to be passed on to the farmer will emerge from this team's research. The subject matter specialist, because of his duties with the development societies, should not have a large research assignment, but he must be thoroughly knowledgeable about all the facets of this research program.

It is necessary for the individual scientist to spend a significant amount of time in the farmer's fields so that he can learn the farmer's system, his constraints, and his needs in terms of improved technology. This is a continuing activity which must be exercised without interruption. The farming systems research should be conducted on experiment stations, PAPEM's, and farmers' fields. The most complicated and hard-to-manage experiments would be conducted on experiment stations where they can be more easily controlled. From these more sophisticated experiments the best treatments would be extracted and inserted into smaller, more easily managed experiments to go onto PAPEM's and farmers' fields. From the results of these experiments, existing farming systems can be modified or new systems devised. Then the research team, in cooperation with agents from the development societies would conduct experiments with farmers and on farmers' fields to fine tune the package of technology.

In effect, this last activity is essentially what the existing two Unites Experimentales are intended to do. While the concept and objectives of the Unites Experimentales are sound and commendable, it appears that these units are too expensive to be replicated in the desired number. For this reason, it is believed that each farming systems team, working in farmers' fields in cooperation with the development societies can effectively improve farming systems and help introduce new technology to the development societies and farmers.

b. Senegal River Valley

The research team at Fanaye would focus on irrigated farming systems. Since irrigation is relatively new in parts of the river valley, there is an opportunity to develop, from the beginning, one or more farming

systems for this region. With irrgation, many different crops can be grown, and in three seasons of the year. Rice will certainly be the backbone of the farming system, but there is the possibility of combining rice production with many other crops and with animal production. Wheat, now 100% imported, could be grown in this region during the cold season with irrigation. All the important crops produced in Senegal now can also be grown in this area with irrigation.

Although the principal focus should be on irrigated agriculture, the traditional systems will continue to exist for many years until they are replaced by irrigation. Some farming systems research necessarily will have to be directed at the improvement of those traditional systems.

c. Central Zone

The research team at Bambey will perhaps have the simplest research problem because in this area of relatively low rainfall the complexity of farming systems is restricted. Almost no double cropping is possible and the array of crops which can be grown is relatively small. The research in this region should be focused on rainfed cropping systems based on groundnuts and millet. Smallstock are an important component of farming systems in this area.

In southern Sine Saloum around Kaolack, rainfall is higher, the rainy season is longer, yield potentials are higher, and farming systems are more complex. In this area, animals have a high potential in an integrated crop/livestock farming system. In fact, this research team would have a very strong interest in livestock production and could possibly have been placed in the Animal Science Department along with the other livestock production systems teams. The research team would attempt to devise farming systems that maximize crop production and at the same time maximize livestock production. Livestock in this region perhaps would be from herds which are kept in the area throughout the year. In this situation it would be necessary to utilize crop by-products and residues to the maximum extent for livestock feed.

In the area around Kaolack, insects and diseases affecting both animals and plants are more serious than farther north. The farming systems team would devise techniques for protecting crops and livestock from insects and livestock from diseases. Hopefully, plant breeders in the crops research program would develop varieties which have resistance to the most important diseases.

d. Casamance

The farming systems research team at Djibelor would concentrate on rice-based agriculture. This area is strikingly different from the Senegal River Valley and, as such, requires its own farming systems research team. The problems of rice production under mangrove swamp conditions, as irrigated paddy, and as an upland crop will require a concerted research effort. It is felt that the findings of the Kaolack-based farming systems team will be applicable to upland farming areas of lower and perhaps middle Casamance and a livestock production systems program is proposed at Kolda. It appears reasonable, then, for the

Djibelor farming systems team to concentrate on rice-based farming systems.

Support Research

To conduct the necessary research in support of the farming systems teams, throughout the country, eight scientists are proposed. Seven of these would be located at Bambey. These scientists would be: a bio-climatologist, soil chemist, soil physicist, soil conservationist, agricultural engineer, weed control scientist, and a post harvest technologist specializing in on-farm storage. At Fanaye, an irrigation specialist, who would probably be a soil scientist or an agricultural engineer, is proposed. These scientists would conduct research programs in their own area of expertise aimed at developing recommended practices to feed into the farming systems programs. For example, the soil fertility scientist would evalute various fertilizer products, study the soil fertility status of representative soils of Senegal, and, with the cooperation of agronomists in the farming systems teams, work out the fertilizer requirements of the crop components of the farming system.

These scientists would also respond to requests from the farming systems teams for help in solving specific problems in their research region. If, for example, the farming systems team at Djibelor found that a weed species was especially troublesome, they would request the weed control scientist at Bambey for help. He would respond by initiating research in Casamance to find a technique to control this weed species.

D. Training Requirements

Farming Systems

The following table shows the proposed staffing of the farming systems research teams and indicates which posts could be filled by scientists currently in ISRA.

Location	Discipline	Current Status
Fanaye	soil science (irrigation)	vacant
Bambey	bioclimatology	Dancette (IRAT)
"	soil fertility	Diatta
"	soil physics	Chopert (IRAT)
"	soil conservation	Niang
"	agricultural engineering	Pirot (IRAT)
"	weed control	vacant
"	post harvest technology	vacant

If the personnel shown in the above table are correctly allocated to this program, at least six Senegalese must be trained to replace the foreign scientists and to fill the vacant posts. It is also possible that the Senegalese scientists currently filling these positions might benefit from further study for advanced degrees.

Annex Table 11.3 indicates the training costs and Annex Table 11.4 indicates the operating costs for the support research program.

E. Linkage with External Organizations

Among the international agricultural research centers, ICRISAT, IRRI, and IITA have strong farming systems research programs that might be useful to Senegal. ILCA's livestock systems programs should also be useful. A number of nations, notably Guatemala and India, have systems research programs that should provide helpful inputs to Senegal. A small amount of funds have been proposed to enable some Senegalese scientists to visit these and similar institutions.

F. Proposed Budget

Costs of the farming systems research program for the six-year period total to CFAF 716,853,000 operating costs, CFAF 855,891,000 salaries, and $984,000 training expenses. These budgets are detailed in Annex Tables 11.3 and 11.4.

To prepare these budgets an initial salary of CFAF 3,250,000, an annual operating cost of CFAF 5,500,000 per senior scientist, and a scholarship cost of $13,500 per student per year have been assumed. Incentive pay of 25% has been added to salaries at Fanaye. At research locations where no senior scientist is located but research is to be carried out, an arbitrary figure of 1/10 annual operating costs has been assigned for each technician at that station. Funds for technical cooperation--scientific interchange between Senegal and other scientific institutions--were calculated using $2500 as the cost figure for the travel and subsistance for one scientist on a two-week travel program.

Annex Table 11.1 Farming Systems and Support Research Program Staffing Pattern

Farming Systems	Man-years					
LOCATION	PY1	PY2	PY3	PY4	PY5	PY6
Fanaye						
Scientists						
agronomist	1(w)	1(w)	1(w)	1(w)	1(w)	1(w)
agronomist	1	1	1	1	1	1
economist	-	-	-	1	1	1
sociologist	-	-	-	1	1	1
extension	-	-	-	1	1	1
entomologist	-	-	-	1	1	1
animal husbandman	-	-	-	1	1	1
Senior technicians	2	2	2	7	7	7
Junior technicians	2	2	2	7	7	7
Bambey						
Scientists						
agronomist	-	-	-	1	1	1
agronomist	1	1	1	1	1	1
economist	1	1	1	1	1	1
sociologist	1(f)	1(f)	1(f)	2(1f)	1	1
extension	-	-	-	1	1	1
animal husbandman	1	1	1	1	1	1
Senior technicians	4	4	4	6	6	6
Junior technicians	4	4	4	6	6	6
Kaolack						
Scientists						
agronomist	-	-	-	1	1	1
agronomist	-	-	-	1	1	1
economist	-	-	-	1	1	1
sociologist	1	1	1	1	1	1
extension	-	-	-	1	1	1
entomologist	-	-	-	1	1	1
animal husbandman	-	-	-	1	1	1
Senior technicians	1	1	1	7	7	7
Junior technicians	1	1	1	7	7	7
Djibelor						
Scientists						
agronomist	1	1	1	1	1	1
agronomist	1(AID)	1(AID)	1(AID)	1	1	1
economist	1(AID)	1(AID)	1(AID)	1	1	1
sociologist	-	-	-	1	1	1
extension	-	-	-	1	1	1
entomologist	-	-	-	1	1	1
Senior technicians	3	3	3	6	6	6
Junior technicians	3	3	3	6	6	6

(w) It is proposed that existing WARDA staff be assigned to this position.
(AID) It is proposed that existing USAID staff be assigned to this position.

(Continued)

Annex Table 11.1 Farming Systems and Support Research Program Staffing Pattern

Supporting Research	Man-years					
LOCATION	PY1	PY2	PY3	PY4	PY5	PY6
Fanaye						
Scientists						
soil scientist (irrigation)	-	-	-	1	1	1
Senior technicians	-	-	-	1	1	1
Junior technicians	-	-	-	1	1	1
Bambey						
Scientists						
bioclimatologist	1(f)	1(f)	1(f)	2(1f)	1	1
soil chemist	1	1	1	1	1	1
soil conservationist	1	1	1	1	1	1
soil physicist	1(f)	1(f)	1(f)	2(1f)	1	1
agricultural engineer	1	1	1	1	1	1
post harvest technologist	-	-	-	1	1	1
weed scientist	-	-	-	1	1	1
Senior technicians	3	4	5	6	6	6
Junior technicians	3	4	5	6	6	6

Annex Table 11.2 Farming Systems and Support Research Program
Training Schedule and Costs

LOCATION	NO.	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Farming Systems				U.S. Dollars				
Fanaye								
Scientists								
economists	1	13,500	13,500	13,500	-	-	-	40,500
sociologist	1	13,500	13,500	13,500	-	-	-	40,500
extension	1	13,500	13,500	13,500	-	-	-	40,500
entomologist	1	13,500	13,500	13,500	-	-	-	40,500
animal husbandman	1	13,500	13,500	13,500	-	-	-	40,500
Bambey								
Scientists								
agronomists	1	13,500	13,500	13,500	-	-	-	40,500
sociologist	1	13,500	13,500	13,500	-	-	-	40,500
extension	1	13,500	13,500	13,500	-	-	-	40,500
Kaolack								
Scientists								
agronomist	1	13,500	13,500	13,500	-	-	-	40,500
agronomist	1	13,500	13,500	13,500	-	-	-	40,500
economist	1	13,500	13,500	13,500	-	-	-	40,500
extension	1	13,500	13,500	13,500	-	-	-	40,500
entomologist	1	13,500	13,500	13,500	-	-	-	40,500
animal husbandman	1	13,500	13,500	13,500	-	-	-	40,500
Djibelor								
Scientists								
sociologist	1	13,500	13,500	13,500	-	-	-	40,500
extension	1	13,500	13,500	13,500	-	-	-	40,500
entomologist	1	13,500	13,500	13,500	-	-	-	40,500
Technical Cooperation		5,000	5,000	5,000	5,000	5,000	5,000	30,000
Total		234,500	234,500	234,500	5,000	5,000	5,000	$718,500

(Continued)

Annex Table 11.2 Farming Systems and Support Research Program
Training Schedule and Costs

U.S. Dollars

LOCATION	NO.	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Support Research								
Fanaye								
Scientist, soil	1	13,500	13,500	13,500	-	-	-	40,500
Bambey								
Scientists								
bioclimatologist	1	13,500	13,500	13,500	-	-	-	40,500
soil physiologist	1	13,500	13,500	13,500	-	-	-	40,500
agricultural engineer	1	13,500	13,500	13,500	-	-	-	40,500
weed scientist	1	13,500	13,500	13,500	-	-	-	40,500
Technical Cooperation		2,500	2,500	2,500	5,000	5,000	5,000	22,500
Total		70,000	70,000	70,000	5,000	5,000	5,000	225,000
Total Training		304,500	304,500	304,500	10,000	10,000	10,000	943,500

Annex Table 11.3 Farming Systems and Support Research Program Operational Costs

(1,000's CFAF)

Salaries

LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Farming Systems							
Fanaye							
Scientists							
agronomist	-	-	-	-	-	-	-
agronomist	4,063	4,469	4,916	5,408	5,949	6,544	31,349
economist	-	-	-	4,063	4,469	4,916	13,448
sociologist	-	-	-	4,063	4,469	4,916	13,448
extension	-	-	-	4,063	4,469	4,916	13,448
entomologist	-	-	-	4,063	4,469	4,916	13,448
animal husbandman	-	-	-	4,063	4,469	4,916	13,448
Senior technicians	3,750	4,125	4,538	14,367	15,807	17,387	59,974
Junior technicians	1,312	1,443	1,587	5,026	5,530	6,082	20,980
	9,125	10,037	11,041	45,116	49,631	54,593	179,543
Bambey							
Scientists							
agronomist	-	-	-	3,250	3,575	3,933	10,758
agronomist	3,250	3,575	3,933	4,326	4,759	5,235	25,078
economist	3,250	3,575	3,933	4,326	4,759	5,235	25,078
sociologist	-	-	-	3,250	3,575	3,933	10,758
extension	-	-	-	3,250	3,575	3,933	10,758
animal husbandman	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	6,000	6,600	7,260	10,988	12,088	13,298	56,234
Junior technicians	2,100	2,310	2,541	3,850	4,236	4,660	19,697
	14,600	16,060	17,667	36,490	40,142	44,160	169,119
Kaolack							
Scientists							
agronomist	-	-	-	3,250	3,575	3,933	10,758
agronomist	-	-	-	3,250	3,575	3,933	10,758
economist	-	-	-	3,250	3,575	3,933	10,758
sociologist	3,250	3,575	3,933	4,326	4,759	5,235	25,078
extension	-	-	-	3,250	3,575	3,933	10,758
entomologist	-	-	-	3,250	3,575	3,933	10,758
animal husbandman	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	1,500	1,650	1,815	10,997	12,097	13,307	41,366
Junior technicians	525	578	636	3,850	4,238	4,663	14,490
	5,275	5,803	6,384	38,673	42,544	46,803	145,482

(Continued)

Annex Table 11.3 Farming Systems and Support Research Program Operational Costs

(1,000's CFAF)

Salaries LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Djibelor							
Scientists							
agronomist	-	-	-	3,250	3,575	3,933	10,758
agronomist	3,250	3,575	3,933	4,326	4,759	5,235	25,078
economist	-	-	-	3,250	3,575	3,933	10,758
sociologist	-	-	-	3,250	3,575	3,933	10,758
extension	-	-	-	3,250	3,575	3,933	10,758
entomologist	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	4,500	4,950	5,445	10,490	11,541	12,696	49,622
Junior technicians	1,575	1,733	1,906	3,675	4,044	4,449	17,382
	9,325	10,25	11,284	34,741	38,219	42,045	145,872
Total Salaries Farming Systems	38,325	42,158	46,376	155,020	170,536	187,601	640,016
Supporting Research							
Fanaye							
Scientists							
soil scientist	-	-	-	4,063	4,469	4,916	13,448
Senior technicians	-	-	-	1,875	2,063	2,269	6,207
Junior technicians	-	-	-	656	722	794	2,172
				6,594	7,254	7,979	21,827
Bambey							
Scientists							
bioclimatologist	-	-	-	3,250	3,575	3,933	10,758
soil chemist	3,250	3,575	3,933	4,326	4,759	5,235	25,078
soil conservationist	3,250	3,575	3,933	4,326	4,759	5,235	25,078
soil physicist	-	-	-	3,250	3,575	3,933	10,758
agricultural engineer	3,250	3,575	3,933	4,326	4,759	5,235	25,078
post harvest technologist	-	-	-	3,250	3,575	3,933	10,758
weed scientist	-	-	-	3,250	3,575	3,933	10,758
Senior technicians	4,500	6,450	8,595	11,369	12,506	13,757	57,177
Junior technicians	1,575	2,259	3,011	3,839	4,223	4,645	19,552
	15,825	19,434	23,405	41,186	45,306	49,839	194,995
Total Salaries Support Research	15,825	19,434	23,405	47,780	52,560	57,818	216,822
Total Salaries	54,150	61,592	69,781	202,800	223,096	245,419	856,838

Annex Table 11.3 Farming Systems and Support Research Program Operational Costs

Field and Laboratory Operations (1,000's CFAF)

LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Farming Systems							
Fanaye	5,500	6,050	6,655	24,921	27,413	30,154	100,693
Bambey	15,400	16,940	18,634	28,198	31,018	34,119	144,309
Kaolack	2,200	2,420	2,662	29,328	32,261	35,487	104,358
Djibelor[1]	5,500	6,050	6,655	24,921	27,413	30,154	100,693
	28,600	31,460	34,606	107,368	118,105	129,914	450,053
Support Research							
Fanaye	-	-	-	5,500	6,050	6,655	18,205
Bambey	27,500	30,250	33,275	47,605	52,365	57,600	248,595
	27,500	30,250	33,275	53,105	58,415	64,255	266,800
Total Field and Lab Operations	56,100	61,710	67,881	160,473	176,520	194,169	716,853
Total Operations	110,250	123,302	137,662	363,273	399,164	439,093	1,572,744

[1] It is assumed that U.S. AID funds will be available for two scientists during PY 1, 2 and 3. Operating funds for these two positions have been provided for PY 4, 5, and 6 only.

TERMS OF REFERENCE FOR FARMING SYSTEMS STAFF

Agronomist

This scientist should hold at least the M.Sc. degree in agronomy or soil science (crop and soil management). He should be knowledgeable about crop production methods which would entail familiarity with the crops being grown, soils, fertilizers, use of agricultural implements, and techniques for weed control. He should also have a good understanding of experimental design and basic statistics.

The agronomists in the farming systems research program would study the current farming systems utilized by the local farmers to understand exactly what the farmer does and why he does it.

They would conduct field experiments to determine the optimum techniques for cultivating all the crops in the farming system, both as sole crops and as components of a farming system. They would then seek to find ways to modify the farming system (by adding missing inputs, for example) to make it more productive and more economically profitable to the farmer.

After devising a better farming system, the agronomists (and the team), working closely with the subject matter specialist and other extension personnel, would conduct research in farmers' fields to verify that the experimental system was, indeed, more productive and profitable, and that it was acceptable to the farmers.

The agronomists at Fanaye should have training in irrigated agriculture and should be able to conduct experiments involving irrigation variables, (determining critical stages for irrigation, irrigation requirements of crops, etc.).

At least one of the agronomists in each farming systems team should be knowledgeable about herbicide materials and their use.

Entomologist

The entomologist should be trained at least to the M.Sc. level in entomology (pest management or applied entomology). He would be responsible for determining which insects were important in the farming systems and for devising methods to limit insect damage in the farmers' fields. As a component of the overall farming system, the pest management practices must be practicable and profitable.

The entomologist would conduct surveys of insects in his region, collecting the insects, estimating their economic importance, and studying their dynamics. He would conduct research to find techniques to eliminate or limit insect damage to individual crops and the entire farming system

sequence of crops. He would study naturally occurring predators, chemicals, and crop manipulations as possible techniques for reducing damage by insects.

After developing successful experimental control measures, he would verify these techniques by applying them under farmer conditions (working closely with the subject matter specialist, other extension personnel, and farmers).

Economist

The economist in the farming systems team should have at least the M.Sc. degree, probably in the farm management specialty.

Working closely with the sociologist and the subject matter specialist, he would study the current conditions in the rural sphere to learn about the farmer and his farming system. He would try to learn what the farmer's practices are, why he uses these practices, and what the constraints are--physical, social, and economic--that limit the farmer's actions.

The economist would study the effect on the farmer of economic factors such as price and availability of inputs (labor, fertilizers, machinery, seed, etc.), prices paid for farm products, efficiency of markets, and consumer requirements relating to quality of farm products.

He would work with the farming systems team to assure that practices recommended to farmers were economically sound. Also he would be responsible to follow closely any adoption of new technology to determine what the social and economic effects of adoption are.

Sociologist

The sociologist should have an M.Sc. degree in rural sociology, or its equivalent.

His responsibility would be to study the social influences which shape the farmer's decisions relating to his farming system. He (and the economist) should be fully knowledgeable about the problems faced by farmers and should continually pass such information (together with suggestions of how the problem could be solved) on to the appropriate authorities in government.

The sociologist should investigate the adoption process, focusing particularly on reasons farmers do or do not adopt recommended technological changes in their farming systems. The goal of his research would be to help design technological changes in farming systems which would be practicable, productive, and profitable and which would benefit the most deserving social element.

Animal Scientist

This scientist should hold at least an M.Sc. degree in animal science (range management) and he should have a broad understanding of

animal management in grazing systems. Moreover, he should be knowledgeable about the use of agricultural by-products as feeds. This scientist should be able to work with small ruminants and mixed species, as well as cattle.

Broadly, his responsibility would be to determine how animals fit best in a farming system. He should first study the farming system carefully to fully understand what is being done by the farmer and herdsman and the reasons for their actions. He should know the constraints to increased productivity.

Then research should be undertaken to determine better management practices whether they be related to nutrition, herd health, reproduction, or other factors. The aim would be to modify the present system to make it more productive and efficient.

Once a modification proved to be useful at the experimental level, the animal scientist, and the farming systems team as a whole, would work with farmers and extension personnel to prove that the change was workable and profitable.

Subject Matter Specialist (Annex 20)

This specialist should have the equivalent of the M.Sc. degree in a field of agricultural science, preferably general agronomy, or extension education. He would be placed with the farming systems team but his responsibilities would be to act as a bridge between research and extension activities. He could carry on a limited amount of research but this should not be his major effort.

This man would maintain a complete understanding of the research being conducted by the farming systems team, and other researchers, and he would analyze the implications of the research results for the farmer. He would prepare extension publications explaining research results for use by extension personnel in the development societies. He would organize farmer field days at the experiment station and training courses for extension personnel.

The subject matter specialist would assist the researchers in locating cooperative farmers for placing experiments in farmers' fields. An important aspect of his job would be to keep the researchers informed of problems occurring in farmers' fields and the research needed to solve field production problems.

LIVESTOCK PRODUCTION SYSTEMS RESEARCH PROGRAM

A. Importance of Livestock in Senegalese Agriculture

Economic Value of Livestock

Beginning in 1966, Senegal experienced a series of drought years which culminated in the severe pan-Sahelian droughts of 1972 and 1973. The total cattle population was reduced by an estimated 15% because of the drought. Northern regions suffered the most; in the department of Louga, for example, an estimated 65% of the cattle population died. Prior to 1972-73, the livestock populations were gradually increasing, and this appears to be the case once again (Annex Table 12.1). The total value of cattle, sheep, goat, swine, and poultry production for 1978 was 18.5 billion francs CFA based on estimated herd offtakes. This is 10-15% of the total value of the agricultural output.

Annex Table 12.1. Livestock Population Estimates (1000s).

	1972	1973	1976	1978	% Offtakes	Value of 1978 Offtake (millions CFAF)
Cattle	2,639	2,200	2,440	2,533	10	9500
Small ruminants	2,575	2,500	2,660	2,821	25	3200
Horses	207	207	216	240	10	
Donkeys	192	185	200	230	10	
Swine	203	180	166	300	75	2000
Camels	5.7	6.5	6	7	5	
Poultry		6,000	6,800	7,500	100	3800

Sources:
1. "Situation Economique du Senegal, 1976"
2. "Note Succincte sur la Situation Sanitaire et les Methods de Prophylaxie Appliquees au Senegal Pendant 1'Annee 1978"
3. World Bank "Appraisal of Eastern Senegal Livestock Development Project"

Live animals and fresh or frozen meat do not appear on the list of principal commodities imported into Senegal (Statistiques Economiques et Monetaires, Banque Centrale des Etats de l'Afrique de l'Ouest, publication No. 269). However, it has been estimated that prior to 1973 up to 20% of the cattle slaughtered in Senegal were imported from Mauritania. Mauritania now exports meat to other countries at effectively higher prices thereby reducing the supply to Senegal.

High demand for sheep and goat meat on traditional holidays is reputed to greatly increase the unofficial price of these commodities. The deficit is thought to be 50% during such periods of high demand. There is a widely-held opinion that the population of Senegal would readily utilize any increase in productive offtake of meat which could reasonably be expected from the present livestock sector.

Milk and dairy products are imported, reflecting the deficit in domestic production. Approximately 2 billion francs CFA are spent annually for dairy commodities imports.

Systems of Livestock Production

In 1965 livestock production was a major enterprise for an estimated 10% of the Senegalese population, 25% of whom were engaged exclusively in this activity. An estimated 70% of the cattle are owned by the "Peul." At least 80% of the Senegalese "Peul" are now sedentary or semi-sedentary, often grazing cattle during the rainy season in an area no more than several days' walk from the home village. The major grazing areas are the northern sylvo-pastoral zone and the open forests of the upper Casamance River Valley. Ninety percent of the cattle, sheep and goats are raised in the regions of Casamance, Fleuve, Sine-Saloum, Louga, and Senegal Oriental. (See Annex Table 1.6.)

Traditionally, cattle are kept as symbols of prestige and as repositories of wealth, little regard being given to production efficiency or quality. However, due to increasing settling of nomads and the example set by cash agriculture, attitudes are changing in favor of production for a market economy.

Livestock are also raised by other ethnic groups (mainly Wolof, Toucouleur and Serer) as a minor enterprise associated with agriculture. These animals graze on fallowed land, forage from crop residues, and are fed agricultural by-products such as groundnut hay, cottonseed hulls, and grain stalks.

Sheep and goats are usually kept in small flocks around the villages. A majority of Senegal's population does not eat pork so that the distribution of the swine population is more localized. About 75% of the swine are raised in the Casamance with most of the remainder in Cap Vert and Thies.

A phased beef production program has been initiated in Senegal. Yearling cattle are purchased by SODESP from sylvo-pastoral herdsmen in the lower Ferlo Valley. These are shipped to the Doli Ranch in the southern Diourbel where they are pastured and given supplemental feed. There are currently 3000-5000 head of cattle at the Doli Ranch. After one year on the Doli Ranch the cattle increase in weight on the average from 175 kg. to 300 kg. and are shipped to a dry lot in Cap Vert where they are finished for two months. Currently 400-500 head are being finsished at one time (2500/yr.). The planned future capacity of the dry lot is 1600 head.

Constraints to Livestock Production

A complex of social, economic, biological, and physical conditions limits the productivity of Senegal's livestock sector. The traditional value of cattle emphasizes large herd size rather than meat production as the principal objective of cattle rearing. Poor rural education provides few opportunities to change this attitude or to teach technical aspects of animal husbandry. Consequently, inefficient management of

animals and land continues. Furthermore, human populations are unevenly distributed in the extensive grazing areas resulting in simultaneous overexploitation and underexploitation of the rangeland resource.

Natural hazards are numerous. Contagious and soil-borne diseases, gastro-intestinal parasitism, and arthropod-borne protozoal diseases are common. Recurrent drought reduces the primary productivity of rangeland and fires destroy unutilized grass. Soil infertility and mineral deficiencies adversely affect livestock directly and indirectly. After years of culling by natural hazards, the indigenous breeds are well adapted for survival in their environment although they have low intrinsic reproductive, maturation, and growth rates.

The low official price to the producer discourages the development of market-oriented production, and there is insufficient knowledge as to the relative biological and economic merits of the production systems which could be implemented. Infrastructure required to support both traditional and modern production systems (such as transportation, watering facilities, fire breaks, and feedlots) is lacking, particularly in the eastern half of Senegal. Economics research is required to determine the need for high volume marketing schemes to supplement the traditional marketing system which is geared to a low rate of herd offtake.

B. Present Status of Animal Science Research

Animal research began with the establishment of the "Laboratoire National d'Elevage et de Recherches Veterinaires" (LNERV) at Hann near Dakar in 1935. This research station had a regional responsibility for all of French West Africa until Senegalese independence in 1960 when it became a Senegalese institute under the management of the French organization, "Institut d'Elevage et de Medecine Veterinaire des Pays Tropicaux" (IEMVT). With the creation of ISRA in 1975 it came under Senegalese management with the support of IEMVT staff and funding. Throughout its history the main activities of this laboratory have been directed toward animal health, the production of vaccines, and animal nutrition.

Research activities at LNERV are supported by an auxiliary station at Sangalkam, outside of Dakar. This station is situated on 545 ha. Animals are maintained for the supply of biological materials used in veterinary medical research and vaccine production at LNERV. There are two selection programs for dairy cattle employing Montbeliard and Pakistani breeds. There is also some irrigated forage production and ensiling research.

Two large research facilities have been constructed in outlying areas. The oldest of these, the "Centre de Recherches Zootechniques de Dahra," is for research on animal breeds suitable for the northern ecosystems of Senegal. There are a number of buildings for animals, machinery, offices, human habitation, etc., but they have badly deteriorated. Major refurbishing is required to reestablish the center as a major research facility.

The Dahra center comprises almost 7,000 ha. of land on which a 1000-head experimental cattle herd is maintained. Several flocks of sheep and a dozen stud horses are also kept for breeding programs. There is one resident researcher who is soon to leave for further training in nutrition. He will be replaced by a researcher who is now completing one year of advanced training in reproduction and genetics. A staff of more than 80 workers is employed by the center.

The research programs now in progress at Dahra are a selection program for cattle and a breeding program for sheep. Equine stud service is provided without a research component.

The second outlying animal research facility is the Centre de Recherches Zootechniques de Kolda in Casamance. This center, operated by ISRA since 1975, is for research on animal breeds suitable for the southern tsetse-infested region of Senegal. It comprises 2000 ha. of which 20 ha. is reserved for animal housing, human habitations, guest facilities, laboratories, and offices. Although most major construction has been completed, some finishing work is still in progress. The perimeter of the range area has been fenced and the land has been divided into parcels, mostly of about 100 ha. About 50 workers staff this center.

There is currently one animal scientist with one year of postgraduate training in agronomy stationed at Kolda. Approximately 300 N'dama cattle and 250 local sheep comprise the experimental herd. A genetic selection program has been started for the cattle, and some feeding experiments are underway. There are also several experimental plots which have been seeded with forage plants.

The Centre National de la Recherche Agronomique (CNRA) at Bambey and the crops station at Djibelor have both developed techniques for animal traction but the research aspects of this work have been completed. There is currently some animal nutrition research at the CNRA dealing with alkali treatment of low quality roughages.

There are currently eleven Senegalese animal scientists on the ISRA staff. Their distribution according to professional activity is: animal health, four; animal husbandry, five; administration and technical advisory, two.

The Senegalese scientific staff is supplemented by 6-9 foreign scientists, of which three perform research in the animal health sciences and 3-6 in animal husbandry. Following is a table giving the location of the scientific staff and the present research activities.

ISRA Animal Research Facilities: Location of Scientists and Research Activities

	ISRA Headquarters	LNERV	CNRA Bambey	CRZ Dahra	CRZ Kolda	Educational Leave
Senegalese Scientists	1	~~6~~ 8	1	1	~~1~~ 2	1
Foreign Scientists	0	~~6-9~~ 10	0	0	~~0~~ 1	-
Research	-	parasitology virology microbiology vaccine production agrostology nutrition genetics	forage processing	breeding	breeding nutrition forage production	-

The most important achievments in research have been on the development of preventive measures for infectious microbial diseases of cattle. The suppression of rinderpest and contagious pleuropneumonia have undoubtedly had significant effects on the cattle population.

Also important has been the formulation of supplementary and growth rations based on groundnut roughage. Many of the feeding programs now being implemented have made use of this information. Cattle finishing programs have also made use of information generated regarding the potential productivity of Gobra zebu cattle when fed high quality rations with mineral supplements.

Other types of research have not yet resulted in noticeable improvements in the field, or were rendered ineffective by the drought of 1972/73. Included in this category are studies on infectious diseases of small ruminants, disease surveys, nutritional biochemistry, range ecology, forage crop production and utilization, selection and breeding programs, and dairy development.

C. Proposed Research Project

Livestock Production Systems, Northern Eco-Zone

The program would have as its objectives:

1. To develop locally acceptable range management procedures for efficient livestock production combined with range conservation;

2. To develop methods for range improvement;

3. To maintain animal breeding programs for improvement of local breeds;

4. To develop methods for range surveillance, and follow range trends;

5. To determine the major causes of reproductive failure and poor herd health, and to develop means to combat these production constraints.

The research would be concerned with problems which inhibit the efficient production of livestock on northern rangelands. The area of interest is the 60,000km^2 sylvo-pastoral zone of the northern and north-eastern regions (Diourbel, Fleuve, Senegal Oriental). The sylvo-pastoral zone lies between the 400 mm and 700 mm isohyets, but on an 80% probability basis the zone receives considerably less rain than this. Due to low and erratic annual rainfall it has low agricultural potential. Therefore, present research would be directed towards improving the traditional enterprise of livestock production.

The Director of the Dahra Center would also be the Program Coordinator. All program activities would be based at or around the center for the foreseeable future. The research group would seek methods to increase meat production by cattle and small ruminants on rangeland, conserve the rangeland resource, and improve the standard of living for the pastoralists.

The principal production problems are low reproductive rates, high calf mortality, and slow growth and maturation. Research concerning the primary productivity of rangeland would involve the development of techniques for the restoration of degraded range, prevention of further degradation, and improvement by animal management and plant manipulation. The group would become a nucleus of expertise which would have an advisory role on implementation projects in range development.

Most of the animal research would be with the indigenous breeds which are well adapted to the dry environment in tsetse-free or low fly pressure areas. However, some cross-breeding may be attempted, especially to increase mutton production. Only livestock breeds which are now maintained at the Dahra Center would be used in breeding programs.

The range animal management specialist, the range nutrition specialist, the economist, the sociologist, and the extension specialist would work together as a field research team to collect data on the rangeland, the pastoralists, and their livestock. At least one member of this group should speak the local language. The extension specialist would be a member of SODESP staff assigned to the Dahra research group.

The range agronomist and the herd health reproduction specialist would do their experimental work principally at the center. The geneticist would live in Kolda but would supervise the selection and breeding programs at Dahra where he would have a resident technician. He should visit Dahra often enough to ensure adequate supervision of the breeding programs and he should attend the monthly meetings of the research group.

Experiments on animal nutrition and forage agronomy would require fenced range areas. For this purpose, a 3 X 5 km. block would be fenced

and sub-divided into 10 150-acre parcels. The parcels would be equipped with animal watering and feeding facilities. Water would be obtained from the bore-hole now in place on the range area, and existing fencing would be utilized for the block perimeter.

The present experimental cattle herd at Dahra Center is too large, at 1000 head, toensure adequate health and nutritional status. Therefore, it should be destocked to a level which would be determined by the research group. The horses presently at Dahra should be transferred to a different site so that the stables could be used as a sick-animal and semi-isolation facility.

The government of Belgium is considering the implementation of an animal development project in the sylvo-pastoral zone located at Dahra. If initiated, this project would support several foreign scientists and construction of buildings at Dahra. The status of this project should be clarified by future review teams.

Each senior staff member would be assigned one senior technician and one junior technician. One additional junior technician would be located at Dahra to collate local data for the geneticist. The following table shows the proposed staffing pattern at Dahra.

Discipline	Current Status
1 Range Nutrition Specialist	(1 Senegalese soon to be sent for training)
1 Range Agronomist	Vacant
1 Range Animal Management Specialist	Vacant
1 Herd Health/Reproduction Veterinarian	(1 Senegalese now in training)
1 Extension Specialist	Vacant
1 Economist	Vacant
1 Sociologist	Vacant
1 Geneticist.	

Livestock Production, Southern Eco-Zone

The objectives of the research would be:

1. To determine the production potential of local breeds of livestock under improved disease control and husbandry conditions;

2. To develop economic methods for livestock rearing and finishing on local agricultural by-products and residues;

3. To determine the importance of trypanosomiasis and other diseases in limiting reproduction and growth;

4. To develop methods for range and pasture improvement combined with tsetse fly control;

5. To develop methods for livestock management on native and improved southern grazing areas;

6. To maintain animal breeding programs for improvement of local breeds.

The research would be concerned with problems of livestock development in the regions of Casamance and southern Senegal Oriental. These regions lie within the 1100 mm and 1400 mm isohyets in the West and the 900 mm and 1200 mm isohyets in the East. In contrast to the sylvo-pastoral zone this area has relatively good agricultural potential. West of Kolda the land becomes increasingly agriculturally developed whereas to the east the land is largely undeveloped, open forest which is used for grazing. Thus, Kolda is conveniently located for studying livestock production which is integrated with agriculture as well as open grazing and pasture programs.

The Director of Kolda Center would also be the Program Coordinator. The goals of the research would be to improve meat production by cattle and small ruminants, conserve the rangeland resource, and increase the standard of living of the people of southern Senegal.

Research conducted at the center itself would have application to both range production systems and integrated crop/livestock systems. Off-station research would apply initially to range production but, as agricultural production increases in the vicinity of Kolda, it would eventually encompass pasture development and integrated crop/livestock systems. Cattle and small ruminants would be studied initially but swine and poultry production at the village level could be added in the future.

There would be a team to gather data on the range, the herdsmen and their livestock. The team would include the range nutrition specialist, the range animal management specialist, the extension specialist, the sociologist, and the economist. The research team would work with the same groups of people which are located around Dahra and Djibelor. Therefore, they could utilize data collected by the sociologists at these locations. The economist would be responsible for verifying the applicability of the sociological data.

On-station research would be performed by the herd health/reproduction veterinarian, the forage agronomist and the geneticist. The health status of livestock in Casamance is poor. A number of diseases are known to be prevalent but the degree to which individual diseases contribute to the overall health picture is not well understood. The veterinarian would perform research to determine which diseases were major production constraints and how they could be controlled. He would also provide a service function for Kolda Center in maintaining herd health and in assisting in the animal breeding programs.

The forage agronomist would research methods for range improvement, including modifications by bush clearing and the introduction of new forage species. The present effort to cultivate leguminous forages would be expanded. Since Casamance and southern Senegal Oriental have good potential for range improvement and pasture development, the range animal management specialist, range nutrition specialist and forage agronomist would design and implement animal production trials using

different classes of livestock and various grazing schemes on native and modified pastures.

Feeding trials would emphasize the use of locally available agricultural by-products and residues. The use of commercial rations and supplements would be minimized so that experimental results would be directly applicable to the field. Kolda Center is already fenced and divided into parcels which are suitable for both range modifications and feeding trials.

The geneticist would monitor the breeding programs for cattle and sheep, and would analyze data used in selection. He would also assist the research program at Dahra. Breeding programs already in existence would continue. Any cross-breeding attempted would be on a small scale using only breeds available from within Senegal.

Each senior staff member would be assigned one senior technician and one junior technician. The following table indicates the proposed staffing pattern at Kolda.

Discipline	Current Status
1 Range Nutrition Specialist (agrostologue)	Vacant
1 Forage Agronomist	M. Gaye
1 Range Animal Management Specialist	Vacant
1 Herd Health/Reproduction Veterinarian - santé	Vacant
1 Extension Specialist - zootechnicien	Vacant
1 Economist zoo-economiste	Vacant
1 Geneticist	Vacant
sociologue	Vacant

Two internationally recruited range management scientists would be placed in the field for six months each during project year 4. They would have research experience in range management, preferably under semi-arid African conditions. They would arrive at Dahra and Kolda when the Senegalese study fellows return. Their primary function would be to help organize the off-station research teams consisting of the range animal management specialist, the range nutritionists, the sociologists, and the economists. They would assist in planning the initial phase of off-station research and would work with the teams to guide them in the methods for systematic collection of field data.

Additional Livestock Research Activities

There are at least two additional livestock research activities which should be a part of ISRA research. One, the Animal Health Research Program, is currently ISRA's principal livestock research activity. The second, the Intensive Livestock Production System, is not currently in progress and is of lower priority than the systems research programs in the northern and southern eco-zones. Even though no funding is proposed in this project for these two research activities, some suggestions concerning these programs are given.

a. Animal Health

The major portion of the research in Animal Health would be carried out at the "Laboratoire National d'Elevage et de Recherches Veterinaires" (LNERV) at Hann where the Program Coordinator and participating researchers would be stationed. In addition, the station at Sangalkam would function as a "point d'appui," and a mobile unit would support field studies. The objectives of the animal health research would be:

1. To determine the seasonal and geographic distribution of diseases in order to apply local control measures;

2. To develop specific means and programs to prevent, control and treat animal diseases;

3. To develop and produce animal vaccines for regional distribution;

4. To serve as a support facility by offering laboratory services required by research programs at other stations.

The research would incorporate the following disciplines and activities: microbiology, virology, parasitology, nutritional physiology, diagnostic pathology, vaccine production, and epidemiology. Researchers need not be restricted to a single discipline or activity and should be encouraged to contribute to several different activities depending on need, interest, and competence. Diseases which affect all important species and classes of animals would be studied.

Greater emphasis would be placed on determining the importance of specific diseases in the field. This can be accomplished by the creation of an epidemiology unit using the mobile station already in operation. Research would be conducted at locations known to have poor herd health status. Broad geographical surveys which give little information on incidence or seasonal fluctuations should be avoided. A site in the lower Casmance Valley is a suggested starting point for this activity.

The epidemiologist would identify specific diseases and evalute the relative importance of each in reducing production efficiency of various classes of livestock. He would also determine the seasonal fluctuations in the incidence of each disease. The information collected by the epidemiologist would then be used to evaluate the need for treatments and control measures, and to determine the time of year at which they would be most effective.

The information from these studies would be made available not only to the animal health group at LNERV but also to the research groups at Dahra, Kolda, and Kaolack so that preventive measures could be incorporated into herd management programs. Recommendations would then be made to the Veterinary Service for implementation.

Throughout the animal health program there should be some shift in emphasis from diseases of cattle to diseases of sheep and goats. Small ruminants have been neglected in the past to the extent that their productivity is very low, and they are difficult to keep healthy even in a

managed environment. Added emphasis should be given to disease conditions which cause major impairment of production efficiency but are often disregarded in the field because of low mortality or unspectacular signs (e.g. gastrointestinal parasitism).

b. Intensive Livestock Production System

The Program Coordinator of the Intensive Livestock Production System and most researchers would be stationed at the "Laboratoire National d'Elevage et Recherches Veterinaries" at Hann. The station at Sangalkam would continue to serve as a "point d'appui," housing the experimental cattle. The objectives of the intensive livestock systems research would be:

1. To develop and test animal breeds and crossbreeds suitable for production at the urban and village levels;

2. To develop husbandry techniques applicable to commerical animal production at urban perimeters;

3. To develop husbandry techniques applicable to commercial animal production at major by-product feedstuff producing regions.

The research program would concern itself principally with the development of dairy cattle for both urban and village use. While the latter is not strictly an intensive husbandry situation, it would be included in this program since initial research would be conducted in the controlled environment at Sangalkam, and the same researchers could work on both dairy situations. Two artificial insemination stations for dairy cattle would be placed into operation. In the future the program could be expanded to include research on other intensive production operations such as commercial dry lot feeding, egg and poultry production, and swine production. Apiculture would come within the scope of this program.

D. Training Requirements

Northern Eco-Zone Program

Fellowship recipients would be chosen with the stipulation that they already hold an undergraduate degree in animal husbandry, crop science, veterinary medicine, economics, or social science. Three-year fellowships would be required for all seven positions for study to the M.Sc. level. Care should be taken in the selection of universities and, whenever possible, students should receive training in programs designed for study of arid or semi-arid rangeland. Individual students should acquire experience with cattle, sheep or goats so that the research group would have expertise with all important ruminants.

Southern Eco-Zone Program

Fellowship recipients would be chosen with the stipulation that they already hold an undergraduate degree in animal husbandry, crop science, veterinary medicine, or economics. The animal husbandryman presently employed at Kolda has had some postgraduate training in agronomy but probably would require additional training to the M.Sc. level. Therefore, seven three-year fellowships would be required for study to the M.Sc. level. Care should be taken in the selection of universities and, whenver possible, students should receive training in programs designed for semi-arid conditions. Individual students should acquire experience with cattle, sheep or goats so that the research group would have expertise with all important ruminants.

E. Linkage with External Organizations

L'Institut d'Elevage et de Medecine Veterinaire des Pays Tropicaux (IEMVT) is the French organiztion which had managerial responsibility for LNERV until ISRA assumed the function in 1975. The IEMVT continues to provide considerable technical assistance to LNERV. The relationship should continue so that scientists at Dahra and Kolda as well as at LNERV could benefit from interaction with IEMVT scientists on matters concerning animal health, nutrition, and genetics.

The International Livestock Center for Africa (ILCA), located in Addis Ababa, Ethiopia, conducts research programs principally on systems of livestock production in Africa and occasionally on components of production systems. Research projects now in progress which are relevant to Senegal's production systems focus on livestock husbandry in semi-arid and subhumid environments. Senegalese scientists could benefit from brief visits to the center or to the sites in which the research programs are conducted. ILCA would be a potential source of scientists for short-term technical advisory or evaluation consultations in Senegal.

The International Laboratory for Research on Animal Diseases (ILRAD) in Kenya is a potential source of information for Senegalese scientists. ISRA already has firm ties with ILRAD in that an ISRA scientist is a member of ILRAD's board of trustees.

The Winrock International Livestock Research and Training Center, located in Arkansas, U.S.A., is concerned with the role of animal agriculture and the proper utilization of natural resources for human nutrition. In the international area the center has concentrated on ruminant production by family farm units, in both mixed crop/livestock systems, and in grazing systems. Possibly Winrock International Center could be a source of information or assistance for the livestock systems teams.

F. Proposed Budget

Costs of the livestock production systems research program for the six-year period total to CFAF 230,637,000 operating costs, CFAF 395,426,000 salaries, and $622,500 training expenses. These budgets are detailed in Annex Tables 12.3 and 12.4.

To prepare these budgets an initial salary of CFAF 3,250,000, an annual operating costs of CFAF 3,500,000 per senior scientist, and a scholarship cost of $13,500 per student per year have been assumed. Incentive pay of 25% has been added to salaries at Dahra and Kolda. At research locations where no senior scientist is located but research is to be carried out, an arbitrary figure of 1/10 the annual operating costs has been assigned for each technician at that station. Funds for technical cooperation--scientific interchange between Senegal and other scientific institutions--were calculated using $2500 as the cost figure for the travel and subsistence for one scientist on a two-week travel program.

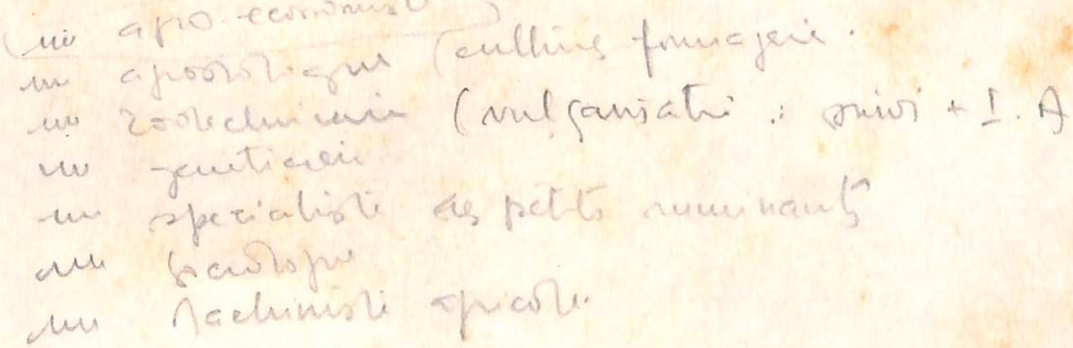
Annex Table 12.2 Livestock Systems Research Program Staffing Pattern

LOCATION	Man-years PY1	PY2	PY3	PY4	PY5	PY6
Dahra						
Scientists						
range agronomist	-	-	-	1	1	1
range agronomist	-	-	-	1	1	1
animal husbandman	-	-	-	1	1	1
extension	-	-	-	1	1	1
animal health scientist	-	-	-	1	1	1
economist	-	-	-	1	1	1
sociologist	-	-	-	1	1	1
Senior technicians	3	3	3	7	7	7
Junior technicians	3	4	6	8	8	8
Kolda						
Scientists						
range agronomist	-	-	-	1	1	1
range agronomist	-	-	-	1	1	1
animal husbandman	-	-	-	1	1	1
extension	-	-	-	1	1	1
animal health scientist	-	-	-	1	1	1
animal geneticist	-	-	-	1	1	1
economist	-	-	-	1	1	1
sociologist	-	-	-	1	1	1
Senior technicians	3	3	3	7	7	7
Junior technicians	3	4	6	7	7	7

Annex Table 12.3 Livestock Systems Research Program Training Schedule and Costs

U.S. Dollars

LOCATION	NO.	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Dahra								
Scientists								
range agronomists	1	13,500	13,500	13,500	-	-	-	40,500
range agronomist	1	13,500	13,500	13,500	-	-	-	40,500
animal husbandman	1	13,500	13,500	13,500	-	-	-	40,500
economist	1	13,500	13,500	13,500	-	-	-	40,500
extension	1	13,500	13,500	13,500	-	-	-	40,500
animal health scientist	1	13,500	13,500	13,500	-	-	-	40,500
sociologist	1	13,500	13,500	13,500	-	-	-	40,500
Kolda								
Scientists								
range agronomist	1	13,500	13,500	13,500	-	-	-	40,500
range agronomist	1	13,500	13,500	13,500	-	-	-	40,500
animal husbandman	1	13,500	13,500	13,500	-	-	-	40,500
economist	1	13,500	13,500	13,500	-	-	-	40,500
extension	1	13,500	13,500	13,500	-	-	-	40,500
animal health scientist	1	13,500	13,500	13,500	-	-	-	40,500
animal geneticist	1	13,500	13,500	13,500	-	-	-	40,500
sociologist	1	13,500	13,500	13,500	-	-	-	40,500
Technical Cooperation		-	-	-	5,000	5,000	5,000	15,000
Total		202,500	202,500	202,500	5,000	5,000	5,000	622,500



Annex Table 12.4 Livestock Systems Research Program Operational Costs

(1,000's CFAF)

Salaries LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Dahra							
Scientists							
range agronomist	-	-	-	4,063	4,469	4,916	13,448
range agronomist	-	-	-	4,063	4,469	4,916	13,448
animal husbandman	-	-	-	4,063	4,469	4,916	13,448
economist	-	-	-	4,063	4,469	4,916	13,448
extension	-	-	-	4,063	4,469	4,916	13,448
animal health scientist	-	-	-	4,063	4,469	4,916	13,448
sociologist	-	-	-	4,063	4,469	4,916	13,448
Senior technicians	5,625	6,189	6,807	14,988	16,490	18,139	68,238
Junior technicians	1,968	2,322	4,416	6,248	6,785	7,462	29,701
	7,593	9,011	11,223	49,677	54,558	60,013	192,075
Kolda							
Scientists							
range agronomist	-	-	-	4,063	4,469	4,916	13,448
range agronomist	-	-	-	4,063	4,469	4,916	13,448
animal husbandman	-	-	-	4,063	4,469	4,916	13,448
extension	-	-	-	4,063	4,469	4,916	13,448
animal health scientist	-	-	-	4,063	4,469	4,916	13,448
animal geneticist	-	-	-	4,063	4,469	4,916	13,448
economist	-	-	-	4,063	4,469	4,916	13,448
sociologist	-	-	-	4,063	4,469	4,916	13,448
Senior technicians	5,625	6,189	6,807	14,988	16,490	18,139	68,238
Junior technicians	1,968	2,822	4,416	5,592	6,063	6,668	27,529
	7,593	9,011	11,223	53,084	58,305	64,135	203,351
	15,186	18,022	22,446	102,761	112,863	124,148	395,426
Field and Laboratory Operations							
Dahra	1,650	3,300	6,600	28,600	31,460	34,460	106,216
Kolda	1,650	3,300	6,600	34,100	37,510	41,261	124,421
	3,300	6,600	13,200	62,700	68,970	75,876	230,637
Total	18,486	24,622	35,646	165,461	181,833	200,015	626,063

TERMS OF REFERENCE FOR KEY LIVESTOCK SYSTEMS STAFF

Geneticist

One Senegalese with a general animal husbandry undergraduate education would be given training to the M.Sc. level in quantitative animal genetics. His training would include breeding and genetics of both cattle and small ruminants even though his research project would probably concern only one species. Although he would be stationed at Kolda, he would also have responsibility for the breeding programs at Dahra where he would have a resident junior technician under his supervision. His primary concern would be selection programs for indigenous breeds of cattle and sheep. He would be responsible for analysis of phenotypic measurements, determinations of heritability, and indexing of selection traits. He would be responsible for the introduction of improved stock into the field. He would provide technical assistance for reducing the herd size at Dahra. Cross breeding would be limited to small-scale programs utilizing breeds already in place in Senegal. A limited amount of research would entail periodic inspection of off-station herds into which improved stock had been introduced.

Range Nutrition Specialists

Two Senegalese with undergraduate degrees in agronomy, animal husbandry or veterinary medicine would be given fellowships for further training to the M.Sc. level. Studies should be undertaken in departments of crop science or agronomy which offer range management programs. They would acquire experience in rangeland evaluation and methods of monitoring the primary productivity of rangeland. In order to broaden Senegal's expertise one of the students should acquire experience with cattle grazing systems and the other with sheep or mixed usage grazing systems. Upon returning to Senegal these researchers would be members of the off-station teams which would father data on the traditional systems of rangeland livestock production and develop programs of management for increased productivity.

Range Agronomist (Dahra) and Forage Agronomist (Kolda)

Two Senegalese with undergraduate degrees in crop science or general agriculture would be given fellowships for further training to the M.Sc. level in a department of agronomy. Experimental rather than descriptive agronomy would be emphasized with one of the students studying methods for semi-arid range improvement and the other studying methods for pasture development in subhumid climates. Upon returning to Senegal one would be stationed at Dahra and one at Kolda where they would perform manipulative research on station plots. At Dahra the research would concern means for post-drought reestablishment of indigenous forage plants, especially legumes, and reseeding and overseeding trials with introduced species. Plots would be evaluated for drought and grazing resistance and for primary productivity and nutritional value, with technical indices. At Kolda the agronomist would expand the ongoing trials with

introduced legumes and native grasses, and evaluate their performance on experimental plots. Research at Kolda would be directed toward pasture development as well as range improvement.

Range Animal Management Specialists

Two Senegalese with undergraduate degrees in general agriculture, animal husbandry, or veterinary medicine would be given fellowships for study to the M.Sc. level in a range management program within a department of animal science. Training for one of the students would emphasize small ruminant or mixed species range management, whereas training for the other would emphasize management of cattle herds. However, both should acquire a broad understanding of the general principles of animal management in grazing systems. These researchers would be members of the off-station research teams collecting data on local practices. Field data on herd structure and management methods would be collected in order to develop management programs for herdsmen which would increase the efficiency of rangeland utilization and preserve the rangeland resource. Limited on-station research would be conducted jointly with the range nutrition specialists to determine the feasibility of, and advantages derived from, managed systems such as rotational, delayed, and mixed usage grazing.

Herd Health/Reproduction Veterinarians

Two Senegalese with undergraduate degrees in veterinary medicine would be given fellowships for further study to the M.Sc. level in herd health and reproduction. Programs combining these fields of study are offered by departments of clinical medicine at several veterinary colleges. The programs should emphasize preventive population medicine and practical aspects of reproductive physiology including artificial insemination. One of the study fellows would undertake training research in bovine medicine and the other in ovine medicine although both would acquire a broad understanding of the principles of preventive medicine. Upon returning to Senegal the researchers would provide a service function for the Dahra and Kolda stations. They would monitor the health status of the herds, institute management methods to maintain the herd health level, and would be responsible for routine preventive and control procedures. Efforts would be directed towards minimizing the need to treat sick animals. The researchers would also provide technical assistance for the breeding programs, including fertility examinations, pregnancy diagnoses, and semen evaluations. They would establish research programs on herd health, reproduction, or both depending on the priorities set by the research groups at each station.

ANNEX 13

THE ECONOMICS AND SOCIOLOGY RESEARCH PROGRAM

A. The Need

Economic and sociologic analyses and studies are indispensable to an understanding of cultural or institutional impediments to technological advance in agriculture. Also they can contribute to identification of technical research problems with high potential for economic pay-off, and to estimation of cause and effect coefficients necessary for rational planning for agricultural development. The details of resource ownership and use rights, household production and consumption habits and decision structures, the workings of input and output markets, the effects on the rural economy of alternative governmental policies, and the opportunities in international markets are among the questions about which too little is known in Senegal. The lack of knowledge about these and other similar questions is as constraining on the government's ability to positively affect agricultural productivity as is the lack of knowledge about improved technology.

In addition to the primarily descriptive economic and social research activities implied by the gaps in knowedge outlined above, research that directly affects decisions with respect to research and extension programs, agricultural policy, investments, and institutional development is also needed.

A particularly important task for economic and social researchers is to assist in assessment of the practicability and probable impacts of adoption of new technology developed by the biological scientists. What enterprise combinations, methods of production, and resource use patterns for specified farm types in each of the main regions of the country will or should be adopted in light of new technology? Is the new technology economic in the context of the farmers' limitations and opportunities? What choices will or should be made by farmers to meet food and net income needs? Economic analysis provides guides that can be used by both farmers and policy makers in this area.

Choices must be made among investment projects proposed by the development societies and other agencies. Like all economies, Senegal has limited financing and resources to undertake projects. Furthermore, many projects, once examined in light of economic return are not viable. Economic analyses can and do provide methods and information necessary for evaluating projects and placing priorities on them in terms of one or more dimensions such as rates of return, value added, employment, income distribution, balance of trade, and so forth.

The consequences of possible alternative government policies with respect to product pricing, taxing of farm product sales, fixing of input prices, and subsidization of inputs deserve greater attention prior to policy implementation. Each decision with respect to these types of policies has impacts far beyond the immediate targeted factor. A good illustration of this was the policy of maintaining low consumer food prices in Senegal during the early 1970's. The policy did maintan

the purchasing power of urban wage-earners. On the other hand, it represented a transfer of income from the agricultural to the urban sector, it stifled investment in agricultural production, and it reduced incentives to expand production. Though the subsidation policy is still followed, it is revised from time to time. Better decisions could be made if the economics of the policy were better known.

B. Current Status of Economic and Social Research

Within the current research program of ISRA and SERST, there is almost no economic and social research. ISRA has a department entitled Agricultural Economics, Economics, and Sociology but, because of lack of staff it is headed by the ISRA General Director with the assistance of a foreign technical counselor, neither of whom have time for economics research. No other economics or sociology staff are located at the ISRA headquarters.

Field personnel attached to this department include two agro-economists at Bambey (one foreign, one Senegalese) and two sociologists at Kaolack (both Senegalese). Each of these researchers is trained to the French "license" plus one year level, roughly equivalent to a U.S. masters degree. The agro-economists' training is primarily in agronomy, with some exposure to farm management and investment analysis techniques. All of these researchers devote much of their time to operation of the Pilot Farm at Bambey, the PAPEM's, and the "Unites Experimentales"--which leaves little time for economic research. About ten assistants, having roughly ten years of formal schooling, are located in field stations. They gather agronomic and limited economic data at PAPEM's and from 35 farm families in four villages. They also cooperate with local extension agents in encouraging adoption of practices suggested by the station personnel.

The economics research program categories currently defined formally are:

1. Farm management (budgeting of crop activities)
2. Farm organization (pilot farms integrating agriculture, livestock and improved equipment)
3. Information transfer evaluation
4. Farm management modeling (linear programming of farms)
5. Farm management (extensive livestock activity analysis)
6. Economics of mechanization

The very limited research program now operational includes work only in the first two of these categories. Some crop activity and farm budget analyses based on both survey and experimental (pilot farm) data have been completed at Bambey over the past several years. Publications attributed to the Rural Economics section total almost 40 since 1970,

with about a third of these being reports of research results. Most report descriptive farm management studies with little comparison among alternate farming structures, techniques, or technology levels.

Other work in progress includes experimentation with an assessment of land tenure adjustments within the Unites Experimentales, and some collection and descriptive analysis of data on consumption, land tenure, and decision structures within villages. This research, conducted primarily by the sociologists stationed at Kaolack, has resulted in several publications describing tenure structures, and the socio-economic effects of adjustments implemented in the Unite Experimentale program.

No research in the areas of marketing, price and income policy, credit, investment or capital allocation has been done or is in progress.

C. The Proposed Research Program

As indicated by the statements of economic and social research needs and current status above, most of the research needs in this area have not been addressed nor can they be with current staffing levels and program orientation. To provide a capability for analysis of the critical economic and social problems and opportunities within the agricultural sector, a Department of Economics and Sociology comprised of five sections is proposed.

Farm Management and Production

This section would have both headquarters and field components. The headquarters component would include the section head, who would be trained in farm management and production economics to a level equivalent to the U.S. Ph.D., and one other researcher trained to the equivalent of the U.S. masters level. The field staff of the Farm Management and Production Economics Section would consist of six farm management economists trained to the M.Sc. level, each assigned to one of the regional research stations as a member of the respective production systems teams.

Initial responsibilities of the section head would include design and development of the farm management research components of the various farming systems research programs at the regional stations. Continuing duties would be to coordinate and assist the regionally based farm management economists in their work, particularly in the areas of project design, evaluation and publications. He would also be responsible for estimating aggregate and regional resource requirements and constraints, production potentials by product under alternative technologies, price relationships, etc. Information for this research would be obtained from the regional research studies and also through independently obtained data on total resource availability and use, and output. The second farm management economist at ISRA headquarters would pursue his own research project(s) within the research program outlined above for the section head. He would also assist the section head in the collection of necessary data and in the supervision of regional programs.

The farm management researchers attached to the regional systems teams would be administratively responsible to the heads of the Farming Systems or Animal Science Departments as appropriate through the team coordinators. However, they would also receive professional assistance and guidance from the farm management section head at ISRA headquarters. Research responsibilities of these economists would be to work as an integral part of the respective production systems teams, with particular responsibility for assessment of proposed agronomic, husbandry, and farming systems innovations with respect to financial feasibility and compatibility with real and financial constraints. They would also develop and periodically revise enterprise and farm budgets for relevant enterprises and farm types representative of various homogeneous areas (with respect to soils and climate, enterprise mixes, and tenure) within each region.

Rural Socio-Economic Systems

This section would be staffed as the Farm Management-Production Economics Section described above. ISRA headquarters staff would consist of the section head, a Ph.D. level rural sociologist and an agricultural economist with specialization in land tenure, trained to the M.Sc. level. The field staff would include 6 M.S. level rural sociologists, each assigned to one of the regional production systems teams.

Responsibilities of the section head would include program design, development and supervision, and a research program that would integrate the results of regional work into a national scale descriptive and analytic format that would assist in the identification and evaluation of policy options. He would also monitor structural changes over time and identify and assess their impacts on incomes and income distribution, production, market participation, etc. The tenure specialist in this section would assist the section head as needed but would also pursue independent research on systems of land ownership and control, land rights transfers, parcialization, and land use patterns.

The rural sociologists with field assignments would evaluate the social limitations on and social effects of proposed new production systems. They would describe rural resource (particularly land and labor) ownership, transfer and rights patterns, both static and dynamic; and assess the probable effects of feasible changes. They would also describe for their respective regions, rural households consumption and savings patterns and assess the interactions of consumption-production activities and decisions as they affect income potential or earnings, technological advance, and market orientation. For most of these tasks they would work in close collaboration (joint projects) with the economists assigned to their respective production systems teams.

Marketing

The marketing section would be staffed with one Ph.D.-level and four M.S.-level marketing economists, all stationed at ISRA headquarters. The Ph.D. level economist would serve as section head and would have research responsibilities either for cereals or livestock marketing. The M.S. economists would all have general marketing training but would pursue

research in the specialty areas of cereals and groundnuts, livestock, specialty products (e.g. vegetables, citrus, dairy), and input markets and credit. Among specific research tasks of the marketing section would be:

-- To describe farmers' marketing practices and the operation of markets by region for each major crop or livestock commodity. Included in the descriptions would be information about the activities of private traders, market shares, competition, the effects of government price policy and market intervention, quality control, typical sales quantities, market information, market and transportation facilities and financing.

-- To determine pricing efficiency for each major commodity and each marketing area by examining intra and inter market price dispersions, price responsiveness to supply and demand conditions, including interseasonal fluctuations, and the relationship of local market prices to world market levels.

-- To evaluate the potential for exports of commercial crops such as cotton, citrus, mangos, papayas, livestock and livestock products.

-- To give particular attention to the efficiency of livestock marketing and to the cultural factors affecting the livestock economy in general--marketing in particular.

Price and Income Policy

This section would include only one professional level economist, the section head,who would be trained to the Ph.D. level with emphasis in price analysis and/or agricultural policy. This researcher would work closely with economists in the marketing section in evaluating market mechanisms, price formation, and price policies. He would pursue detailed analyses designed to estimate demand and supply elasticities and cross elasticities for various commodities in various markets and to identify the key factors affecting demand and supply responses. Also, he would seek to describe and quantify the impacts of government farm policies, particularly price policy, on production and production location, product mix, productivity, incomes and income distribution, market participation and land and other resource use.

Resource Economics and Investment Analysis

Professional staff for this section would be the section head, a Ph.D. level economist with specialization in resource economics, and one M.S. level economist, also having a resource economics speciality. The research to be performed in this section would include studies to estimate the benefits and costs, both pecuniary and non-pecuniary, of feasible alternative strategies for public investments for resource development. An example of such a study might be a comparison of the probable rates of economic return to proposed investments in large scale irrigation developments with the probable rates of return to investment of roughly equivalent magnitude in the dryland agriculture sector, say for tree and

brush removal, deep plowing and subsidizing a rational cropping, and fertilizer use plan. These economists would also evaluate historical investment patterns and estimate returns in order to develop information useful for identification of the types of investments promising high pay-off in terms of such things as output, employment, and improved income distribution. Although these economists would be expected to assist the development societies and other agencies with evaluations of proposed investment projects, their role should be primarily advisory. Their research program should develop coefficients and analytical methods or results that would enable improved project evaluation; however, if their efforts are diverted from research to project analysis on any large scale, the basic coefficients and information essential to good project analysis will no longer be generated.

As the economics and social research program within ISRA grows, a department head with few duties other than administration will undoubtedly be required; however, for the first few years the department head function can probably be performed adequately by one of the heads of the various sections. It would not be feasible, however, for either the Farm Management and Production Economics or the Socio-Economic Systems section heads to serve in this capacity, because of their already heavy supervisory and field duties.

Summary of Staffing Proposed

Overall staff needs for the agricultural economics and rural sociology research programs outlined are summarized in Table 1.

Annex Table 13.1 Total Staff Requirements by Location for the Economics Department

	ISRA Headquarters	Fanaye	Dahra	Bambey	Kaolack	Djibelor	Kolda	Total
Farm Management & Production Econ.	2	1	1	1	1	1	1	8
Rural Socio-Economic Systems	2	1	1	1	1	1	1	8
Marketing	5	-	-	-	-	-	-	5
Price and Income Policy Analysis	1	-	-	-	-	-	-	1
Resource Economics and Investment Analysis	2	-	-	-	-	-	-	2
	12	2	2	2	2	2	2	24

Annex Table 13.2 Economics Research Program Training Schedule and Costs

	Man-years NO.	U.S. Dollars PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Fellowships								
Economist, Farm Management	2	27,000	27,000	27,000	-	-	-	81,000
Technical Cooperation		-	-	-	2,500	2,500	2,500	7,500
Total		27,000	27,000	27,000	2,500	2,500	2,500	88,500

Annex Table 13.3 Economics Research Program Operational Costs

	(1,000's CFAF) PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Salaries	-	-	-	6,500	7,150	7,865	21,515
Field and Lab Operations	-	-	5,500	11,550	12,705	13,976	43,731
Total	-	-	5,500	18,050	19,855	21,841	65,246

Economics and sociology professional staff for the regional station positions (as described above) are included in the staff lists and cost estimations for the respective production system programs. Therefore the following listing summarizes only the needs at ISRA headquarters.

	Economists		Sociologists		Total	
	Ph.D.	M.S.	Ph.D.	M.S.	Ph.D.	M.S.
Total Program Staff at ISRA Hdqs.	4	7	1	0	5	7
Senegalese now in place or in training	0	0	0	0	0	0
Technical Assistance Personnel	0	0.5	0	0.5	0	1
Proposed Training Program (USAID sector analysis project)	3	6	1	0	4	6
Residual training needs	1	1	0	0	1	1

Thus, the economics and sociology training for ISRA headquarters needed as a supplement to the training that is likely to be authorized under the USAID sector analysis project is only two persons. The total training time required would be six man-years. At $13,500 per man-year the total cost could be $81,000.

D. Proposed Budget

Because one foreign socio-economist is now on the ISRA headquarters staff and there is a substantial technical assistance component in the proposed USAID project (14.75 man-years), the residual technical assistance need would appear to be for one internationally recruited agricultural economist (Ph.D. level) to assume duties as the Farm Management section head in PY3 for a four-year term. Total cost for this post would be $334,100. Scheduling of the training and project-related Agricultural Economics and Sociology Department costs at ISRA headquarters are summarized in Annex Tables 13.2 and 13.3.

INTERNATIONALLY RECRUITED SCIENTISTS

A. Proposed Positions

Seven internationally recruited scientists are proposed in this project to assist in organizing and initiating the research programs. These scientists would be specialists in: Farming Systems, Livestock Systems, Experiment Station Development and Management, Farm Management Economics, Research Management, and Animal Science. Five of these scientists would be located in ISRA headquarters and would have country-wide responsibilities. Two animal scientists would be placed in the livestock systems research teams, one at Dahra and one at Kolda, beginning in PY4.

Funds for short-term consultants have been proposed so that ISRA can call on persons with specific talents when needed. These funds can also be used for external evaluation of research plans and progress.

A total of 67 man-months of short-term consulting has been provided.

B. Terms of Reference for International Scientists

Farming Systems Specialist (Annex 11)

An internationally recruited scientist would be located at ISRA headquarters for a six-year period. He would assist the farming systems research teams to shape their research programs and assist the Head of the Farming Systems Department to administer this research department. To accomplish this job it would be necessary for the Farming Systems Specialist to travel frequently to all the major research stations. In PY1-PY3 this scientist would take a direct part in carrying out the research, but his direct role should diminish as the Senegalese scientists return to Senegal from study programs abroad.

This scientist could have advanced degrees and research experience in any one of the disciplines represented in the farming systems teams; however, a research background in agronomy probably would be preferred. Research experience in multidisciplined teams in developing countries, particularly in Africa, would be desirable.

Livestock Systems Specialist (Annex 12)

An internationally recruited scientist would be stationed at ISRA Headquarters throughout the six-year project period. He would assist in the selection of candidates for fellowships and the selection of universities. This specialist would have wide experience in extensive livestock husbandry systems preferably under semi-arid African conditions. This scientist should have advanced degrees in animal science, preferably in range animal management, animal nutrition or herd health and reproduction.

He would have a research background corresponding to one of the line research positions at Dahra or Kolda and would assist in starting the research by making regular visits to the stations to guide the initial activities of the senior technicians before the arrival of the resident scientists. He would assist in overseeing the station development during the initial years. He would assist in the selection of internationally recruited resident scientists for Dahra and Kolda and would assist in repatriating the returning Senegalese study fellows. When these scientists are in place, he would assist the Animal Science Department Head in coordinating the research and in preparing reports and budget submissions.

Animal Scientists

Two internationally recruited animal scientists would be placed in the field during PY4 to 6. One would be stationed at Dahra and the other at Kolda. They would have livestock experience under African semi-arid conditions and would have a research background in one of the line positions. In PY4 they would help organize the centers and prepare research plans and budget submissions for the following year in cooperation with the returning study fellows. These scientists should have advanced degrees in animal science, preferably range animal management, nutrition, or herd health and reproduction.

Experiment Station Operations (Annex 21)

This internationally recruited scientist would be located at ISRA Headquarters (6 years) and would have the responsibility to assist in the planning, development, organization, and management of agricultural experiment stations throughout Senegal. He should also assist in selecting capable Senegalese to be experiment station superintendents, and he should train them to perform that function. He would work closely with the Technical Support Unit in all matters relating to development of experimental sites.

Experience in developing and managing experiment stations is the most important requirement for this position. Preferably the person filling this position would have advanced degrees in agronomy or agricultural engineering, but experience in experiment station management would be the prime prerequisite. It would be highly desirable for this scientist to have experience in experiment station management in developing countries. He should be knowledgeable about management of irrigated as well as rainfed experiment stations.

Research Management Specialist

An internationally recruited scientist would be stationed at ISRA Headquarters for the project's six-year period. He would assist with the development of a program-planning, budgeting, and management system and a project structure that will serve as a base also for program coordination and evaluation. This system would provide:

1) A complete description of ISRA operations and activities.

2) Clearly defined units of work, for the guidance of the research staff.

3) A record of objectives and plans of work, with maximum delegation of responsibility for performance.

4) A framework for the regular reporting of progress and status of research, and for the evaluation of performance of research units and of individual research workers.

The discipline in which the Research Management Specialist is educated is less important than the experience he has in managing active research activities. Ideally, this person would have a Ph.D. degree in some phase of biological science or socio-economics. He should have several years experience managing research activities, preferably with experience in developing nations. Directors and Assistant Directors of State experiment stations in the United States, for example, should be highly qualified to fill this position.

Economist, Farm Management (Annex 13)

An internationally recruited scientist would be stationed at ISRA Headquarters for four years, beginning in PY3. He would assist in establishing the economics component of the farming and livestock systems teams. He would assist the regionally based farm management economists in their work, especially in project design, research methodology, and evaluation. He would help to estimate aggregate and regional resource requirements and constraints, production potentials of products under alternative technologies, price relationships, and other economic factors.

Ideally, this scientist should have a Ph.D. degree in Economics (Farm Management) and several years experience with economic research in a developing nation.

C. Proposed Budget

Costs of international scientists have been calculated using $72,000/year as total costs for long-term scientists and $6,000/month for short-term consultants. A fund of $10,000 per year has been provided scientists stationed at ISRA Headquarters for operating expenses. Costs are $3,032,300 for long-term scientists, $412,000 operating costs, and $402,000 for short-term consultants. The total cost is $3,444,300 for the six-year project period. Staffing and cost details are given in Annex Tables 14.1, 14.2, and 14.3.

Annex Table 14.1 Internationally Recruited Scientists Staffing Pattern

International Scientists	Man-years						
ISRA Headquarters	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Farming Systems	1	1	1	1	1	1	6
Livestock Systems	1	1	1	1	1	1	6
Experiment Station Operations	1	1	1	1	1	1	6
Research Management	1	1	1	1	1	1	6
Economics	-	-	1	1	1	1	6
Dahra							
Livestock Systems	-	-	-	1	1	1	3
Kolda							
Livestock Systems	-	-	-	1	1	1	3

Annex Table 14.2 Internationally Recruited Scientists Costs and Operating Funds

Compensation	1,000's U.S. Dollars						
ISRA Headquarters	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Farming Systems	72.0	79.2	87.1	95.8	105.4	115.9	555.4
Livestock Systems	72.0	79.2	87.1	95.8	105.4	115.9	555.4
Experiment Station Operations	72.0	79.2	87.1	95.8	105.4	115.9	555.4
Research Management	72.0	79.2	87.1	95.8	105.4	115.9	555.4
Economics	-	-	72.0	79.2	87.1	95.8	334.1
Dahra							
Livestock Systems	-	-	-	72.0	79.2	87.1	238.3
Kolda							
Livestock Systems	-	-	-	72.0	79.2	87.1	238.3
	288.0	316.8	420.4	606.4	667.1	733.6	3,032.3

Operating Funds[1]	1,000's U.S. Dollars						
ISRA Headquarters	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Farming Systems	10	11	12	13	14	15	75
Livestock Systems	10	11	12	13	14	15	75
Experiment Station Operations	10	11	12	13	14	15	75
Research Management	10	11	12	13	14	15	75
Economics	-	-	10	11	12	13	46
Dahra							
Livestock Systems	-	-	-	10	11	12	33
Kolda							
Livestock Systems	-	-	-	10	11	12	33
Total Operating Funds	40	44	58	83	90	97	412
Total Costs and Operating Funds	328.0	360.8	478.4	689.4	757.1	830.6	3,444.3

[1] A figure of $10,000 (CFAF 2,200,000) has been provided as operating costs per year.

Annex Table 14.3 Short Term Consultants Phasing and Cost

Consultants, Short Term (1-6 months)

(Man months) 1,000's U.S. $

	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Millet	(1) 6	(1) 6	(2) 12	(2) 12	(2) 12	(2) 12	(10) 60
Sorghum	-	-	(1) 6	(1) 6	(1) 6	(1) 6	(4) 24
Maize	-	-	(1) 6	(1) 6	(1) 6	(1) 6	(4) 24
Rice	(2) 12	(2) 12	(2) 12	(2) 12	(2) 12	(2) 12	(12) 72
Cowpeas	-	-	-	(1) 6	(1) 6	(1) 6	(3) 18
Groundnuts	(2) 12	(2) 12	(2) 12	(2) 12	(2) 12	(2) 12	(12) 72
Farming Systems	(1) 6	(1) 6	(1) 6	(2) 12	(2) 12	(2) 12	(9) 54
Livestock Systems	-	-	(1) 6	(2) 12	(2) 12	(2) 12	(7) 42
Supporting Research	(1) 6	(1) 6	(1) 6	(1) 6	(1) 6	(1) 6	(6) 36
	(7) 42	(7) 42	(11) 66	(14) 84	(14) 84	(14) 84	(67) 402

CIVIL WORKS

A. Project Description

The construction projects which would form the civil works component of the proposed research project are:

Administrative Headquarters for ISRA together with houses for senior staff;

Further development of the research centers at Fanaye, Kaolack, Kolda, Dahra;

A new Library and Documentation Center and storage facilities for experimental seeds at Bambey together with renovation work in the laboratories;

New houses, a barn, and renovation work at Nioro Du Rip;

Renovation work at Sefa.

Preliminary schedules of accommodation have been developed which reflect the needs of the research programs, staff needs, and requirements for supporting services. It is anticipated that these schedules would be refined during the course of project development. Tentative cost estimates have been prepared. These are found in the tables attached to this Annex together with the schedules of accommodation. The research facilities and equipment to be provided are predicated on the assumption that detailed soil and plant analysis would be undertaken centrally by sending all samples to the laboratories at Bambey.

The research centers would be planned to permit easy growth and change in order to accommodate the inevitable changes of function and program over time. Utility services would be provided on a modular basis to provide this flexibility, and provision would be made in the supply conduits for the inclusion of additional services, if necessary, at a later date.

ISRA Headquarters

The proposed new building would replace the present rented building which is quite inadequate to house an organization of the calibre proposed in this report.

Two sites are available, one in Dakar on the Corniche and the other at St. Louis, in the grounds of the Botanical Garden. The site at Dakar has advantages in that air and road connections to the regional station are superior; also, it would permit easier access to Government Agencies and the resources of the University, particularly the Veterinary College. Furthermore, the capital cost of constructing houses for senior staff and providing furniture, amounting to $2,000,000, would be obviated by use of the Dakar site.

The schedule of accommodation calls for offices for the Director General and the supporting departments listed on the organogram in Annex 3. A conference room, with projection and simultaneous translation facilities would be provided together with seminar rooms.

The technical support sections would include Cartography, Information, and Publication, with art and photostudies together with printing and binding facilities. Space for a computer facility has also been provided in the schedule of accommodation although further discussion is merited on its location and relationship with the Oceanographic Institute in Dakar.

The linkage, currently obtaining at Bambey of Library-Cartography-Publication, results from the paucity of trained staff in Senegal. It is proposed that cartography and publications be detached and become a headquarters function. Tentatively it is proposed to locate the Library and Documentation Center at Bambey.

Research Center at Fanaye

It is proposed that this center would be the focus of research for the entire area of the Fleuve in which major irrigation development schemes are underway. Development of the experimental fields has already started at Fanaye. It is an excellent choice in that there are several representative soil types on the site. The main research thrust would be to evolve farming systems appropriate to the newly irrigated areas. In addition, research work would be undertaken in connection with the national programs for sorghum, maize, and rice.

Laboratories are proposed for entomology, pathology, soils, and agronomy, together with offices for researchers. Provided also would be cold storage facilities for experimental seed and supporting farm buildings.

Ideally, housing for researchers and staff should be located in close proximity to the research station and experimental fields. Land is available at Fanaye for this purpose and this location would have the additional advantage of being in proximity to the field station at Guede, some 45 km. to the east. At present, there is no social infrastructure at Fanaye but doubtless a health center and a small primary school could be included in a project to be supported by the World Bank. Additional support could be provided by Dagana, a prefecture town, which is but 20 minutes drive to the west. At Dagana there are food markets, primary and intermediate schools with a lycee proposed; also medical facilities, a telegraph station and regional offices of the Ministry of Agriculture. It is understood also that Dagana will be a center for future rural development.

Alternative locations suggested for staff housing were Dagana itself, Richard Toll and St. Louis, 50 km. and 150 km. to the west respectively. St. Louis is too distant from the proposed research station and experimental fields, and Richard Toll offers little in terms of social infrastructure. The existing station at Richard Toll is in poor condition physically, and all the associated agricultural land has

been requisitioned for other purposes. Moreover, there appear to be serious problems of surface and subsurface drainage. There seems little social infrastructure in the town and it would appear that there are no good grounds for locating either housing or research facilities there.

Research Station at Kaolack

This station would concentrate on farming systems research including livestock for areas with 800-1,000 mm. rainfall. Integrated with this would be research for the national programs in millet, sorghum, maize, groundnuts, and cowpeas.

New facilities would be provided at Kaolack which would be the focus of research activities, but experimental field work will be undertaken at Nioro Du Rip, Darou, and Sintiou-Malem. At Kaolack, laboratories would be constructed for entomology, pathology, nutrition and forage agronomy, and post-harvest technology, together with offices for researchers. At the field level, facilities would be provided for plant breeders together with cold storage facilities for experimental seed. Although strictly outside of the World Bank program, space would be provided for the three scientists working in the cotton program supported by a unilateral donor. At Nioro Du Rip a new barn would be provided while the existing farm buildings would be renovated under the proposed construction program.

As Kaolack is a well developed town, new houses on site will be limited to those for the Director, two senior level scientists, and a watchman. At Nioro Du Rip, houses will be provided for four senior and four junior technicians.

Research Center at Kolda

Research at Kolda would be addressed to livestock production systems in the southern ecosystem with rainfall between 1,000-1,400 mm. Kolda is a former sisal plantation and the existing farm buildings, houses and guesthouse are about 10 years old. New construction would provide laboratories for herd health, range agronomy, and nutrition research. Offices will be provided for researchers and for genetic work. The existing administration and farm management offices will continue in use.

As there are no houses in the vicinity, the existing houses will be renovated and supplemented by new houses to accommodate the entire scientific staff.

The electrical supply must be improved. Further investigation must be made to ascertain the relative costs of generators versus installing transmission lines and transformers to connect to the high tension city supply some 3 km. distant.

Research Center at Dahra

Research at this center would concentrate on livestock production systems for the sylvo-pastoral region. There are existing buildings

some of which would be renovated and reused for the proposed program. New buildings would include a range agronomy and forage laboratory and offices for researchers and for genetic work. The upgraded buildings would accommodate:

Herd Health Laboratory

Seminar and Library Room

Administration

Farm Management

There are few houses in this vicinity; for this reason the entire scientific staff would be accommodated either in newly constructed houses within the proposed program or existing houses which would be renovated. The water supply at Dahra would require upgrading. A new well, pumps, and connections would be required.

Research Center at Sefa

Research at this center would be directed towards upland crops in the ecological environment of the Casamance region. This work would complement that of Djibelor where the problems of rice and lowland crops would be investigated.

There is an existing station at Sefa and it is proposed that the existing buildings be upgraded. An allowance for this had been made in the cost estimates based on a quotation from a local contractor.

Bambey

Pending resolution of the location of the ISRA Headquarters, it is proposed that ISRA's central Library and Documentation Center remain at Bambey but be provided with new buildings. In this location it would remain easily accessible to the locus of major scientific research in Senegal. However, if ISRA Headquarters are located at Dakar rather than St. Louis there would be grounds for including the library as a headquarters function. Dakar will obviously remain the intellectual center of Senegal and locating the library there would strengthen its resources on account of accessibility to the University libraries, particularly the National Library for Livestock and Veterinary Research. The library will be the primary reception point for overseas journals and literature and part of its function will be to selectively copy and distribute this to each research station according to its specialty. Here again, location in Dakar would provide superior air and road communications.

The building program for the new library would include stack space for 15,000 volumes (at present the collection total 7,000 volumes), a reading room with 10 stations and facilities for display of recent publications and journals, a librarian's office and a workroom. The library would be centrally air conditioned to provide temperature and humidity control.

To reinforce the research programs two environmentally controlled storage facilities for experimental seeds have been included in the building program.

The research laboratories at Bambey were constructed in the 1920's. They appear basically sound though this should be verified in more detail by a structural engineer. The electrical system is very poor and constitutes an immediate hazard. Subject to an engineer's report an allowance for renovation costs has been included in the cost estimates; it is understood, however, that the Government of France has been asked to support these costs.

B. Provisional Cost Estimates

A summary of provisional costs is included in Annex Table 15.1. They have been based on recent contract awards for analogous building types together with the recent experience of ISRA and architects in the private sector. A Provincial Cost Variation has been included to reflect the higher costs of construction in the rural areas due to increased costs of skilled labor and transportation of building materials. Design and construction contingencies have been included. A consensus of professional judgment in Dakar indicates that the rate of escalation in the construction sector is about 12% per annum; this has been taken into account. Pending clarification of the needs for laboratory equipment and furniture, allowances have been made in light of the experience of recent World Bank projects, i.e., 25% and 8% construction costs respectively.

The cost of renovation work at Sefa has been based on a contractor's estimate. However, the estimates for upgrading the laboratories at Bambey and the houses and other buildings at Dahra and Kolda have been based on a notional figure of 25% of new construction cost; this should be refined during the course of project preparation.

The foreign exchange component for civil works in the World Bank Education projects has been calculated at 35%. Prima facie, there is no reason to challenge this figure, but it should be verified at the time of appraisal.

The present lack of clarity concerning the intentions of unilateral donors leads to difficulty in determining the capital costs of the project to be presented to the World Bank. It is known, for instance, that the CILSS program may finance four entomology and pathology laboratories, three of which have been included in the cost estimates; similarly USAID may contribute to the ISRA Headquarters; the French Government to work at Bambey; and possibly the Belgian Government to Dahra. There may be other contributions. It is hoped that the intentions of all donors will be coordinated by the time of appraisal.

A summary of civil works costs is given in Annex Table 15.1, with details in Annex Tables 15.2 through 15.22.

Annex Table 15.1 Summary of Estimated Costs of Civil Works[1] ('000 CFAF)

	·Construction ·Site Works ·Provincial Cost Var'n	·Design & Construction Contingencies	·Prof. Fees	·Furniture & Equip.	·Escalation	Total
ISRA Admin.	329,700	69,300	49,900	20,800	267,700	737,400
ISRA Housing	188,100	39,500	9,100	42,900	159,400	439,000
Fanaye	695,200	146,000	55,600	169,100	607,600	1,673,500
Kaolack	250,200	52,500	37,800	56,500	226,300	623,300
Nioro du Rip	91,900	9,200	5,100	17,600	70,600	194,400
Kolda						
New Work	294,100	56,100	40,400	30,100	239,800	660,500
Renovations	28,500	2,900	1,600	-	18,800	51,800
Electrical Connections	-	-	-	-	-	16,000
Dahra						
New Work	123,600	26,000	18,700	31,000	113,600	312,900
Renovations	52,900	5,300	2,900	-	34,800	95,900
Bambey						
New Work	42,000	8,800	6,400	8,300	37,300	102,800
Renovations	40,300	4,000	2,200	-	26,500	73,000
Sefa						
Renovations	5,500	600	300	-	3,648	10,000
						4,990,500

(U.S. $22,684,000)

1 Excluding development costs of experimental fields

Annex Table 15.2 ISRA Headquarters Staff List

	Senior Administrator	Junior Administrator	Clerical	Secretaries
Director General	1	1		2
Deputy Director General	1			
Conseilleurs Techniques	2			
Coordinator, External Relations	1			
Administration and Finance				
Director	1	1		
Finance	1	1 budget 1 contracts	1 travel 1 prchsg.	
Personnel	1	1	2	4
Accounts	1	1	3	
Scientific and Technical Administration				
Conseilleurs Techniques	2			
Crop Science	1	2		
Animal Science	1	2		4
Farming Systems	1	2		
Natural Resources	1	2		
Economics and Sociology	12	5		
Research Support Services	1			
Technology Transfer	1		1	
Manpower	1		1	2
Experimental Stats. Dept.	1		2	
Statistics	1		2	
Production and Technical Services	--	1	1	
Support				
Information and Publication	1 director 1 editor --	1 artist 1 photo 1 printer	1 1 2	1
Library and Documentation	1	1	2	1
Cartography	1	1	1	
Technical Support Unit	1 architect 1 engineer	2		1
Transportation	--	1	1	--
	38	28	22	15

Annex Table 15.3 ISRA Administrative Headquarters at St. Louis
Preliminary Schedule of Accomodation

SPACE	STAFF OR CAPACITY	NO. OF UNITS	AREA M^2	TOTAL AREA M^2
A. DIRECTORS OFFICES				
Director General	1	1	x 30	= 30
Deputy	1	1	x 13	= 13
Personal Assistant	1	1	x 13	= 13
Conseilleurs Techniques	1	2	x 13	= 26
Coordinator External Relations	1	1	x 13	= 13
Secretaries (2) and Waiting Area				= 26
Filing and Photocopy				= 20
B. OFFICES FOR SCIENTIFIC DIVISIONS				
Offices for:				
Senior Administrators	1	21	x 13	= 286
Assistants	2	7	x 22	= 154
Secretaries (11) and Clerical (3)				= 100
Filing and Photocopy				= 25
C. ADMINISTRATION AND FINANCE				
Administrative Director	1	1	x 20	= 20
Directors for Finance Personnel and Accounts	1	3	x 13	= 39
Assistants Clerical (7) and Secretarial (4)	shared			= 55
Filming and Photocopy				= 50

Annex Table 15.3

SPACE	STAFF OR CAPACITY	NO. OF UNITS	AREA M^2	TOTAL AREA M^2
D. TECHNICAL SUPPORT				
Cartography Section				
Studio	2			= 15
Mapreading and Store				= 15
Office	1			= 15
Information and Publication				
Art Studio and Materials Store	2			= 20
Photo Studio, Lab. and Dark Room	2			= 40
Printing and Binding	2			= 40
Paper and Materials Store				= 10
Photocopy				= 10
Offices for:				
Director and Editor	1	2 x	15	= 30
Secretarial (2) and Filing				= 14
Mailroom and Dispatch				= 15
Technical Support Unit				
Offices for:				
Architect				
Irrigation Engineer	1	2 x	13	= 26
Drafting Office	2	1 x	20	= 20
Secretary (1) and Filing				= 7
Computer Section 3/				
Offices for:				
Experimental Draft				
Statistician	1	2 x	13	= 26
Equipment and Operators	4			= 26
Secretary (1) and Filing				= 7
Transport				
Office				= 20
Drivers Waiting Room				= 15

Annex Table 15.3

	STAFF OR CAPACITY	NO. OF UNITS	AREA M^2	TOTAL AREA M^2
E. ANCILLIARIES				
Entrance Hall and Reception				30
Seminar Rooms 1/	10	2	x 18	= 36
Conference Room with Projection	50	1	x 75	= 75
Simultaneous Translation				= 10
Foyer/Exhibition Area				= 30
Cloak Rooms				= 30
Coffee Bar				= 15
F. GENERAL SUPPORT				
General Storage and Central Records				= 75
Toilets and Cleaners				= 50
Telephone Equipment, Plant Room and Technical Equipment				= 30
				1609
		Grossing factor 35%		563
Total Gross Area				2172

G. HOUSING 2/			GROSS AREA M^2
Senior Administrator	13	x 130 m^2	1690

1/ One in vicinity of Director Generalŝ office.
2/ Limited to senior staff only.
3/ May be located with Oceanographic Institute in Dakar.

Annex Table 15.4 ISRA Headquarters at St. Louis
Cost Estimate of Administrative Building

		'000 CFA	US $ 2/
1.	Construction cost 2172 m^2 @ 120 CFAF 1/ / m^2	260600	1184500
2.	Site Works 15%	39100	177500
		299700	1362000
3.	Provincial Cost Variation 10%	30000	136000
		329700	1498000
4.	Design Contingency 10%	33000	150000
		362700	1648000
5.	Construction Contingency 10%	36300	165000
		399000	1813000
6.	Professional Fees 12 1/2%	49900	227000
		448900	2040000
7.	Furniture 2/	20800	95000
		469700	2135000
8.	Escalation (4 years at 12% = 57%)	267700	1217000
		737,400	3,352,000

1/ Dakar cost base mid 1979 including central air conditioning
2/ US. $ 1 = 220 CFAF
3/ Preliminary Estimate 8% of construction cost

Annex Table 15.5 ISRA at St. Louis Cost Estimate of Housing

		'000	US $[2]
1.	Construction Cost 1690 m^2 @ 88 CFAF[1] / m^2	148,700	676,000
2.	Site Works 15%	22,300 171,000	101,000 777,000
3.	Provincial Cost Variation 10%	17,100 188,100	78,000 855,000
4.	Design Contingency 10%	18,800 206,900	85,000 940,000
5.	Construction Contingency 10%	20,700 227,600	94,000 1,034,000
6.	Professional Fees 4% (repetition)	9,100 236,700	42,000 1,076,000
7.	Furniture and Equipment 3/	42,900 279,600	195,000 1,271,000
8.	Escalation (4 years at 12% = 57%)	159,400 439,000	724,000 1,995,000

1/ Dakar cost base mid 1979, air conditioning units included in furniture and equipment allowance.
2/ US $ = 220 CFAF
3/ Preliminary estimate at $15,000 per Senior Administrator.

Annex Table 15.6 Research Center at Fanaye Staff List

	Researchers	Senior Tech	Junior Tech	Secs.	Labour
Pathology	1	1	1		
Entomology	2	2	2		
Breeders	3	3	3		
Agronomists	2	2	2		
Economist	1	1	1		
Sociologist	1	1	1	7	
Soil Physicist	1	1	1		
Animal Husbandry	1	1	1		
Extension	1	-	-		
Administration					
Director	1	-	-		
Accts/Purch/Pers.	-	4	4	2	
Farm Manager	-	1	1		
Mechanical Maintenance	-	1	2		
Building Maintenance	-	1	3		
Irrigation control	-	1	2		
	14	20	24	9	

Annex Table 15.7 Research Center at Fanaye
Preliminary Schedule of Accomodation

SPACE	STAFF OR CAPACITY	NO. OF UNITS		AREA M2		TOTAL AREA M2
1. CENTRAL FACILITIES						
A. Laboratories						
Entomology 5/	4	1	x	40	=	40
Insect Breeding		1	x	13	=	13
Pathology	2	1	x	20	=	20
Sterile Transfer		1	x	5	=	5
Soil	2	1	x	20	=	20
Agronomy	2	1	x	20	=	20
Preparation Areas					=	20
Instrument Room (a/c)		1	x	15	=	15
Glassware and Chemical Store		1	x	15	=	15
B. Research Offices						
Researchers	1	13	x	15	=	195
Senior Technicians (4) 1/	2	2	x	22	=	44
Junior Technicians (2) 1/					=	14
Secretaries (7) and filing					=	50
C. Administration						
Director	1				=	25
Assistants for Finance, Personnel and Purchasing	1	4	x	11	=	44
Clerical (4) and Secretaries (2)					=	42
Filing and Stationery Store					=	20
Photocopy					=	10
Reception and Public Area					=	30
D. Ancillaries						
Seminar and Library Room	20	1	x	40	=	40
E. Support						
Records and General Storage					=	30
Toilets and Cleaners					=	35
Telephone and Electrical Equipment					=	15

Annex Table 15.7 (Continued)

SPACE	STAFF OR CAPACITY	NO. OF UNITS	AREA M^2	TOTAL AREA M^2
2. FIELD SERVICES CENTER				
Agronomy and Breeders Work Room with Samples Storage	8		=	200
Agronomy Preparation Room			=	15
Seed Storage (a/c)			=	20
Seed Storage (5°F)			=	15
Offices for Farm and Irrigation Managers, Mechanical and Building Maintenance Engineers			=	60
				1072
		Grossing factor 35%	=	375
Total Gross Area				1447
3. FARM BUILDINGS 2/				Gross Area M^2
Screen House for Agronomy				50
Screen House for Entomology				50
Pesticide and Equipment Stores				35
Fertilizer Store	20 tons			30
Workshops for Mechanical and Building Maintenance				300
Implement and Tractor Sheds				300
Meteorological Station				--
				766
4. HOUSING 4/				
Researchers		14 x	130 M^2 =	1820
Senior Technicians		20 x	95 M^2 =	1900
Junior Technicians 3/		12 x	58 M^2 =	696
Guest House for 6 with Lounge, Dining and Kitchen			=	192
				4608
5. PARKING				
Covered Parking for 14 Researchers Cars			=	252

1/ Non lab based.
2/ Two barns existing totaling 600 M^2.
3/ Assumed 50% Junior Technicians will be locally recruited.
4/ Need for Health Centre and Club will be reviewed during Appraisal.
5/ May be supported by the CILSS program.

Annex Table 15.8 Research Center at Fanaye Cost Estimate
New Buildings

New Buildings Construction Cost. 1/		'000 CFAF	US $ 4/
1. Central Facilities and Field Services Center	1447 m^2 @ 91.5 CFAF/m^2	132400	602000
Farm Buildings	766 m^2 @ 44 CFAF/m^2	33700	153000
Housing:			
Researchers and Guest House	2012 m^2 @ 88 CFAF/m^2	177000	804000
Senior Technicians	1900 m^2 @ 77 CFAF/m^2	146300	665000
Junior Technicians	696 m^2 @ 66 CFAF/m^2	45900	209000
Covered Parking	252 m^2 @ 17.5 CFAF/m^2	4400	20000
		539700	2453000
2. Site Works 15%		81000	368000
		620700	2821000
3. Provincial Cost Variation 12%		74500	339000
		695200	3160000
4. Design Contingency 10%		69500	316000
		764700	3476000
5. Construction Contingency 10%		76500	348000
		841200	3824000
6. Professional Fees: 4% on repetitive housing 12 1/2% on remainder		55600	252000
		896800	4076000
7. Lab Equipment 2/		33100	151000
Office and Laboratory Furniture 3/		10600	48000
House Furniture and Equipment		125400	570000
		1065900	4845000
8. Escalation (4 years at 12%=57%)		607600	2762000
		1,673,500	7,607,000

NOTE:

1/ Assumed central electrical supply will be available
2/ Preliminary estimate at 25% of construction cost
3/ Preliminary estimate at 8% of construction cost
4/ US $ 1 = 220 CFAF

Annex Table 15.9 Research Center at Kaolack Staff List

	Researchers	Senior Tech	Junior Tech	Secs.	Labour
Agronomy	2	2	2		
Nutrition	1	1	1		
Breeders	(7) 1/ 5	(7) 1/ 5	(7) 1/ 5		
Pathology	1	1	1	8	
Entomology	3	3	3		
Post Harvest Technology	1	1	1		
Sociologist	1	1	1		
Economist	1	1	1	1	
Director and Administration	1	4	4	2	
Extension	1	-	-		
Geographer	(1) 1/				
	17	19	19	11	

1/ Includes staff of Cotton Program funded by French Government

Annex Table 15.10 Research Center at Kaolack
Preliminary Schedule of Accommodation

SPACE	STAFF OR CAPACITY	NO. OF UNITS		AREA M^2		TOTAL AREA M^2
1. CENTRAL FACILITIES						
A. Laboratories						
Entomology 1/	6	1	x	55	=	55
Insect Breeding		1	x	13	=	13
Pathology	2	1	x	20	=	20
Sterile Transfer Room		1	x	5	=	5
Nutrition and Forage Agronomy	6	1	x	55	=	55
Post Harvest Technology	2	1	x	20	=	20
Preparation		1	x	20	=	20
Instrument Room (a/c)		1	x	15	=	15
Glassware and Chemical store		1	x	15	=	15
B. Research Offices						
Researchers	1	19	x	15	=	285
Senior Technicians 2/	2	1	x	22	=	22
Junior Technicians (2) 2/					=	14
Secretaries (9) and filing					=	63
C. Administration						
Director	1				=	25
Assistants for Finance, Personnel and Purchasing	1	4	x	11	=	44
Clerical (4) and Secretaries (2)					=	42
Filing and Stationery Store					=	20
Photocopy					=	10
Reception and Public Area					=	30
D. Ancillaries						
Seminar and Library Room	20	1	x	40	=	40
E. Support						
Records and General Storage					=	30
Toilets and Cleaners					=	35
Telephone and Electrical Equipment					=	15

Annex Table 15.10 (Continued)

SPACE	STAFF OR CAPACITY	NO. OF UNITS	AREA M^2	TOTAL AREA M^2
2. FIELD SERVICES CENTER				
Breeders Workroom and Samples Storage				= 200
Agronomy Preparation Room				= 15
Seed Storage (a/c)				= 20
Seed Storage (5°F)				= 15
				1143
				400
				1543
				Gross Area M^2
3. FARM BUILDINGS				
Screen House for Agronomy				= 50
Screen House for Entomology				= 50
Meteorological Station				--
				100
				Gross Area M^2
4. HOUSING 3/				
Researchers		3	x 130 M^2	= 390
Watchman		1	x 58 M^2	= 58
				448
5. PARKING				
Covered Parking for 20 Researchers				= 360

1/ This may be financed by CILS Program
2/ Non lab based technicians
3/ 4 Senior Technicians and 4 Junior Technicians housed at Nioro Du Rip

Annex Table 15.11 Research Center at Kaolack
Cost Estimate New Buildings

New Buildings: Construction Cost

		'000 CFAF	US $ 2/
1. Central Facilities and Field Services Center	1543 m^2 @ 91.5 CFAF/m^2	141,200	642,000
Farm Buildings	100 m^2 @ 44. CFAF/m^2 1/	4,400	20,000
Housing			
Researchers	390 m^2 @ 88. CFAF/m^2	34,300	156,000
Watchman		3,000	13,000
Covered parking	360 m^2 @ 17.5 CFAF/m^2	6,300	29,000
		189,200	860,000
2. Site Works 15%		28,400	129,000
		217,600	989,000
3. Provincial Cost Variation 15%		32,600	148,000
		250,200	1,137,000
4. Design Contingency 10%		25,000	113,000
		275,200	1,250,000
5. Construction Contingency 10%		27,500	125,000
		302,700	1,375,000
6. Professional Fees 12½%		37,800	172,000
		340,500	1,547,000
7. Lab. Equipment, prelim. estimate 3/		35,300	161,000
Office and laboratory furniture 3/		11,300	51,000
House furniture and equipment 4/		9,900	45,000
		397,000	1,804,000
8. Escalation (4 years @ 12% = 57%)		226,300	1,029,000
		623,300	2,833,000

1/ Dakar cost base mid 1979
2/ US $ 1 = 220 CFAF
3/ Preliminary Estimate at 25% and 8% of construction cost respectively.
4/ Preliminary Estimate at $15000 for each Researchers' house.

Annex Table 15.12 Research Center at Nioro du Rip New Buildings

SPACE	STAFF OR CAPACITY	NO. OF UNITS	AREA M^2		TOTAL AREA M^2
					Gross Area M^2
Barn for sorting and packing plant materials and stores					300
Housing:					
Senior Technicians		4 x 95 m^2		=	380
Junior Technicians		4 x 58 m^2		=	232
					612

Annex Table 15.13 Research Center at Nioro du Rip
Cost Estimate New Buildings

		'000 CFAF	US $ 3/
1.	New Barn 300 m^2 @ 26.5 CFAF/m^2	8000	36000
2.	New Housing		
	Senior Technicians 380 m^2 @ 77 CFAF/m^2	29300	133000
	Junior Technicians 232 m^2 @ 66 CFAF/m^2	15300	70000
3.	Renovation of Existing Buildings		
	Housing 505 m^2 @ 20 CFAF/m^2 1/	10100	46000
	Farm Buildings 886 m^2 @ 7 CFAF/m^2 1/	6200	28000
		68900	313000
4.	New Pumps, Well, Tank, Transformer and lines 2/	23000	105000
		91900	418000
5.	Construction Contingency 10%	9200	42000
		101100	460000
6.	Professional Fees, say 5%	5100	23000
		106200	483000
7.	Furniture and Equipment for new Houses	17600	80000
		123800	563000
8.	Escalation (4 years at 12% = 57%)	70600	321000
		194000	884000

1/ Preliminary estimate at 25% of new construction cost
2/ ISRA Estimate
3/ US $ 1 = 220 CFAF

Annex Table 15.14 Research Center at Kolda Staff List

	Researchers	Senior Tech	Junior Tech	Secs.	Labour
Range Agronomy	1	1	1		
Nutrition	1	1	1		
Herd Health	1	1	1		
Geneticist	1	1	1		
Animal Management	1	1	1		
Economist	1	1	1	4	
Sociologist	1	1	1		
Administration	-	1	1		
Farm Manager	-	1	1		
Extension	1	-	-		
Intl. Scientist	1	-	-		
	9	9	9	4	

Annex Table 15.15 Research Center at Kolda
Preliminary Schedule of Accommodation

SPACE	STAFF OR CAPACITY	NO. OF UNITS	AREA M2	TOTAL AREA M2
CENTRAL FACILITIES 1/				
(a) Laboratories ; centre d'I.A.				
Herd Health (wet)	2	1 x	20 =	20
Range Agronomy and Nutrition (dry)	4	1 x	40 =	40
Glassware and Chemical Store		1 x	10 =	10
Preparation Room		1 x	10 =	10
(b) Research Offices				
Researchers	1	8 x	15 =	120
Senior Technicians (4)	shared		=	44
Junior Technicians (4)	shared		=	28
Secretaries (4) and filing			=	28
Photocopy			=	10
(c) Support				
Seminar and Library room	12	1 x	25 =	25
Records and Storage			=	20
Toilets and Cleaners			=	20
Telephone and Electrical			=	15
				390
		Grossing factor 35%		136
Total Gross Area				526

1/ The existing administration and farm management offices will be continued in use.

Annex Table 15.16 Research Center at Kolda Cost Estimate

		'000 CFAF	US $[2/]
A. New Buildings: Construction			
1. Central Facilities	526 m^2 @ 91.5 CFAF/$m^{1/2}$	48100	218500
Housing			
Researchers	520 m^2 @ 88 CFAF/m^2	45800	208000
Senior Research Technicians	570 m^2 @ 77 CFAF/m^2	43900	199500
Junior Research Technicians	522 m^2 @ 66 CFAF/m^2	34500	157000
		172300	783000
2. Site Works 15%		25800	117000
		198100	900000
3. Provincial Cost Variation 35%		69300	315000
		267400	1215000
4. Design Contingency 10%		26700	122000
		294100	1337000
5. Construction Contingency 10%		29400	133000
		323500	1470000
6. Professional Fees 12½ %		40400	184000
		363900	1654000
7. Laboratory Equipment		12000	154000
Office and Lab Furniture		3800	17000
House Furniture and Equipment		14300	65000
		394000	1790000
8. Escalation (4 years at 12%=57%)		224600	1021000
		618600	2,811,000
B. Existing Buildings: Renovation Costs			
1. Housing			
Researchers and Guest House	1027 m^2 @ 22 CFAF/m^2	22600	103000
Senior Technicians	300 m^2 @ 19.5 CFAF/m^2	5900	27000
		28500	130000
2. Construction Contingency 10%		2900	13000
		31400	143000
3. Professional fees say 5%		1600	7000
		33000	150000
4. Escalation 57 %		18800	86000
		51800	236000

.../..

Annex Table 15.15 (Continued)

SPACE	STAFF OR CAPACITY	NO. OF UNITS		AREA M^2		TOTAL AREA M^2
HOUSING						Gross Area m^2
Researchers' Houses						
Total required		9				
Existing		5				
Additional needs		4	x	130	=	520
Senior Technicians' Houses						
Total required		9				
Existing		3				
Additional needs		6	x	95	=	570
Junior Technicians' Houses						
Total required		9				
Existing		-				
Additional needs		9	x	58	=	522
						1090

	'000 CFAF	US $
C. Electrical Connection 3/		
3 km line to City supply 200 kw transformer and building Circuit accessories and connections	16000 4/	73000

1/ Dakar cost base mid 1979

2/ US $ = 220 CFAF

3/ Appraisal Mission should evaluate whether independent generators would be less costly and whether, in fact, these costs should be borne by the Project.

4/ ISRA estimate based on estimates for similar installation at Richard Toll.

730 000
22 =
146
146
16060000

Annex Table 15.17 Research Center at Dahra Staff List

	Researchers	Senior Tech	Junior Tech	Secs.	Labour
Range Agronomy	1	1	1		
Nutrition	1	1	1		
Herd Health	1	1	1		
Animal Management	1	1	1		
Geneticist	-	-	1	4	
Economist	1	1	1		
Sociologist	1	1	1		
Administration	-	1	1		
Farm Manager	-	1	1		
Extension	1	-	-		
Intl. Scientist	1	-	-		
	8	8	9	4	

Annex Table 15.18 Research Center at Dahra
Preliminary Schedule of Accommodation

SPACE	STAFF OR CAPACITY	NO. OF UNITS	AREA M^2	TOTAL AREA M^2
CENTRAL FACILITIES				
(a) Dry Laboratories and Researchers' Offices				
Range Agronomy and Nutrition Lab	4	1 x	40 =	40
Preparation Room		1 x	10 =	10
Researchers' Offices	1	7 x	15 =	105
Senior Technicians (3)	shared		=	33
Junior Technicians (4)	shared		=	28
Secretaries (4) and filing			=	28
Photocopy			=	10
(b) Support				
Records and Storage			=	20
Toilets and Cleaners			=	20
Telephone and Electrical Eqpt.			=	5
				299
		Grossing factor 35%		105
Total Gross Area				404

NOTE:

The following functions will be accommodated in existing buildings which will be upgraded:

- Library and Journal Room
- Herd Health Laboratory
- Administration
- Farm Management

Annex Table 15.18 Research Center at Dahra
Preliminary Schedule of Accommodation (cont'd)

SPACE	STAFF OR CAPACITY	NO. OF UNITS	AREA M^2	TOTAL AREA M^2
HOUSING				Gross Area M^2
Researchers' Houses				
Total required		8		
Existing		6		
Additional Needs		2	x 130	= 260
Senior Technicians' Houses				
Total required		8		
Existing		6		
Additional Needs		2	x 95	= 190
Junior Technicians' Houses				
Total required		9		
Existing		4		
Additional Needs		5	x 58	= 290
				610

Annex Table 15.19 Research Center at Dahra Cost Estimate

		'000 CFAF	US $ 2/
A. New Buildings: Construction Cost			
1. Central Facilities	404 m^2 @ 91.5 CFAF/m^2 1/	37000	168000
Housing			
Researchers	260 m^2 @ 88 CFAF/m^2	22800	104600
Senior Technicians	190 m^2 @ 77 CFAF/m^2	14600	66000
Junior Technicians	290 m^2 @ 66 CFAF/m^2	19100	87000
		93500	425000
2. Site Works 15%		14000	63600
		107500	488600
3. Provincial Cost Variation 15%		16100	73200
		123600	561800
4. Design Contingency 10%		12400	56400
		136000	618200
5. Construction Contingency 10%		13600	61800
		149600	680000
6. Professional Fees 12 1/2%		18700	85000
		168300	765000
7. Laboratory Equipment 3/		9300	42000
Office and Lab Furniture 3/		3000	14000
House Furniture and Equipment 4/		18700	85000
		199300	906000
8. Escalation 4 years at 12% = 57%		113600	516000
		312900	1422000

1/ Dakar cost base mid 1979
2/ US $ 1 = 220 CFAF
3/ Preliminary Estimate at 25% and 8% of construction cost respectively
4/ Preliminary Estimate at $15000 for Researchers and Senior Technicians, $5000 for Junior Technicians

Annex Table 15.19 (cont'd)

B. Existing Buildings: Renovation Cost 1/

		'000 CFAF	US $
1. Laboratory	400 m^2		
Administration and Library	420 m^2		
	820 m^2 @ 23 CFAF/m^2	18900	86000
Researchers Houses (6)	780 m^2 (est) @ 22 CFAF/m^2 2/	17200	78000
Senior Technicians (6)	570 m^2 (est) @ 19.5 CFAF/m^2	11100	50000
Junior Technicians (4)	344 m^2 @ 16.5 CFAF/m^2	5700	26000
		52900	240000
2. Construction contingency 10%		5300	24000
		58200	264000
3. Professional fees say 5%		2900	14000
		61100	278000
4. Escalation 57%		34800	158000
		95900	436000

1/ Possible Funding available from Belgian Government
2/ Tentative Estimate at 25% of new construction cost

General renovation of all buildings including offices, laboratories, housing and stores.

	'000 CFAF	US $
Contractors Estimate (June 1979)	5,500	25,000
Contingency	600	2,500
Professional Fees (say 5%)	300	1,400
Escalation (57%)	3,600	16,600
	10,000	45,500

Annex Table 15.21 Research Center at Bambey New Buildings

SPACE	STAFF OR CAPACITY	NO. OF UNITS		AREA M2		TOTAL AREA M2
1. Library and Documentation Center 1/						
Stacks	15000 vols	1	x	85	=	85
Reading Room with periodicals and display	10 places	1	x	30	=	30
Workroom, binding and photocopy	2	1	x	20	=	20
Librarian's Office	1	1	x	15	=	15
Secretary and filing					=	7
Toilets and Cleaners					=	15
						172
	Grossing factor 35%					60
Total Gross Area						232
2. Seed Storage Facilities 1/						Gross Area M2
Air conditioned Storage					=	40
Storage to 5 F					=	30
						70

1/ Temperature and humidity controlled.

Annex Table 15.22 Research Center at Bambey - Cost Estimate

		'000 CFAF	US $
A.	New Buildings: Construction Cost		
1.	Library and Seed Storage 302 m^2 x 110 CFAF/m^2 1/	33200	151000
2.	Site Works 15%	5000	23000
		38200	174000
3.	Provincial Cost Variation 10%	3800	17000
		42000	191000
4.	Design Contingency 10%	4200	19000
		46200	210000
5.	Construction Contingency 10%	4600	21000
		50800	231000
6.	Professional Fees 12 1/2%	6400	29000
		57200	260000
7.	Library Furniture and Stacks 2/	8300	38000
		65500	298000
8.	Escalation (4 years at 12%=57%)	37300	169000
		162800	467000
B.	Existing Buildings: Renovation Cost 3/		
1.	Laboratories 1753 m^2 x 23 CFAF/m^2 4/	40300	183000
2.	Construction Contingency 10%	4000	18000
		44300	201000
3.	Professional Fees, say 5%	2200	10000
		46500	211000
4.	Escalation	26500	120000
		73000	331000

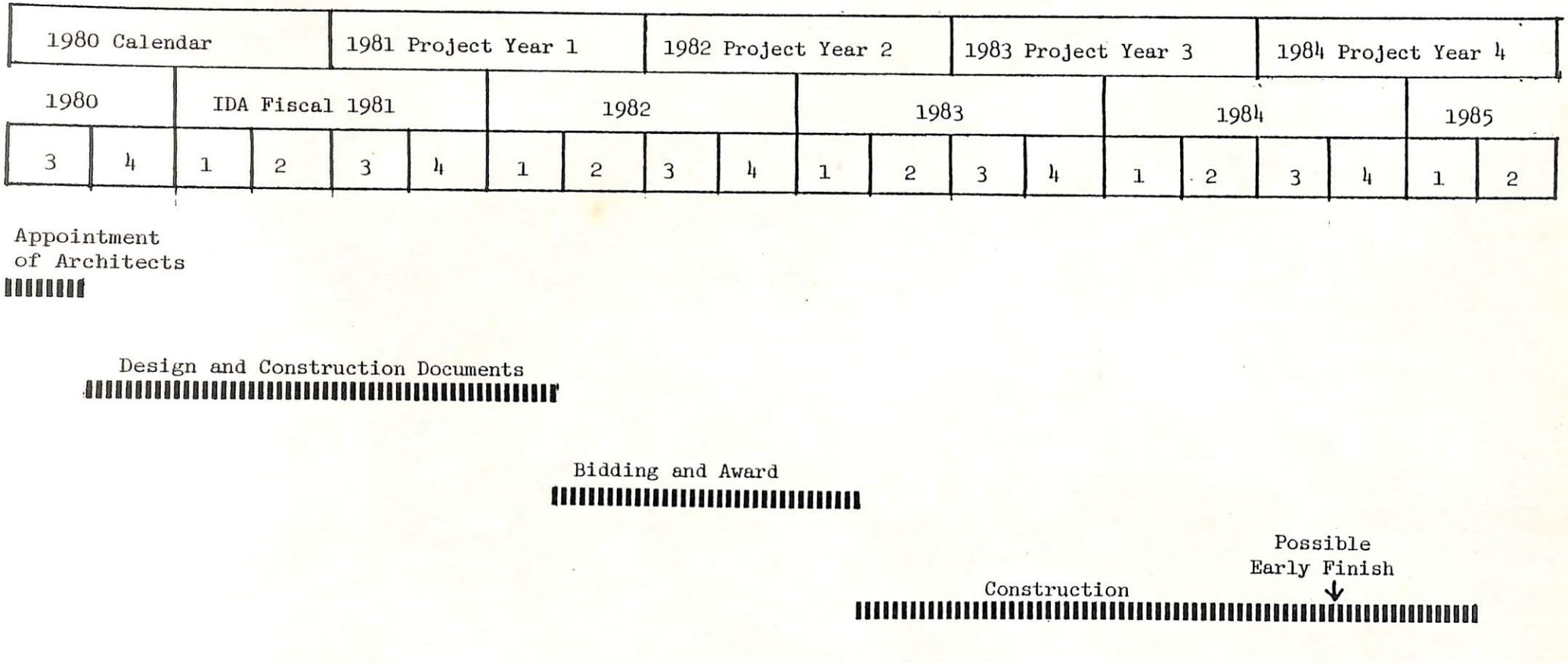
NOTES:

1/ Including temperature and humidity control, Dakar cost base mid 1979
2/ Preliminary estimate at 25% of construction cost
3/ Funding Application already made to French Government
4/ Tentative Estimate at 25% of new construction cost

SENEGAL

AGRICULTURAL RESEARCH PROJECT

Civil Works Implementation Schedule



ANNEX 16

SENEGAL
AGRICULTURAL RESEARCH PROJECT

Outline of Responsibilities of the Technical Support Unit

1. As distinct from the architects and associated professionals whose responsibilities are executive and who are legally responsible for health and public safety, the responsibilities of the TSU are administrative. The TSU would provide counsel to ISRA on technical matters and would be the locus of overall project coordination and liaison with the Bank in respect to civil works and equipment.

2. The duties of the TSU would include:

(a) Assisting ISRA in the retaining of professional services;

(b) Representing ISRA in participating with the consultants retained to prepare the development plan required for each center;

(c) Arranging for the review and approval of architectural and engineering reports, plans, specifications, equipment lists and other material by ISRA and the Bank at the following stages:

(i) schematic design;

(ii) final design; and

(iii) working drawings and contract documents.

(d) Participating in the following:

(i) weekly meetings between ISRA and the executive architects during the design phase;

(ii) monthly progress meetings with the contractors and architects during the construction phase;

(iii) selection and prequalification of contractors;

(iv) approval and supervision of bidding procedures; and

(v) adjudication and award of contracts.

(e) Preparing the pre-ordering schedule for equipment and furniture and ensuring timely delivery in order that the centers may be commissioned on schedule;

(f) Overseeing project progress, making weekly progress reports to ISRA and quarterly reports to the Bank;

(g) Processing contractors' bills for payment by ISRA and subsequent forwarding to the Bank for disbursement; and

(h) Preparing a commissioning program, and at the completion of construction, participating with the executive architects in advising ISRA on the acceptance of the completed buildings.

SENEGAL
AGRICULTURAL RESEARCH PROJECT

Outline of Duties of the Executive Architects

1. Establish and manage a work program, utilizing appropriate programming tools such as network analysis, for all activities during the design, construction and commissioning phases of the project.

2. Prepare sketch designs and design development drawings for client approval.

3. Prepare contract documents, namely, working drawings, specifications, bidding documents.

4. Coordinate work of structural engineers and mechanical services engineers.

5. Prepare and update cost estimates and indicate cash flow projections to indicate funding requirements throughout the construction period.

6. In cooperaton with the TSU, administer bidding procedures and award of contract including:

   (i) prequalification of contractors;

   (ii) announcement and calling for bids;

   (iii) adjudication;

   (iv) award of contract.

7. Supervision of construction, reinforced by resident clerk of works.

8. Final inspection and acceptance of completed buildings.

9. Preparation of final accounts.

SUBJECT MATTER SPECIALISTS

There is an increasing awareness of the need to expedite transfer of improved technology from research stations to farmers' fields. The present gap between yields at the station and yield on farm fields in Senegal indicates that production could be increased substantially by doing a better job of using the improved technology now available.

There has been a tendency in the past, in developing countries, to develop extension services and, more recently, to strengthen research systems on the assumption that these two kinds of organizations would first produce technology and then extend it. Experience has shown that the linkage between research and extension organizations is often lacking or ineffective. And there is usually a deficiency in the quality of precision of the transfer of technology from the research station to the extension organization.

ISRA, the national research organization, should have the responsibility to carry through the evaluation and field testing of improved materials or methods whether they be single advances or new "packages of practices"--so that they can be taken up with confidence by farmers. The tendency in recent years has been to offer improvements as combinations of practices--improved seeds; specific rate, date, and depth of planting; irrigation regimes; and weed and pest control. This requires that the precision or integrity of the package be maintained throughout the transfer to farm fields.

Research workers should be familiar with problems faced by farmers, but they cannot devote sufficient time to the technology-testing and transfer task. Both their research and the job of transfer would suffer.

Subject matter specialists, persons trained through the B.Sc. degree and eventually the M.Sc. degree in one or more of the technical fields or disciplines, would be appointed to handle the technology transfer job. The subject matter specialist would have an appreciation of the interaction of the various factors that affect production. He would be located at the research station where he would maintain contact with the research staff.

The subject matter specialist would be assigned to the farming systems or livestock systems research team. His principal responsibilities would be to keep abreast of the research results and to convey these results to extension agents in the production societies. To do this he would prepare publications suitable for use by the development societies. He would also prepare radio and television releases to publicize research results. Training of extension personnel would be a major responsibility which would be done by organizing training courses in which he would enlist assistance from the scientists. He would also organize field days for farmers to visit the experiment station. The subject matter specialist would be the principal contact between researchers and farmers; he would make the necessary arrangements for locating experiments on farmers' fields.

The subject matter specialist would be a staff member of a developmental society but he would be located at the experiment station. His training would be to the same level as the research scientists. Funds have been included in this project for salaries, operating expenses, and training costs for the subject matter specialists.

Some of the reasons for the current poor communication between research and extension are: (1) researchers feel extension personnel are under-trained; (2) extension personnel feel that researchers are out of touch with the needs of the farmer, and (3) both organiztions are physically isolated from each other. By placing subject matter specialists in the research organization, ensuring that they are well trained, and charging them with the responsibility to take research results to the extension personnel and to continuously help keep research scientists aware of farmers' problems, more effective communication will be established and maintained.

EXPERIMENT STATION ORGANIZATION AND MANAGEMENT

In many instances valuable resources in manpower and capital are being devoted to train highly qualified scientists without adequate consideration to the support functions necessary to realize the fullest productive potential of these people. In coordinated research projects that are specifically directed toward improving the yield and quality of crops and livestock the research is highly field oriented. It is important that the management personnel of the research centers and the field stations be trained and organized so that they can provide the best possible support to the multidisciplinary research teams.

The most important mission of research station management is to provide the best possible physical facilities for the research teams so that they can maximize their research potential. Their responsibilities will include the maintenance of buildings and grounds; equipment maintenance and repair; development and maintenance of irrigation and drainage systems; soil preparation, cultural care, assistance in seeding and harvesting experimental plots; the care of livestock; production of seed and feed, and other service duties prescribed by proper authority.

The size and composition of the experiment station management unit will vary with the size of the experiment station and the size and complexity of the research program. Other factors that will affect the nature of this unit are: the degree of mechanization, cropping intensity, the need for land development, and the irrigation and drainage requirement.

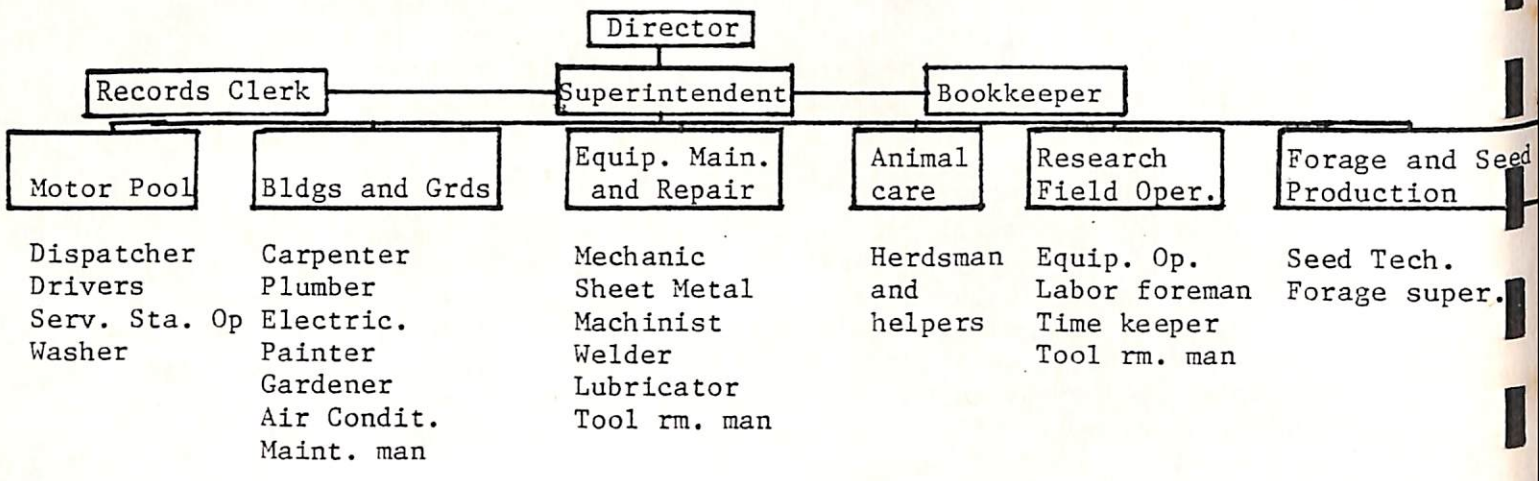
It must be kept in mind that the experiment station management unit exists primarily to serve the needs of the research staff. This would be a simple task if there were always sufficient facilities such as land, machinery, and manpower to satisfy all demands at the same time. In actual practice there are never enough facilities to satisfy everyone at the same point in time, especially on a multidisciplinary station with a large progressive research staff. In order to avoid disruptive conflicts of interest among researchers, between researchers and the research support unit, good organization together with careful and willing cooperation by everyone involved are needed.

It is proposed that the management unit of an experiment station consist of a director (who is a scientist) and a superintendent (who is directly responsible to the director) and his supporting staff. The superintendent should not be actively engaged in a research project. He should be a generalist whose primary concern is that all research on the station proceeds at maximum speed with the highest possible control of timing and precision. He must be a highly qualified person with exceptional characteristics and his pay and rank should be on par with the scientists'.

The intention of these recommendations is to emphasize the importance of providing for competent and adequate experiment station management through the superintendent so that the director, who is a scientist, can devote as much time as possible to his research effort. Before this

situation can exist it is not only essential to hire the most competent superintendent possible but that the director be willing to delegate to him all possible responsibility and authority for the day-to-day operations of the experiment station.

Below is a suggested organogram for the research support unit of a large research center such as Bambey.



Suggested job descriptions for the administrators of experiment stations are given below.

Director, Regional Center

The director would be responsible for the overall operation of the research center. It would be his duty to assist the station's scientists in carrying out the research required by the coordinated multidisciplinary projects. In this respect he would advise and assist the researchers, but he would not bear the responsibility for planning or directing the research. The latter function is accomplished through the coordinated research projects as discussed elsewhere in this report.

The director would be empowered to authorize the expenditures of all funds provided for the general experiment station budget (general farming operations, maintenance, etc.). It would be his responsibility to ensure that funds budgeted for research in the coordinated research projects at his research center are expended according to the official budget and in accordance with established fiscal policy. Because the budget for a coordinated project is prepared by the project scientists and because these funds are allocated specifically to carry out the project's research plans, the director would not have the authority to shift these funds to another project or prohibit their expenditure for properly budgeted purposes.

To the extent possible, the director should carry out a research program in his own discipline. The amount of research he could undertake effectively would depend on the size and complexity of the experiment station, as determined by the size of its staff, the number of hectares

under crops, the number of different crops grown, and similar considerations. Obviously, the manager of a large regional research center would have less time to conduct research than the manager of a smaller station. The basic philosophy is that full responsibility and authority for routine, day-to-day tasks should be delegated to the station superintendent, freeing the director for his own research.

The director would be the chief ISRA representative in the area served by the center, and as such, he should be the spokesman for ISRA. He should work closely with ISRA leaders and local agricultural authorities to ensure that the problems, opportunities, and needs of the region are fully recognized and addressed.

The director should schedule seminars and other appropriate scientific meetings at his research center.

He would also be required to submit periodic reports on the performance of the staff at his research center.

Because of the importance of the director's position, he should receive extra pay.

Superintendent, Regional Center

The superintendent should hold at least a B.Sc. degree in Agriculture that included some courses in Agricultural Engineering or Irrigation Engineering. If possible he should have a M.Sc. in Agronomy or Animal Husbandry depending on the type of experiment station where he is working. He should have a broad knowledge of the agricultural area to be served by his research station. He should be thoroughly familiar with modern farming practices, farming equipment, and equipment maintenance. He must be able to work with scientists as well as to manage skilled and unskilled labor.

The superintendent would be responsible for the day-to-day operations of the station, including general farming operations, equipment assignments, equipment maintenance, maintenance of buildings and facilities, labor assignments, irrigation management, general animal care, stores, procurement, accounting, and other general management tasks. Upon request he would assist scientists, directly and indirectly. However, he would not be expected to conduct the research for the scientists.

The superintendent would be responsible for the general appearance of the station and for the housekeeping required to maintain healthy and safe working conditions.

Where crops, seeds, or animals are produced for sale, the superintendent would have direct responsibility for those operations, ensuring that production and/or profits are maximized.

Ideally, the superintendent should be well-known by local farmers, business leaders, scheme managers, and extension personnel. His pay and rank should be on par with scientists, based on his demonstrated administrative capability.

The superintendent would report to the director of the regional research center, and his performance would be evaluated by the director.

ANNEX 21

EXPERIMENT STATION DEVELOPMENT

The principal needs for experiment station field development in Senegal in the near future are at Fanaye. Some landshaping to improve existing field areas will be needed at some of the other stations. However, if the scrapers and landplanes that have been recommended are purchased, this can be done as on-going field operations and included in the normal field operation budget.

The costs for development at Fanaye are high on a per unit area basis because it must be developed as a polder. A dike must be constructed to protect the low-lying land from river flooding during the rainy season, when drain water must be pumped out; and in the dry season, irrigation water must be pumped into the area from the river. The present plans call for several small pumping stations to pump in irrigation water and a larger station to pump out the drainage water.

It would be advisable to have an engineering study to determine the feasibility of one dual-purpose pumping installation to serve both purposes. It is possible that long-term costs could be substantially reduced.

A dike 1.2 kilometers in length has been completed, and 3.5 kilometers more are needed. The drainage system will need to be extended as well as the irrigation system.

Approximately 18 ha of land with full water control have been developed in the low-land area of the station. Twelve hectares have been developed by ISRA and 6 ha by WARDA. The immediate plans call for the further development of an additional 48 ha of net cultivated area under full water control. This would total to 66 ha of cultivated land for research work.

Estimates of costs for this work have been developed by ISRA, as well as a time table for engineering works.

In the livestock program at Dahra there is a need for setting up a system of pastures for animal research work. This work would involve drilling a well for water, providing pipe to transport the water to several paddocks, and erecting fencing with gates to create a series of grazing paddocks for experimental purposes.

A summary of these costs is given in Annex Tables 21.1 and 21.2. Labor is included in these costs.

Annex Table 21.2 Dahra Experimental Station Development Costs

Item	Description	Unit Cost U.S. $	Cost U.S. $
Barbed wire fencing	33 km, four-strand fence	$1.00/M	$33,000
Water lines	4 km internal lines from well to watering troughs	$1,000/km	4,000
Water troughs	10 units, complete with fittings	500/unit	5,000
Feed racks	mobile racks, 10 units	1,000/unit	10,000
Gates	perimeter gates, 10 units	100/unit	1,000
Drive-through gates	internal drive-through gates, 13 units	350/unit	4,550
Water well	drilling of well and installing of pump		27,000
Perimeter roads	16 km combination road and firebreak	CFAF 44,000/km	CFAF 704,000 ($3,200)
			$87,750

FIELD EQUIPMENT AND VEHICLES FOR EXPERIMENT STATIONS

Field Equipment

The field equipment requirements for the proper operation of an experiment station depend on a number of factors: size of the station, soil textures and other soil characteristics, crops to be grown, climatic conditions, power sources, amount of seed and feed production, and cropping intensity are some of the factors affecting the types and amount of equipment that will be needed.

The tillage equipment needed on a fully mechanized experiment station on light soils under rainfed conditions can be fairly simple in most instances even if the soil tends to become quite hard in the dry season. A rotary or flail type chopper may be needed to reduce crop residues to a manageable size. This operation followed by a chisel plow and an off-set disc will provide a good seed bed on most light soils. Where wind erosion is a problem, the chopping and chiseling operations will leave an erosion-resistant surface which rainwater can easily penetrate. The off-set discing operation can then be deferred until just prior to seeding.

On heavy clay soils disc or moldboard ploughing followed by an off-set disc and spike tooth harrow may be required for proper soil tilth. The timing of primary tillage operations on heavy soils is usually very important to achieve the best tilth with the lowest possible power requirement.

In mechanized paddy rice production the rototiller usually provides good tilth conditions for the following puddling operation. In larger fields, a tractor equipped with puddling wheels and pulling a rotary puddler will usually give good results. In small fields and plot areas the Landmaster-type walking tractors with cage wheels and puddling rakes have been widely used with success.

These are examples of the variations in primary tillage equipment that may be needed. Seeding, cultivating, pest control, fertilizer, and harvesting equipment has been developed to meet special needs for various soils, crops, and climatic conditions.

To insure that capital cost, operating and maintenance expenses, and repair costs of equipment are properly accounted for, a well developed record keeping system is needed at each station. It is possible and often desireable to do cost accounting for various experiment station functions that come under the jurisdiction of the experiment station superintendent. An accounting can then be made for the field costs of specific research projects.

One of the most important aspects of such a bookkeeping system will be the establishment of realistic depreciation schedules for all equipment for budgeting purposes, and a depreciation reserve maintained. In this way, budgets can be kept on an even keel without the necessity of large

budget increases in the years when expensive items must be replaced. As an example, if tractors are depreciated over a five year period, with good maintenance and skilled operation, then repairs, tire replacement, and general upkeep costs can be kept at a low level and the tractor will still have a good resale value at the end of the period. With the depreciation reserve, no large additional budget amount will be needed. Depreciation schedules on other types of equipment will vary according to use but would be handled in the same manner.

Another important item that must be included in any experiment station budget if the station is to function smoothly is an item for spare parts. Any piece of equipment which is purchased should be accompanied by a complement of spare parts valued at 10 to 20 percent of the cost of that piece of equipment. As items are used out of this inventory of spare parts they should be replaced as soon as possible.

For the ready maintenance and repair of experiment station equipment, the proper tools must be available. It is frequently observed that an experiment station has at one time been adequately stocked with tools for the maintenance and repair of field and laboratory equipment but due to wear, breakage, loss, and theft over a period of time there are very few useful tools left and no provisions are made in the budget for their orderly replacement.

A well run tool and parts room can eliminate most thefts, but tools will wear out with use, they will occasionally break, and some will unavoidably be lost in the normal course of field operations.

Spare parts and tools should be kept on a running inventory and replacements ordered as needed. Of course recommended fuels and lubricants must be kept in constant supply and used accordingly to equipment manufacturers' recommendations.

With the exception of the Fleuve, most of the experiment stations in Senegal have been well equipped at one time. In recent years replacement of older equipment has lagged so that now a major effort is needed to bring this equipment up to a good operating level.

Annex Table 22.1 gives a suggested list of equipment with assignment of units to experiment stations. The unit prices are recent quotes or knowledgeable estimates.

Annex Table 22.2 gives the manufacturers' names, model number, and other information of the equipment priced.

It is strongly recommended that in the future all items of any one type of equipment be purchased from the same country. For instance, all tractors should be Massey-Fergusons, all rotovators should be Howard, etc. This does not imply we are endorsing the equipment of any one company. The purpose is to simplify purchasing procedures, spare parts inventory and general maintenance and repair.

Research Plot Equipment

Research plot equipment is essential for precise field experimentation. Fertilizer distributors, plot seeders, cultivators, and spray equipment for plot use provide the uniformity and precision to conduct field experiments with low uncontrolled variation which result in low coefficients of variation and dependable data. To calculate the costs of research plot equipment a figure of $5000 per senior scientist has been used. Annex Table 22.4 indicates the costs of research plot equipment.

Vehicles

Mobility is a critical factor in conducting agricultural research especially when research must be conducted off the experiment stations in farmers' fields. For a national, coordinated research program to function properly, it is absolutely essential that research personnel and experimental materials have the freedom and ability to travel to all parts of the country. For this reason, a number of vehicles are proposed for this project. As a guideline, one automobile has been proposed for every two senior scientists at a specific location. Four-wheel drive vehicles, pick-up trucks, 5-ton capacity trucks, and "mobylettes" have been proposed for most research locations. Automotive transportation has also been suggested for ISRA Headquarters. Annex Table 22.3 indicates the numbers of vehicles proposed and their costs.

Annex Table 22.1 Experiment Station Equipment Requirements

Function	Item	Unit Cost U.S. $	PYI Center or Station						TOTAL	
			Fanaye	Bambey	Kaolack	Djibelor	Sefa	Kolda	Units	Cost
Tillage	Tractor									
	Medium	13,000		1	2		1	1	5	65,000
	Small	10,000	1			1			2	20,000
	Plows									
	Chisel	1,500	1	1	2	1	1		6	9,000
	Rotovator	3,000		1	2	1	1		5	15,000
	Harrow	1,200			2				2	2,400
Fertilizing (1)										
	Spreader	3,000	1	1	2	1	1		6	1,800
Seeding	Peanut Seeder	5,000		1			1		2	10,000
	Grain Drill	5,000		1			1		2	10,000
Cultivating	Toolbar & Sweeps	1,500		1	2		1		4	6,000
	Rotary	2,000		1			1		2	4,000
Harvesting	Peanut Digger	1,500		1	2		1		4	6,000
	Peanut Harvester	5,500		1			1		2	11,000
	Grain Combine	5,000		1			1		1	10,000
Landshaping	35' Landplane	8,000	1	1	1				3	24,000
	2 cu. ud. Scraper	3,250	1						1	3,250
Seed Processing	Seed Cleaner	12,000	1	1			1		3	36,000
	Seed Treater	3,000	1	1			1		3	9,000
	Seed Elevators	2,000	1	1			1		3	6,000
	Sack Sewing Machine	600	1	1			1		3	1,800
Tools	Hand Tools									
	Field	500	2	2	2	2	2		10	5,000
	Shop	500	2	2	2	2	2		10	5,000
Trailers	20' Low Bed	3,300	1	1	1	1	1		5	16,500
Special Equipment	Rice									
	Landmaster tractors	750	2			2			4	3,000
	Cage Wheels	400	1			1			2	800
	General									
	Rotary Chopper	1,500	1	1	2	1	1	1	7	10,500
										$291,050
										+74,218 (25%)[2]
										$365,268

[1] Fertilizer hopper included on planters & drills

[2] An additional 15% of the cost of each implement should be included for spare parts. An additional amount of 10% should be included for shipping, insurance, and handling.

Annex Table 22.1 Experiment Station Equipment Requirements

PY2

Function	Item	Unit Cost U.S. $	Center or Station						TOTAL	
			Fanaye	Bambey	Kaolack	Djibelor	Sefa	Kolda	Units	Cost
Tillage	Tractor									
	Medium	13,000	1	1		1	1		4	52,000
	Small	10,000		1					1	10,000
	Plows									
	Chisel	1,500				1	1		2	3,000
	Turning	4,000		1	2		1		4	16,000
	Rotovator	3,000	1			1	1		3	9,000
	Harrow	1,200		1			2		3	3,600
Seeding	Peanut Seeder	5,000		1					1	5,000
	Grain Drill	5,000	1	1					2	10,000
Cultivating	Toolbar & Sweeps	1,500	1	1			1		3	4,500
	Rotary	2,000		1			1		2	4,000
Harvesting	Peanut Digger	1,500		2			1		3	4,500
	Peanut Harvester	5,500		1					1	5,500
	Grain Combine	5,000	1						1	5,000
Landshaping	2 Cu. Yd. Scraper	3,250		1	1				2	6,500
Tools	Hand Tools									
	Field	500	1	1	1	1	1	1	6	3,000
	Shop	500	1	1	1	1	1	1	6	3,000
Special Equipment										
	Rice									
	Landmaster Tractors	750	2			2			4	3,000
	Cage Wheels	400	1			1			2	800
	General									
	Rotary Chopper	1,500		1					1	1,500
										$150,400
										+ 37,600 (25%)
										$188,000

Annex Table 22.1 Experiment Station Equipment Requirements

PY3

Function	Item	Unit Cost U.S. $	Center or Station						TOTAL	
			Fanaye	Bambey	Kaolack	Djibelor	Sefa	Kolda	Units	Cost
Tillage	Tractor									
	Large	16,500		1					1	16,500
	Medium	13,000		1					1	13,000
	Small	10,000	1		2				3	30,000
	Plows									
	Chisel	1,500		1					1	1,500
	Turning	4,000		1					1	4,000
	Rotovator	3,000			2				2	6,000
	Harrow	1,200		1					1	3,000
Fertilizing[1]	Spreader	3,000		1					1	3,000
Seeding	Peanut Seeder	5,000			2				2	10,000
	Grain Drill	5,000			2				2	10,000
Harvesting	Grain Combine	5,000		1					1	5,000
Tools	Hand Tools									
	Field	500	1	1	1				3	1,500
	Shop	500	1	1	1				3	1,500
Special Equipment										
	Rice									
	Cage Wheels	400	1						1	400
										$103,600
										+ 25,900 (25%)
										$129,500

Annex Table 22.2 Specifications for Equipment Proposed in Annex Table 22.1

Tractors
- Large - Massey Ferguson 285
- Medium - Massey Ferguson 265
- Small - Massey Ferguson 245

Plow
- Chisel MF 129-7'2" bar - 3 point hitch
- Truning MF 57-3-16" bottoms reversible
- Rotovator Howard Model E-60"

Fertilizing
- Spreader Gandy - 10' width

Seeding
- Peanut Seeder MF 37 4 row unit planter - also OK for corn & beans with fertilizer hoppers
- Grain Drill MF 33 8' with fertilizer hopper

Cultivating
- Toolbar & Sweeps MF 428 Row crop cultivator 4 rows - 168" with gangs, shanks, & sweeps
- Rotary Lilliston 020-11-132 rotary cultivator

Harvesting
- Peanut digger Lilliston 055-11-023 digger/shaker
- Peanut harvester Lilliston 015-11-022 PTO driven
- Grain Combine PTO driven with 5' header (unable to get price)

Landscaping
- Landplane Marvin Model 061 12'x35' w/ manual pump
- Scraper Eversman 2 cubic yard scraper/ complete hydraulic system

Seed Processing
- Air/screen cleaner Ferrel Ross - Clipper - 30 to 50 basket capacity
- Seed treater Gustufson - Mist-O-Matic Model SS-1
- Elevators Universal - 2-13' @ $1,000
- Sack sewers several makes & models

Special Equipment
- Landmaster tractors Walking tractors for rice paddy puddling (Price estimated)
- Rotary choppers MF 68 PTO driven 3 point hitch mounted

Automobiles - Peugot 404 station-wagon
- 4 wheel drive Jeep Wagoneer $10,000, European make $14,000 (est.)
- Pickup - ½ ton, $8,000 U.S. made; European, $10,000 (est.)
- 5 Ton truck - 5 ton capacity estimate based on U.S. prices
- Mobylette - estimate, $1,000

Annex Table 22.3 Costs and Phasing of Proposed Vehicles

	No.	Unit Cost 1000's $	1000's $ PY1	PY2	PY3	Total	Total Millions CEAF
Fanaye							
Autos	6	10	20	20	20	60	13.2
4-wheel	1	14	14	—	—	14	3.1
Pickup	2	10	20	—	—	20	4.4
5-ton	1	18	18	—	—	18	3.9
Mobylettes	13	1	6	4	3	13	2.8
			78	24	23	125	27.4
Bambey							
Autos	10	10	35	30	40	100	22.0
4-wheel	2	14	14	—	14	28	6.2
Pickup	2	14	10	—	10	20	4.4
5-ton	1	18	18	—	—	18	3.9
Mobylettes	25	1	9	8	8	25	5.5
			81	38	72	191	42
Kaolack							
Autos	7	10	—	10	60	70	15.4
4-wheel	1	14	—	14	—	14	3.1
Pickup	2	10	10	10	00	20	4.4
5-ton	1	18	18	—	—	18	3.9
Mobylettes	16	1	6	5	5	16	3.5
			34	39	65	138	30.3
Djibelor							
Autos	5	10	10	10	30	50	11
4-wheel	1	14	—	14	—	14	3.1
Pickup	2	10	10	10	00	20	4.4
5-ton	1	18	18	—	—	18	3.9
Mobylettes	12	1	3	3	6	12	2.6
			41	37	36	114	25
Sefa							
Autos	—		—	—	—	—	
4-wheel	—		—	—	—	—	
Pickup	2	10	—	10	10	20	4.4
5-ton	1	18	—	18	—	18	3.9
Mobylettes	5	1	2	—	3	5	1.1
			2	28	13	43	9.4
Kolda							
Autos	2	10	—	—	20	20	4.4
4-wheel	2	14	—	14	14	28	6.2
Pickup	1	10	—	10	—	10	2.2
5-ton	1	18	—	18	—	18	3.9
Mobylettes	8	1	2	3	3	8	1.8
			2	45	37	84	18.5
Dahra							
Autos	1	10	—	—	10	10	2.2
4-wheel	2	14	—	14	14	28	6.2
Pickup	1	10	10	00	00	10	2.2
5-ton	1	18	—	18	—	18	3.9
Mobylettes	7	1	2	—	5	7	1.5
			12	32	29	73	16
ISRA Hq.							
Autos	12	10	60	60	—	120	26.4
			310	303	275	888	195

Annex Table 22.4 Costs of Research Plot Equipment

LOCATION	PY1	PY2	PY3	PY4	PY5	PY6	TOTAL
Fanaye	20,000	20,000	15,000	-	-	-	55,000
Bambey	40,000	40,000	35,000	-	-	-	115,000
Kaolack	25,000	25,000	20,000	-	-	-	70,000
Djibelor	20,000	20,000	10,000	-	-	-	50,000
Dahra	-	-	10,000	10,000	5,000	-	25,000
Kolda	-	-	10,000	10,000	10,000	-	30,000
	105,000	105,000	100,000	20,000	15,000	-	345,000

CURRENT BILATERAL ASSISTANCE PROGRAMS

Senegal has been successful in attracting relatively large amounts of assistance funds, in the form of loans and grants, from a number of bilateral donors and multilateral institutions. The major donor to Senegal is France, followed by Canada, the United States, the various U.N. agencies, Germany, and other donors. Agricultural projects are many, but only a few are directed toward agricultural research or have a research component. The most prominent agricultural research assistance programs are summarized in the following paragraphs. Very likely, there are projects supporting agricultural research which are not included here.

France

Senegal and France share a unique relationship and it is not surprising that France should be the major assistance source for Senegal. Agricultural research was begun by the French in colonial days and it remained entirely in French hands until relatively recently. Currently, the majority of the research staff in ISRA are supplied through GERDAT and ORSTOM organizations, and a sizable portion of ISRA's budget derives from France. It is clear that Senegal's agricultural research efforts will be dependent on the French assistance for at least the short and mid-term future.

In addition to providing French scientists and operating funds, scholarships are made available by France to SERST. Until recently, scholarships were provided for forty students. Recently that number has been increased to seventy.

Another contribution by France of special interest to this project is one which supplies funds for the planning of ISRA's Headquarters buildings. A fund of CFAF 15 million has been made available for the preparation of the building plans. Requests have been made to France for CFAF 150 million for actual construction. To supplement these construction funds, CFAF 50 million has been requested from the national budget, and ISRA plans to contribute CFAF 50 million. If these requests are accepted, CFAF 250 million would be available for ISRA Headquarters construction.

Because French assistance to Senegal is large and is administered in many different ways, it is difficult to fully comprehend. Undoubtedly, there are other forms of assistance by France to ISRA which have not been listed here.

United Nations Agencies

At least three projects are now functioning in Senegal which involve UNDP or FAO.

a. Belgium/FAO Center for Development of Horticulture

This project, centered at Camberene near Dakar, was financed in its beginning years by UNDP but is currently being financed by the government of the Kingdom of Belgium, the FAO Trust Fund, and the government of Senegal. FAO and Ministry of Rural Development execute the project.

This project includes research, extension, and marketing activities, focussing on vegetable production. Currently there are eleven internationally recruited staff and one or two additions are expected. Phase III of this project is funded through December, 1981.

b. OMVS/UNDP Project

In 1970, with UNDP funding, OMVS established an agronomic research program to develop farming systems for irrigated and rainfed cropping in the Senegal River Valley. Presently, OMVS has reorganized its research activities so that now agronomic research in Senegal is concentrated on irrigated crops other than rice. Currently, three foreign technicians are working with this project: an agronomist, an irrigation specialist, and an agricultural engineer. Apparently the agricultural engineer works mainly with SAED. This project has guaranteed funding until 1981.

c. UNDP/ICRISAT Sorghum and Millet Research

Under a UNDP-funded regional project, which is active in several countries in Africa, ICRISAT has posted a millet breeder and sorghum entomologist at Bambey. These scientists have some responsibility regionally outside Senegal, but they function as ISRA scientific staff. This project also provides equipment, vehicles, operating funds, and possibly funds for other purposes. The director of the project for all of Africa is located in Dakar where ICRISAT maintains a regional office.

United States Agency for International Development

a. Assistance to Djibelor Regional Research Station

As part of USAID's assistance to agricultural development in Casamance, funds are provided to ISRA's Regional Research Station in Djibelor. Approximately $2.4 million have been made available for the five-year period 1978-1982. These funds will be used for training (4 fellowships), technical assistance (3 foreign scientists - 1 economist and 2 agronomists), field equipment and vehicle purchase, construction (offices, agronomy laboratories, 5 houses, land development), and operating costs. In May 1979, one agronomist had been posted and some of the equipment purchased.

b. CFA Funds from Concessional Rice Sales

The United States has made rice available to Senegal on concessional terms as food aid to combat the effects of the recent drought. Part of the funds derived from the sale of this rice in Senegal have been made available to ISRA. The equivalent of $5 million in CFAF have been agreed upon for the period 1979-1984. A budget has been proposed for the expenditure of the funds for construction of buildings, purchase of

materials and vehicles, and operating costs of research activities at five locations: Djibelor, Kolda, Dahra, Fanaye, and at a location in Senegal Oriental.

c. Cereals Production Project

USAID currently is funding Phase I of this project (1975-1978) and is considering a Phase II (1979-1983). Although the bulk of the funds in this project are received by SODEVA, ISRA receives funding for socio-economic research in the groundnut basin by Bambey scientists.

d. Proposed Projects

USAID is considering at least two projects which would support agricultural research in Senegal.

One project is an OMVS/AID agronomic research project. It is not yet known what form this project will take.

Another project is an agricultural sector review. This would be a substantial project, involving technical assistance, training, operating funds, and construction of buildings. A recent summary of the still un-approved project indicated the provision of four foreign economists, training for ten Senegalese economists, provision of $800,000 toward ISRA Headquarters, construction, purchase of vehicles, and operating funds.

IDRC/WARDA Project

The Canadian IDRC, through WARDA, supplies financial assistance for rice research at Fanaye.

Through this project, funds are provided for operating costs and training (3 advanced degrees and training at WARDA headquarters in Monrovia). The Belgian government supplies the team leader and CIDA also has contributed substantially to the project. The IDRC project is funded at for a three-year period, 1978-1980.

CILSS/FAO Integrated Pest Control Project

This project, still in the preparation stage, would have a duration of five years and funds of about $3 million (U.S.). This project proposes constructing an entomology laboratory at Kaolack, a pathology laboratory at Djibelor, and an entomology laboratory at Richard Toll. Six international scientists would be provided. Salaries and operating expenses of associated Senegalese staff would be provided for the first year only. Vehicles and equipment, operating funds, and some training funds are also provided.

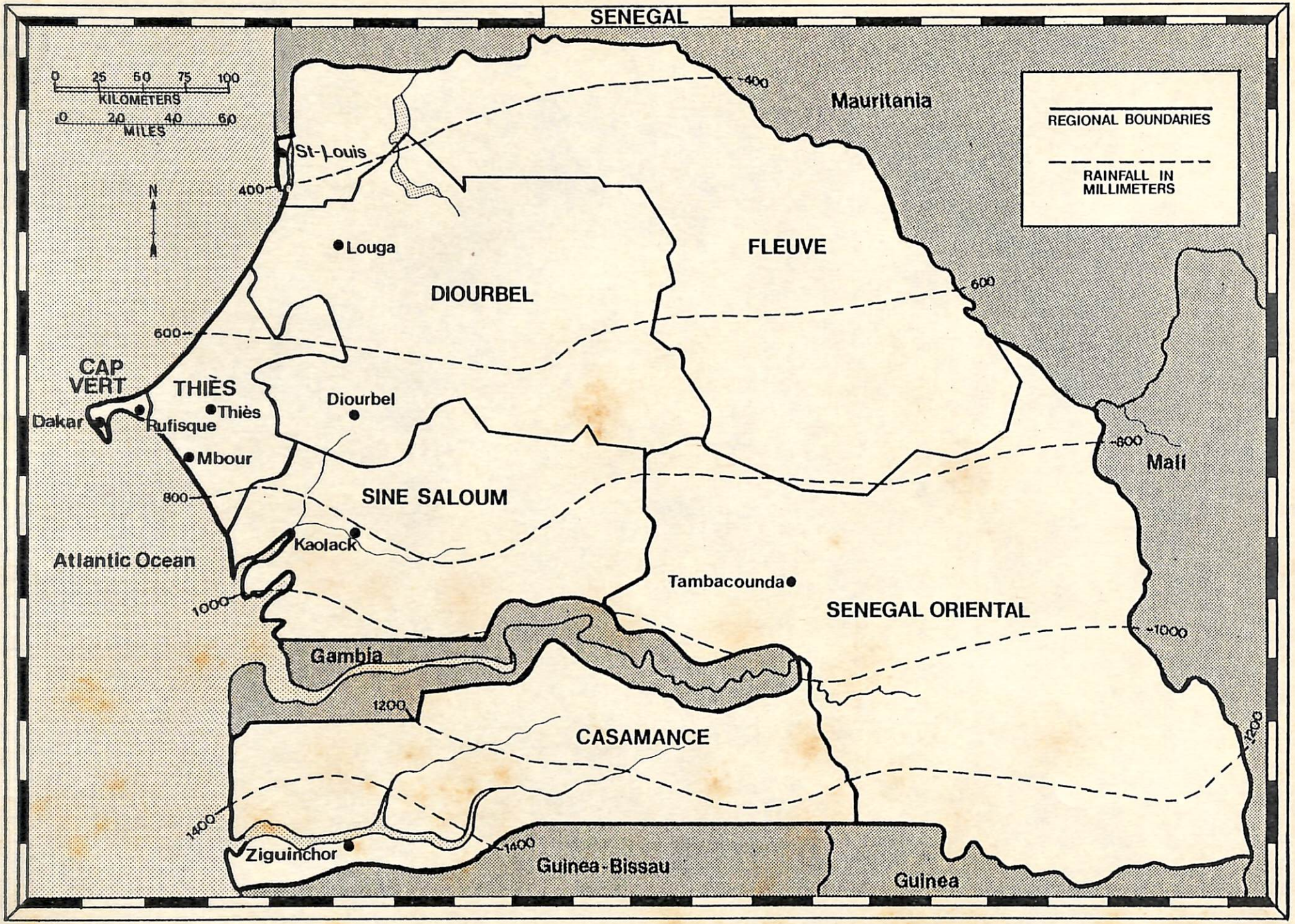
Belgium Animal Project

This project, which is under consideration by the government of Belgium, proposes a cattle production project located at Dahra. If approved, it would provide six foreign scientists, building construction and land development at Dahra, vehicles and equipment, and training.

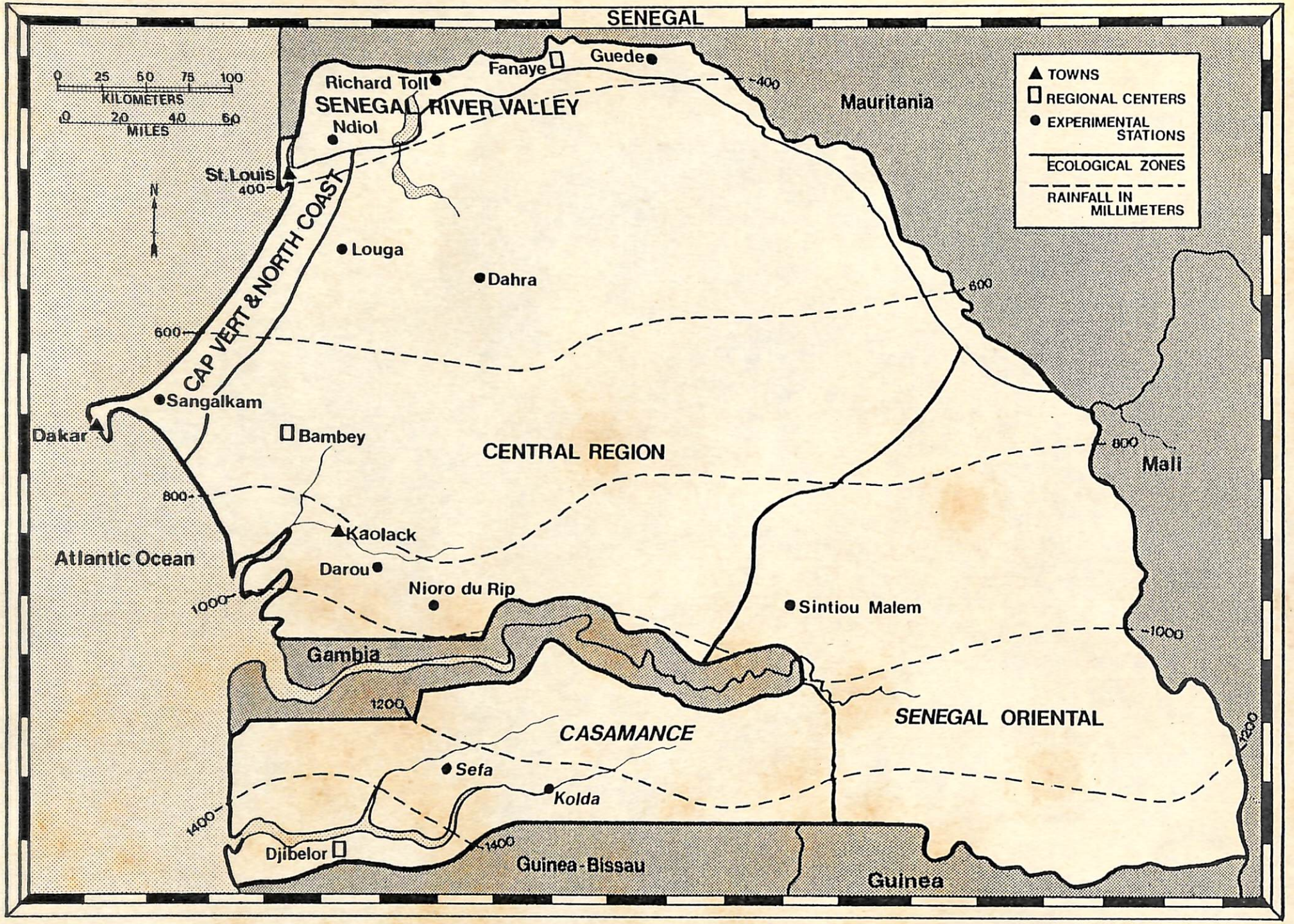
World Bank Funded Projects

The World Bank Group is funding a number of agricultural projects in Senegal, but there is little in the way of funds for research in most of those projects. One exception is the Bank funds which go to support SAED operations through the Debi-Lampsar Irrigation Project. In 1978/79 ISRA received CFAF 29,600,000 from SAED for research in the Senegal River Valley.

MAPS



Map 1. The Republic of Senegal



Map 2. ISRA Experiment Station Locations and Proposed Research Regions