RDA P-131-5

FINAL REPORT MID-TERM EVALUATION

FOOD CROP RESEARCH PROJECT

CAPE VERDE

Prepared for

United States Agency for International Development
Cape Verde

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1.0 EXECUTIVE SUMMARY

1.1 Evaluation Background

The Cape Verde (CV) Archipelago is composed of nine inhabited islands and three uninhabited islets in the Atlantic Ocean located approximately 420 Km west of Senegal. Some specific reasons why agriculture research should be supported in Cape Verde are: (a) The islands are geographically unique; (b) agriculture production must be superimposed on soil conservation, erosion control and water harvesting; (c) there is a history of non-food crop production and colonial-controlled cropping; (d) the climate is unlike that in the continental African countries that are targeted as the technology producing countries; and (e) cultural and geographic isolation from the continent of Africa.

The mid-project evaluation of the Food Crop Research Project (FCRP), as required in AID Agreement (655-001) under contract between the University of Arizona and AID, was completed September 18, 1986. The evaluation included the entire period of the project that commenced on October 21, 1983. As stated in the evaluation work order, (Appendix B), the central objective was to perform this evaluation through an analysis of the project's accomplishments and an assessment of the role of agricultural research in Cape Verde and to make detailed recommendations for future AID involvement in Agriculture Research as warranted. Drawing from the Logical Framework of the original Project Paper (PP), because a project Work Plan was not available, the evaluation team addressed the five central issues: (a) project goal and purpose; (b) project outputs; (c) project inputs; (d) project institutional setting; and (e) technical justification, management and recommendations, as their charge. The team traveled extensively on islands of Santiago, Fogo and Santo Antao for first-hand observations and local discussions.

1.2 Project Description, Goal and Purpose

"The goal of the AID grant assistance project is to assist the Government of Cape Verde (GOCV) to meet its development goals in terms of relative food self-sufficiency, farmer income, rural employment and improved nutrition status" (PP). "The purpose of the project is to increase agricultural productivity, in both irrigated and rainfed farming" (PP). This goal and purpose were to be accomplished through the following means: "(a) AID will provide 3.7 million dollars to help build the adaptive research capacity of the proposed Institute of Agricultural Research (INIA) for Cape Verde, at Sao Jorge, Santiago Island; (b) the GOCV will provide the existing facilities at the proposed Institute, the existing management and support staff, research sites off-station and some logistical support; and (c) AID projects inputs oriented towards providing training to Institute personnel to create a cadre of sufficiently qualified people to give the Institute long term viability. Also provided are institutional support in management, administrative technical assistance and library assistance. Technical assistance will also be provided in those disciplines appropriate to carry out a comprehensive survey of Cape Verdean rural economy and to begin a research program in irrigated and rainfed agriculture. Housing, vehicles, library stock and research equipment will also be supplied" (PP). With the project description, goal and purpose as the basis for the evaluation and the work order (Appendix B) the basis for a project design, the team undertook their dual task in the short period of only four weeks.

1.3 Project Institution Setting

The project is instituted within the National Agricultural Research Institute (INIA) which has administrative and fiscal autonomy within the Ministry of Rural Development (MDR) and is located in Sao Jorge, Santiago. INIA is a new institution, first created in 1977 as a center for Agrarian Studies, elevated to National Institute status in 1985. Because INIA is the only National Agricultural Research Institute, and the Polytechnic Training Center was created and placed under INIA, the FCRP is properly located. Assistance during these early stages of INIA development appears necessary and a worthy investment in Cape Verde's future agricultural development and aspirations for increased relative level of food security. The stability of the government as a newly independent country offers excellent prospects for the FCRP to attain their goals.

1.4 Project Output

The original PP lists very specific outputs to be completed by the FCRP that will increase the capacity of INIA to undertake interdisciplinary adaptive research on the model of Farming Systems. Substantial progress has been made in the following areas since the beginning of the project:

1.4.1 Seven Masters Degree or Equivalent

Five M.S. graduates have either returned from the U.S. or will soon complete their degrees. The remaining two are scheduled to complete their graduate studies in 1987 and 1988.

1.4.2 Two Ph.D's

Both are now in their graduate program. There is concern about the candidate in Agrometeorology (Remote Sensing) rather than Crop Science/whole plant physiology as was programmed in the PP.

1.4.3 Management/Administration

Consulting services for management and fiscal administration has been provided by the contractor and the administrative framework appears to be in place. As INIA sub-stations are brought into operation away from the central headquarters, the administrative services must be expanded to serve their special needs.

1.4.4 Information/Communication Center

The library was functional and was soon to be formally dedicated. There is a need for the installation of a universal cataloging system, more reference materials and additional space will be required if this library is to also serve the needs of the Polytechnical Training Center.

1.4.5 Two Houses and One Duplex

A triplex was near completion, with one unit sufficiently complete to permit occupancy. The house and the other units in the triplex should be completed shortly and certainly before the end of the project.

1.4.6 Research Program Established

The original PP called for a Senior Research Administrator to work with the Director-General (now President) of INIA to identify research priorities and to update the research plan of work. This critical activity, as best could be determined by the evaluation team, was never completed. The PP calls for the development of an updated Research Plan of Work at the initial stage of the project that is agreeable to DONOR/COUNTRY/CONTRACTOR. This would be especially helpful now that the Research Strategy of INIA has received legislative approval and FCRP still has adequate time and resources to strengthen their research focus.

1.4.7 Rural Economy Survey

Phase I Santiago Island Study has been completed and published. Phase I Santo Antao and Sao Vincent data collection has been completed but data and interpretations not yet published. Phase II studies have been initiated and these data are badly needed to help establish the Farming Systems Research priorities.

1.4.8 Preliminary Research Projects Carried Out

The PP calls for this to be: (a) Part of the studies of each of the M.S. and Ph.D. students; and (b) as part of the work of the two long-term Technical Assistance Research Co-Directors. It was suggested by the evaluation team, with some exception for Economic/Agricultural Anthropology, that degrees be completed in the U.S. so as not to delay the return of the remaining candidates.

1.5 Project Inputs

1.5.1 Government of Cape Verde (GOVC)

The GOCV is obligated to provide inputs into seven major areas that are needed to insure success of INIA and to receive full benefit from this project. Based on the limited financial resources of Cape Verde, these inputs will be completed before the end of the project.

1.5.2 AID Inputs

Inputs by AID, through this project, are presented in the outputs listed in the previous section. Problems with Technical Assistance has delayed focus on the priority Research Needs and delayed progress in this phase of the project. In those instances where the TA support was well-matched to INIA's needs, visible progress is clearly apparent. Caution is urged in the continued use of Technical Consultants that outline a large number of potential activities so as not to overload a small research staff and dilute their efforts. Short-term TA's should be utilized to assist the FCRP, as an institutional support project, to strengthen the Farming Systems Research System of INIA in accordance with the Goals, Objectives and Purpose of the Project.

1.6 Technical Justification, Management and Recommendations

1.6.1 Technical Justification

Technical justification for the development of a viable National Agriculture Research Institute in Cape Verde is especially sound and must continue to receive USAID support. This is emphasized throughout this report. In many respects Cape Verde is culturally and environmentally more similar to some regions of Central and South America than to Continental Africa. Therefore, technology transfer from Continental Africa is not always suitable for direct adoption in Cape Verde.

1.6.2 Management

The project has faced some management problems that might have slowed progress in the development of the in-country research component. This is now said to be corrected. While such problems might have been avoided, every effort should be made to prevent their recurrence. Campus inputs must be supportive in nature leaving the day-to-day decision making to the leader and staff in the country.

1.6.3 Recommendations

The evaluation team includes this section to highlight those needs that require added focus under the present contract if the project EOPS verifiable indicators are to be met, and a continuum into the second phase of FCRP, as suggested in the PP.

A) There is a need to complete the rural surveys and make this data available for and utilized in planning the Farming Systems Research Program that will increase productivity of irrigated and rainfed agriculture. Special attention should be given to what are the special economic reasons that the relatively large plantings of sugar cane and banana on the irrigated lands could not be converted to food crops with higher level of energy and nutritional balance. The evaluation team believes this shift would be most difficult and is unlikely to occur. Without this shift more effort must be focused on developing Farming Systems for the rainfed agriculture.

B) There is a need to develop a realistic focus on the research needs of crops and crop management that will improve the productivity of Farming Systems under rainfed conditions along with those highly productive food crops for irrigated agriculture.

C) There should be short-term planning to concentrate on the building of multi-disciplinary teams of 8 to 12 scientists who will develop the research programs on two to four staple crops that will impact on farm productivity through simple farming systems programs. The longer-term objective should be to build INIA to a minimum-sized institution capable of managing at least three to four commodity programs.

D) Increased stability of the fragile, steeply sloping uplands cropped under rainfed agriculture should become the primary focus of farming systems research. Crops that will stabilize soils, increase overall productivity (human and animal food, fuel, etc.) should receive priority in adaptive research programs. Without stabilization of the fragile uplands, there cannot be maximum

utilization of the relatively small area of land suitable for irrigation. The evaluation team views hillside stabilization through soil conservation practices with suitable Farming Systems to be the overall key constraint to increasing agricultural productivity and the increase in relative level of food security.

E) The FCRP is at the point that it should receive some technical assistance from the Small Ruminants and the Sorghum-Pearl Millet CRSPS Projects that are funded throughout AID. Short-term training is recommended for appropriate Cape Verde administration and staff through visits to the U.S. institutions where this supportive research is concentrated.

F) The evaluation team suggests continued support in the institutional development mode in future projects to insure a high probability for future continuity in the advances in agricultural productivity. Future projects need to bring a combined Food Crop Research and Watershed Development into a single project. While efforts in project design were included in the evaluation work order, a complete project design effort is required and should be completed before the present projects in Cape Verde terminate.

2.0 BACKGROUND, STRATEGY, OBJECTIVES AND ADMINISTRATION

2.1 Need for Agriculture Research

2.1.1 AID Strategy

As indicated in the AID Agricultural Research Strategy Paper [1], agriculture provides income and employment for over two-thirds of the population of Africa. The performance of agriculture indicates a decline in per capita food production since 1960. The evaluation of African agriculture, which also appears appropriate for Cape Verde, indicates that the poor performance results from:

1) Unfavorable physical environment and a harsh, unpredictable climate;

2) Unfavorable government policies affecting inputs, marketing, trade and exchanges which do not stimulate agricultural production;

3) Weak institutions which do not have adequate financial backing or facilities to support agricultural research;

4) Insufficient indigenous scientific capacity to carry out a sustainable agricultural development effort;

5) Lack of farmer-acceptable, improved technologies needed to increase agricultural production and productivity.

To increase agricultural production in Cape Verde, improved farmer-acceptable technologies will need to be developed that are location-specific and sensitive to the agro-ecological and socio-economic environment in which a farmer operates.

The program plan in the AID Strategy Paper for AID support in Africa [1] is to adhere to five guiding principles briefly presented as follows:

1) Explicit Program Objectives and Priorities. The bulk of resources will be focused on a relatively limited set of countries, commodities, and research problems - particularly soil and water relationships for key commodities.

2) Balanced and Integrated Commodity and Socio-Economic Research. Increased attention to the development of strong commodity research programs, while refining the role of farming systems research to ensure that on-station research programs respond to the concerns of the African farmer.

3) Sustained and Stable Support for U.S. and International Institutions. The goal is to increase the capacity of several Title XII institutions to support agency, country, commodity and priority problems, and to assist the International Agriculture Research Centers (IARC) in establishing strong in-country participation.

4) Long-term Commitment. Adopt, as a commitment, 20-25 years as the minimum acceptable planning period for the assistance to and development of African agricultural research institutions.

5) Donor Cooperation. Facilitate the most effective collaboration among donors for the development of long-term national research strategies or programs.

Strengthening agriculture research capabilities will be based on the two-pronged approach for enhancing the efficiency of national research institutions and regional research networks as follows:

1) National Research Systems

The dual task of capacity building and technology development will be addressed in two distinct ways depending on present status of in-country research capabilities:

a) Technology Producing Countries. Strengthening of the agriculture research infrastructure in six to eight countries that have relatively strong bases in the areas of manpower, financial resources, area planted to priority food crops, and other donor support available. The long-term objective will be to produce improved technologies on a sustained basis.

b) Technology Adapting Countries. The countries in this category generally need assistance to strengthen their capacities to import and adapt improved technologies to local environments. These are grouped as: (a) countries with natural and human resources approaching minimum research requirements, and (b) those with special problems and lower level of such resources. The short-term objective will be to concentrate on building multi-disciplinary teams of 8 to 12 scientists who will develop research programs on one or two staple foods. The long-term objective will be to build minimum-sized national research institutions capable of planning and managing at least two to three commodity programs. Attention will be given to cost-effective management to promote technology transfer through the research networks. Cape Verde has been placed in group (b) of the countries classified to be the technology adapting countries.

(c) Commodity and Problem-Oriented Research Priorities. Commodity and problem-oriented priorities are determined by the crops most important in the calorie intake of the rural and urban population, land area sown to particular crops, and current and prospective demand for the food crop in each respective ecological zone. Relative importance to crop and crop production systems, mixed farming, livestock and agro-forestry, will differ by ecological and sociological zones.

2) Research Networks

Research networks linking small countries with outside expertise will be facilitated on a zonal basis to compliment national research efforts. The intent is to maximize efforts of thinly-staffed and poorly-financed small country agriculture research efforts. These potential research networks will be based on similarity of ecological zones, crops and cropping/farming systems.

2.1.2 Cape Verdean Research Needs

Of significance, though not necessarily addressed, is the assumption that crops traditionally grown are the crops ecologically and economically best suited for the fragile environments of each country. In numerous situations, crops classified as traditional crops were introduced by colonial powers for

export purpose and not always of maximum benefit to the now independent nation. Long-term agricultural research will be required to identify those agricultural/forestry systems that will maximize environmental stability, food production and other benefits that will improve the quality of life in rural and urban areas. A strong case can be made for specific support for agricultural research in Cape Verde because: (a) The islands are geographically unique; (b) agricultural production must be superimposed on soil conservation, erosion control and water harvesting; (c) there is a history of non-food crop production or colonial-controlled cropping; (d) the climate is unlike that in African countries that are targeted as technology producing countries; and (e) cultural and geographic isolation from Africa.

2.2 Project Background and Rationale

2.2.1 History and Needs

The Cape Verde Archipelago is composed of nine inhabited islands and three uninhabited islets in the Atlantic Ocean located approximately 420 km west of Senegal. All islands are of volcanic origin, soils having formed from basalt, phonolitic rocks, and dolomitic and marl limestone. Climate is classified as: (a) humid; (b) sub-humid; (c) semi-arid; and (d) arid or desert zones. Rainfall varies annually by island according to (a) windward or leeward sides; (b) elevation above sea level. Most of the agriculture is located on the islands of Santiago, Santo Antao, Sao Niclau, Fogo and Brava. It is highly related to rainfall areas and availability and utilization of groundwater. Little or nothing is grown on the remaining islands. The extended drought over the past 16 years has been preceeded by 29 recorded droughts varying in lengths of 1-3 years since 1719, when records were first kept.

The islands were settled in 1462 by the Portuguese. The colony served many purposes and retains importance because of its location in shipping lanes and international flight paths. In 1951, Cape Verde's status was changed from a Portuguese colony to overseas province and gained independence from Portugal on July 5, 1975. Despite the proportionally large rural population, agriculture contributes only 20 percent to the G.D.P. Cause and effect from centuries of agriculture for export purposes, gross misuse of the very fragile landscape, and erratic rainfall have left the islands nearly devoid of ground cover. Soil loss by water erosion is out of control. Rainfall records suggest that removal of native ground cover has accentuated the occurrence and severity of droughts and accelerated the problem of land degradation by erosion in mountainous areas. The decrease in crop production during the past 16 years of drought has also led to a decrease in animal production. Population growth rates have fluctuated widely because of famines and drought-induced emigration, primarily to the United States and Portugal. In the absence of emigration the population would increase by about 2.0 percent each year, a rate which implies a doubling of the population every 35 years. Landscape stabilization and innovative cropping systems are a high development priority.

2.2.2 Development of INIA

There were no schools of higher education, research institutes, or extension institutions in Cape Verde before independence. Nearly all technical training was done in Portugal and it was not always applicable to the problems in Cape Verdean agriculture. For many years only one fellowship was available

for university studies in Portugal each year. This has limited human resources for institutional development because potential candidates must first earn their appropriate bachelor degree before specialization at the M.S. and Ph.D. levels. The lack of renewable natural resources, the problem of desertification, the land tenure system, and the need to strive for food self-sufficiency and to improve the rural human environment led to the creation of the Center for Agrarian Study (CEA) by the government soon after independence in July, 1977. The CEA was located in Sao Jorge dos Orgaos, within the administrative framework of the Ministry of Rural Development (MDR). The Center for Agrarian Studies (CEA) was elevated to the Institute of Agriculture Research (INIA) on July 19, 1985. Due to the need for management personnel for rural development, the Polytechnic Training Center was created and placed under the authority of INIA within the MDR. The Agriculture Extension Service was created in 1985 and headquartered in Sao Domingos, about 15 miles from Praia. It presently employs 21 field agents.

The first 4-year National Development Plan for the period 1982-85, included the following major policies:

1) Slowing down and reversing the process of desertification and soil degradation;

2) Establishing infrastructure for long-term development;

3) Guaranteeing employment and income to the unemployed and the under-employed, especially those having to support a family;

4) Satisfying the basic needs of the population, especially for nutrition, health and drinking water supply;

5) Unifying the national territory; and

6) Preventing possible shortages in the economy, especially in food supply.

2.2.3 Food Crop Research Project

Within the context of these national development goals the Project Paper for Food Crop Research (FCRP, 655-0011) was written to provide assistance to the following national priorities for rural development:

1) To implement agrarian reform by generating the basic data required for decision-making and then by planning and implementing well-coordinated projects;

2) To establish agricultural institutions, including one dedicated to agriculture research.

3) To establish support programs for farmers including an extension program.

4) To increase the area devoted to irrigated agriculture, and to emphasize food crop production on irrigated lands;

5) To implement ambitious programs of soil conservation and reforestation designed to upgrade the ecosystem and gradually increase water resources.

The project goal was to assist the GOVC to meet development goals in terms of food self-sufficiency, farmer income enhancement, rural employment, and improved nutritional status. The specific objective was to increase agricultural productivity in both irrigated and rainfed farming. The FCRP was designed as a 5-year project (1982-87), was contracted with the University of Arizona on October 21, 1983, and work was initiated shortly thereafter.

2.3 INIA Research Strategy, Priorities, Long-Term Objectives

The INIA was given financial and administrative autonomy within the Ministry of Rural Development on July 5, 1985. This was about 22 months after the USAID/Arizona Food Crop Research Project (FCRP) was initiated. INIA has the charge to integrate the following services within the Ministry of Rural Development:

1) Administration of agriculture research and experimentation;

2) Administration of those services of formation for Rural Development;

3) Central Administrative Services;

4) Services of a support institution.

The following Technical Departments, Regional Centers and other experimental units have or are being created and/or organized with the operations and programs of INIA:

1) Department of Renewable Natural Resources

   a. Division of Soils
   b. Division of Botany

2) Department of Agricultural Climatology and Hydrology

   a. Division of Agricultural Climatology
   b. Division of Hydrology
   c. Division of logistics, maintenance and treatment of weather data.

3) Department of Agriculture and Silviculture

   a. Division of Crop Production
   b. Division of Plant Production
   c. Division of processing and preservation of agriculture products, plant and animal.
   d. Division of Silviculture

4) Department of Animal Health

5) Department of Social Sciences (Anthropology and Economics).

A Central Experiment Station at Sao Jorge dos Orgao and Sao Domingos, a substation at Tarrafal on the north end of Santiago, a Leeward Regional Center on the Island of Fogo, and a Windward Regional Center on the Island of Santo Antao are presently being developed. The Technical Departments and laboratories are being developed at the INIA Center in Sao Jorge dos Orgaos on the Island of Santiago. Regional laboratories are being developed as needed. On-farm research in cooperating farmers' fields will also be conducted. The Integrated Pest Management Program appears the most advanced with a central laboratory at Sao Jorge dos Orgaos and laboratories in different stages of completion on the islands of Fogo and Santo Antao. The government is acquiring land and/or arranging use of land for experimental purposes to broaden the adaptive research base and maximize use of available infrastructure.

INIA has selected 12 crops for research under irrigated conditions of which three (sweet potatoes, cassava and tomatoes) will have priority and others (carrots, onions, squash, chickpea, chinese cabbage, sweet corn, mung beans, melon and irish potato) will have lesser programs. The three major irrigated crops will have priority research in collection and testing of germplasm and development of production practices while the research focus for the other nine crops will emphasize varietal selection. Rainfed agricultural research is divided into traditional crops (corn, dry beans, cowpeas, lima beans, dolichos lablab and pigeon peas); non-traditional new crops (Cacti of the genus Opuntia, Jojoba, Atriplex); and new crops-traditional (sorghum, millet, barley, forages, legumes and grasses). Other areas of work include the development of a soils laboratory and research involving soil fertility, intensive cropping and pot studies in the greenhouse relating to Rhizobium and nitrogen fixation. The INIA policy is to prepare the research protocol with purpose, objectives, anticipated results, etc., before research will be funded and initiated. Specific research projects are developed, listed and recorded within INIA and serve in the system of budgeting and accounting.

The long-term Research Strategy of INIA was approved by the Council of Ministers either shortly before or during the time the evaluation team was in Cape Verde. Suffice it to say the Research Strategy appeared to the team to be a well prepared document demonstrating a true understanding of Food Crop Research needs.

2.4 GOCV Commitment to Agriculture Research

2.4.1 Physical Facilities and Human Resources

The following demonstrate the commitment of the Government of Cape Verde (GOCV) to the development of the capacity to conduct agriculture research:

1) The Institute of Agriculture Research (INIA), with administrative and financial autonomy was decreed on July 5, 1985, naming Engineer Horacio Constantino Silva Soares as President. The previous institute (CEA) did not have financial or administrative autonomy.

2) Eight hundred hectares encompassing stable and unstable hillsides, terraces, etc., have become part of the INIA research area at Sao Jorge. This is where genetic materials are maintained and the research and production demonstrations are centralized. Laboratories, offices, library and a small computer center have been developed.

3) Five other sub-stations and/or locations have been selected from various climatic regions in Cape Verde to serve as research and farmer demonstration centers.

a. Tarrafal, Santiago - Eight hectares are available for irrigation experiments. This was formerly used by the CV/Utah State Tarrafal Water Resources Project.

b. Fogo - A sub-station for irrigated crops and coffee; a sub-station for fruit crops; and a sub-station for agro-forestry. An irrigation project is also available to conduct intensive vegetable production and related research. An Integrated Pest Management Laboratory has been installed and an upland research area is also available.

c. Santo Antao - Land has been acquired in Ribeira Grande for adaptive research with irrigation water available. The Regional Integrated Pest Management Laboratory is in the final stages of development. A M.Sc. trained agronomist will be placed by the Ministry of Rural Development to be responsible for the adaptive research.

d. Santiago - Research addressing some special problems with salt water intrusion or saline soils will be undertaken in Ribeira Santa Cruz.

e. Sao Domingos - This is where extension, whose activities are to be coordinated by INIA, are centered. One hectare of land will be available for INIA research. Other land is available for demonstration purposes.

4) INIA has taken full advantage of all training opportunities. Three short-term trainees and five M.S. programs have been completed; two M.S. and two Ph.D. candidates are presently in programs through the FCRP alone.

5) INIA has received consultancy assistance in management and library development and received short-term training in the same areas. Systems of literature cataloging, inventory, budget monitoring and general accounting have been suggested and appear to be, in part, incorporated into the institute. However, the system should be improved and made compatible with a standard international literature cataloging system. The management of INIA has taken on a structure of: (a) President, (b) Administrative Council; (c) Coordinator Council; and (d) Scientific Council. Time will be required to train support staff because there are no other public or private institutions to draw from.

2.4.2 Funding

Funding to INIA comes through the Ministry of Rural Development (MDR) as a line item in the budget. The 1985 and 1986 INIA share of MDR budget are as follows:

	1985	1986
	(000 Escudos)	
MDR	124,313	130,529
INIA	12,878	15,325
Percent INIA of MDR	10.4	11.7

In dollar values the total MDR budget was US$1,397,070 in 1985 and about US$1,717,494 in 1986, with the INIA share corresponding to US$145,000 in 1985 and US$204,333 in 1986. Even though the direct INIA share of the MDR budget is quite high, the actual funds available to operate a research institute are quite low. About 75% of INIA funds are used to pay salaries, 22% for commodities and services, and 2% for machinery and equipment. Other sources of support include: USAID, GTZ and other governments in the form of goods and services, sales of produce from the INIA land, and departmental services. Salaries in general in Cape Verde are low while per diem for travel appear to be reasonable.

2.4.3 INIA Objectives

1) The published objectives of INIA are the promotion and coordination of research pertaining to rural development throughout the country, especially in the fields of renewable natural resources, irrigated farming, animal pathology, hydrology, agro-climatology, agronomy, rural sociology, and farming technology. INIA also has responsibility for coordinating the research activities in forestry and rural extension. Other projects presently being coordinated by INIA are two IPM programs, a French Animal Pathology project and certain aspects of the USAID Watershed Development Project.

2) In addition, the INIA budget includes a separate line item for the polytechnical school in the amount of 3,000,000 Escudos (US$40,000) in 1986 and a projected 4,266,000 Escudos (US$54,000) in 1987.

While these numbers appear small to support a research institute by international standards, in real purchasing power and as a proportion of the total national budget commitment, they represent a significant commitment because of the depleted economic status of the country. The efficiency by which donor assistance is used appears very high and staff at INIA appear both knowledgeable and receptive to donor technical assistance and support.

2.5 Technical Assistance Provided to Date

2.5.1 Assistance Provided

The following technical assistance (TA) has been provided through the University of Arizona:

Position	Name(s)	Function/Charge	Months
Soil/Water	T. W. Crawford	Research/Admin.	18
Librarian	I. Stroehlein	Consultant	3
Business Mgt.	D. Anderson	Consultant	2-3
Water Mgt.	W. G. Matlock	Consultant	1
Plant Science	V. Macarian	Research/Admin.	16
Plant Science	F. Delgado	Consultant	1
Plant Science	M. Porto	Consultant	1
Soil Science	J. Stroehlein	Consultant	1
Irrigation	N. Jensen	Consultant	1
Econ/R. Soc.	T. Finan/J. Belknap/ M. Langworthy	Consultants	2-4
Soil/Water	M. Burr	Research	2
Executive	J. S. Hillman B. P. Lardon	Consultants	2 weeks

2.5.2 Evaluation

In many cases this evaluation relies on "best estimates" based on reading through the available reports and from discussions with AID/Praia and long-term personnel. An organized paper trail permitting easy access to this information was not readily available. To date, about 35 months of the 72 months programmed for Research Co-Directors and about 10-12 months of the 46 months of short-term consultants have been utilized. Because the budget proposed in the Project Paper Paper (31 Aug 1982) differs from the final budget and no updated plan of work was prepared, it is not possible to determine if the quantity of TA was reduced. The failure to bring in a Senior Research Administrator as counterpart to the Director General to establish the institutional framework, update the plan of work, and develop a focused, well-defined list of research priorities appears to have resulted in a slow and faltering start for this project. The first soil/water scientist (long-term TA), although adequately trained, did not have sufficient experience, both professionally and in LDC's, to handle the many administrative and professional charges of this project. Thus, after 18 months, he was returned to campus. A replacement arrived 10 months later resulting in loss of time, program continuity and experience. The Crop Scientist arrived near the end of the second year of the contract. She has now assumed the leadership role for the project and established a multitude of research projects. This is discussed in more detail by the Team Agronomist in Section 3.0. Again, failure to develop an updated plan of work probably has resulted in the initiation of a number of individual research projects not centrally focused on maximizing food production. Technical assistance in the social and economic sciences were developed to obtain the best data on costs of production and net returns for the major crops in Cape Verde. These data are not yet available although this information is required by INIA's leaders to properly allocate limited research resources to the crucial research needs. Hopefully these data will be available soon. Short-term technical assistance (TA) in water management/ utilization/harvesting/irrigation has provided some very useful recommendations although there are some aspects which do not appear to be appropriate for the Cape Verdean situation, but testing of these systems is advised to select the best possible alternatives for Cape Verde conditions.

The INIA researchers expressed the need for a complete water management network on the INIA station to insure 100% success of water use studies, variety trials, fertility trials, etc. If plans were developed by TA, these plans were not apparent to the Cape Verde staff nor would be found by the team. Assistance in the form of Library development has been very helpful and continued input in the form of TA and material is important. Technical assistance in Cassava research from a third-country national has contributed the best available expertise in this area. Assistance in administration appears to have arrived at a very critical time with upgrading of CEA to what is now INIA. With the staffing of sub-stations on other islands, funds need to be made available at the respective local levels and suitable decentralized accounting systems developed.

2.5.3 Lessons Learned

The questions at this point in time are (1) what lessons have been learned, (2) have there been missed opportunities and, (3) what directions future technical assistance should take. If the project is to focus on increased food crop production, certainly an updated plan of work with more focus on integrated adaptive research is needed. Completion of the socio/economic study very early or, even before the FCRP project started would have provided the necessary

information to select the food crops best suited to increase the productivity of Cape Verde Farming Systems. This must be developed into the framework of institutional development that addresses not only irrigated agriculture, but also the vast areas where rainfed agriculture and ecosystem conservation are needed. This may require some additional services from short-term TA's. The existence of uncommitted funds suggests that this may be a plausible option.

2.6 Current Agricultural Research Initiatives in Cape Verde

2.6.1 Description

There are seven (7) research programs or sectors which have current projects or research initiatives underway with one major program category targeted for Improvement of Food Crop Production. These programs are assigned to Departments within the Ministry of Rural Development outside INIA, but coordinated by INIA. Several of these research initiatives (projects) and major sponsors are:

1) Improvement of Food Crop Production

   a. Food Crop Research Project; USAID/Arizona

   b. Maize, legume, millet and sorghum production improvement; European Economic Community

   c. Garden Vegetable Production; Switzerland

   d. Integrated Pest Management, USAID and GTZ (Federal Republic of Germany)

The Integrated Pest Management Project started in 1977 and obtained measurable success to increase food production through environmentally sound systems of pest control. Major emphasis has been on insect control. The Food Crop Research Project was mandated to focus on irrigated crop and rainfed crops. The maize, legume, millet and sorghum project appears to have generated some promising data comparing sorghum *vs.* corn yields under rainfed conditions. Little is known about results of the Vegetable Production Project, but this should offer opportunity to add variety and balance to the diets of rural people. A general and extended drought has rendered impact assessment difficult. The maize, legume, millet and sorghum production improvement projects would appear to offer promise to increase crop production in the rainfed areas and offer opportunities to develop soil-saving cropping systems.

2) Forest Production and Reforestation Program

This program includes a number of projects that focus on reforesting mountainous areas, establishing ground covers, soil protection and stabilization. The benefits of soil protection and stabilization are important to the fragile environment and to improve food crop production and general agriculture productivity.

3) Water and Soil Studies Program

A multi-focus program including better utilization of run-off water by forests in arid and semi-arid zones leading to improvement of soil fertility.

This has potential to increase agricultural productivity if integrated into a farming systems approach.

4) Pasture Use Program

Use of the leaves of Parkinsonia acculeata and Prosopis julifora for small ruminant, rabbit and swine feeding. Offers alternatives to crop production for farmers and could provide ecologically sound land use in arid regions.

5) Assessment of Renewable Natural Resources

There are 23 projects in this area receiving support from a number of countries. Excellent basic data on renewable natural resources should come from these studies.

6) Agro-Industrial Unit at INIA and Collaborative Research

Study of dry preservation of bananas on Santiago; oil seeds from Jatrophia curas; coffee production on Fogo and Santiago.

7) Production Systems Program

There is presently no project designed in this area. Certainly offers promise to bring together many programs into a central focus that could increase the production of food crops and agricultural productivity in general.

2.6.2 Assessment

The team visited a number of present and previous USAID and other donor-country sponsored projects designed to increase food crop production. A lasting impact from these projects was observed to be strongly linked to the quantity and quality of training that was part of each project. When central institutional development was not included in the project, the lack of trained management personnel adversely affected achievement of goals and project continuity. There are two bilateral agricultural USAID projects presently in Cape Verde, the Food Crop Research Project (FCRP) and the Watershed Development Project (WDP). The FCRP contract ends 30 September 1987 and the WDP in 1988. While the team was not charged with the evaluation of the WDP, a discussion was organized and their project paper was read to assess how this project might interface with the FCRP. In neither project paper is there a single output suggesting that Increased Food Supply is even a targeted output. Both projects, however, do state this in their respective Project goals. The FCRP strongly supports the development of a national research institute with responsibilities which include adaptive research, resource conservation and coordination of rural extension. This, in itself, suggests the long-term payoff would be a higher level of agricultural productivity and improvement in the quality of life in rural areas. The WDP concentrates on terrace construction, check dams, catchments and other aspects of conservation of fragile nonrenewal resources. There is less of an emphasis on institutional development in the WDP project paper.

3.0 CROP PRODUCTION RESEARCH PROGRESS AND NEEDS

3.1 Cape Verde Land, Climate and Water Resources

3.1.1 Climate and Water Resources

The present structure of agriculture in Cape Verde has evolved in response to: (a) a semi-arid climate punctuated by recurring drought cycles and intense rain; (b) a rugged, mountainous landscape with steep-walled valleys; (c) 500 years under a colonial economic regime; and (d) high population pressures on relatively little arable land.

Little is known about the native vegetation or productivity of Cape Verdean soils that existed at the time of the Portuguese arrival in 1462. The Portuguese settlers colonized the ribeiras and established a plantation agriculture with an emphasis on cash crop exports. Large herds of cattle and goats grazed on the semi-arid plains and mountain slopes. It is noteworthy that prior to discovery by man, no large herbivores were found in Cape Verde. Apparently, the heavy grazing on plant species, which did not evolve with large herbivorous animals, and frequent drought cycles that led to the destruction of the native plant communities as the increasing human population expanded farming activities up the ribeira slopes and into the mountains. This in turn hastened the processes of erosion as the soils were left exposed to intense rainfall events and the ever-present tradewinds. Today, much of the arable land in Cape Verde is severely degraded: loss of topsoil from sloping terrain and from the higher plains has left an infertile landscape strewn with rock, and the ribeira bottom land is cluttered with boulders and gravel.

Agricultural production in Cape Verde is water-limited. The climate is semi-arid subtropical and reflects a geographical location in the Sahelian belt. Rainfall normally follows a unimodal distribution with rainfall exceeding pan evaporation in most agricultural areas only during August, September and October, followed by a nine-month dry season with little or no rainfall [2]. But annual mean rainfall data are misleading since year to year variations are extreme and recurring drought and wet cycles lasting 5 to 17 years have been recorded over the past 100 years. Although average rainfall totals may be high, rainfall distribution is often irregular such that most of the rain occurs in one or two intense, short-duration storms. Poorly distributed rainfall negatively affects dryland crops and rainfall intensity speeds erosion of topsoil. In Praia, on Santiago Island, 40% of the 250 mm rainfall per year occurs in rain events of 50 mm per day or greater [2].

On each of the main agricultural islands of Santiago, Santo Antao and Fogo (which includes 78% of the nation's total population and 92% of all cultivated land), there are distinct rainfall zones which reflect altitudinal and directional gradients: rainfall increases at higher elevations and decreases across each island going from the northeastern windward side to the southwestern leeward coast. Agricultural zones have been defined with respect to average annual rainfall [1, 4] and include: (a) arid zone (<300 mm/year); (b) semi-arid zone (300-400 mm/year); (c) subhumid zone (400-600 mm/year); and (d) humid zone (>600 mm/year).

The maize/bean intercrop system covers 90%, 98% and 100% of the cultivated area in the humid, subhumid and semi-arid zones, respectively [Table 1]. In the

humid zones, sweet potato, cassava and tree crops occupy the 10% of cultivated area not planted to the maize/bean intercrop.

Total arable land on all islands covers approximately 60,000 hectares (ha.), or about 15% of total land area. Since 1967, there has been an extended drought cycle in which annual rainfall and rainfall distribution have been very poor in 16 of the past 18 years. Cultivated area has fallen from 58,000 ha. before the current drought cycle to 36,000 ha. in recent years [Table 1]. Total in-country food production has fallen markedly. The decrease in cultivated area has occurred primarily in the semi-arid and sub-humid zones and there has been a concurrent decline in cattle and goat populations.

TABLE 1:

CULTIVATED AREA, AREA PLANTED TO MAIZE/BEAN INTERCROP SYSTEMS, AND ESTIMATED YIELD IN NORMAL RAINFALL AND DROUGHT YEARS AS CATEGORIZED BY RAINFALL ZONE*

Rainfall Zone	Mean Annual Rainfall (mm)	Total Cultivated Area (ha)	Area Planted to Maize/Bean Intercrop (ha)	Maize Yield**	
				Normal Rainfall (kg/ha)	Drought (kg/ha)
Humid	>600	7,614	6,855	800	100
Subhumid	400-600	15,770	15,455	530	20
Semi-Arid	300-400	11,810	11,810	300	5
Total		35,194	34,120		

* Data modified from Soares, 1984.

** Yields shown represent total production in each rainfall zone divided by the total area planted. Crop failure rates are estimated to be 10%, 20% and 40% in normal rainfall years and 70%, 90% and 95% in drought years in humid, subhumid and semi-arid zones, respectively.

The intensity of rainfall, loss of natural vegetative cover and resulting extensive soil erosion have all contributed to reduced water retention capacity of Cape Verde soils. Surface runoff is estimated to exceed actual percolation to the groundwater by 200% [2]. Surface runoff which is lost to the ocean is calculated to range from 40 to 80% of total annual rainfall volume [2, 4]. Water holding capacity is low on the shallow soils which cover the sloping terrain. There is a lack of terraces and contour furrows on the denuded slopes and, in the bottom of the ribeiras, there are insufficient check dams to dissipate runoff energy. This results in reduced groundwater recharge and serious flood damage to the bottom land in the ribeiras.

Untapped surface and groundwater resources do exist in Cape Verde. Conservative estimates place exploitable water resources at 130 x 106 m3 per year -- sufficient to irrigate 8,600 ha. [2]. Unfortunately, the geology of the areas studied for development thus far have shown these water resources to be costly to develop and difficult to exploit. This was exemplified in the Tarrafal Water Resources Project (1978-1982), which originally proposed to develop wells, galleries and small reservoirs sufficient to irrigate 600 ha. By the end of the project in 1982, water resources sufficient for only 38 ha. had been developed [5] and today less than 10 ha. are presently in irrigated crop production. These realities are reflected in the Second National Plan for Agricultural Development in Cape Verde which projects only a modest increase in irrigated land from 1,811 ha. in 1985 to 2,015 ha. in 1990 [6].

3.1.2 Rainfed Agriculture

Rainfed agriculture accounts for 95% of the cultivated land and contributes 60% of the gross value of crop production in normal rainfall years [4]. Irrigated land represents only 5% of cultivated area and 40% of total gross crop value. A typical farm family on Santiago Island has access to approximately 1.3 ha. of arable, rainfed land [7]. Maize/bean mixed intercrops predominate in dryland cropping systems. It is a low input enterprise with labor and seed as the only inputs. Sowing occurs in July or August just before or after the first rains and harvest occurs in late November and December. Seeds of both maize and bean (either cowpea, common bean, lima bean, or dolichos lablab) are planted together in small depressions scooped out with a hoe. Pigeon pea may also be planted alone, randomly placed throughout the field. After emergence, weeding and harvesting are the only other management operations.

In normal rainfall years with normal rainfall distribution, maize yields average 800, 510 and 100 kg/ha. in the humid, subhumid and semiarid zones, respectively [Table 1]. This would produce a total of 17,000 metric tons. In drought years, yields fall dramatically and crop failure occurs on most of the planted area. In the past 12 years (1974-1985), total maize production averaged 3,400 tons per year and ranged from a high of 9,000 tons in 1979 to a low of 100 tons in 1977 [6]. Bean yields are approximately 40-50% of those of maize. It is noteworthy that in severe drought years, the gross value of rainfed crops is well below that of irrigated crops.

National maize consumption is about 45,000 tons per year (at 400 g per capita per day). Yields from the present maize/bean cropping system will not supply the present needs of the Cape Verdean people. Likewise, this traditional intercrop system may be partially to blame for the excessive erosion. In all three rainfall zones, large areas of maize/bean intercrops are planted on steep terrain ranging from 30% to 70% slope. On such steep land, especially in sub-

humid and semi-arid regions, yields are extremely low even with normal rainfall due to the poor water holding capacity and low fertility of the shallow soils. It is quite evident that the low return maize/bean system is resulting in unstable soil conditions, ecologically destructive and, indeed, a poor use of available soil and water resources. The decrease in cultivated area from 58,000 to 35,000 ha. over the past 20 years may reflect the effect of the extended drought and the degradation of soil resources on these sloping lands. It is possible that more cultivated land will be abandoned unless a more soil stabilizing, ecologically sound and economically viable cropping system can be developed for these sloping rainfed lands.

3.1.3 Irrigated Agriculture

Approximately 1,850 ha. of the total 37,000 ha. presently under cultivation are classified as "irrigated". Some 29% of farm families surveyed on Santiago Island farmed irrigated land with access, on average, to about 0.1 ha. [7]. "Irrigated" land in Cape Verde is considered to be land with access to even small quantities of supplemental water and also includes "areas behind retaining walls located in narrow arroyos or washes which retain sufficient (stored) soil moisture to permit the temporary cultivation of squash, sweet potato, or even cassava" [7]. Thus, it is important to categorize several classes of irrigated land with respect to actual availability of water as follows: (a) fully-irrigated land with abundant water supply; (b) partially-irrigated land with restricted access to water; or (c) areas behind check dams with deep alluvial soils in gulches and ribeiras.

Fully-irrigated land represents only a small fraction of the 1,850 ha. classified as irrigated, although ready access to water provides these holdings with the highest potential productivity. Therefore, by this classification, only 2% of farm households have access to fully-irrigated land on Santiago Island [7]. Water sources for this land are government (or donor) financed public tube wells or water projects such as at Tarrafal or Mount Genebra on Fogo. With a dependable and adequate water supply, farmers have flexibility in crop selection and follow an intensive multiple cropping system with two or three cash crops per year on the same piece of land. High value crops predominate, including tomato, onions, peppers, Irish potatoes, cabbage, kale and sweet potatoes. Bananas and sugar cane are also grown on fully-irrigated land. Generally, these high income crops, not necessarily high volume in human nutrition, are grown in monoculture.

Partially-irrigated land with restricted access to water represents the largest fraction of irrigated areas. Some 21% of farm families surveyed on Santiago Island have access to partially-irrigated land [7]. Water is derived from two sources: (1) hand-dug wells (pocos) which tap shallow (5-10 m) aquifers in the coarse alluvium of ribeira bottom land, or (2) natural springs located along the ribeiras. Availability of water from both sources depends on recharge of the groundwater, and thus the quantity of available water decreases as the dry season progresses. In period of extended drought, these water sources may dry up completely. In low-lying coastal areas at the mouths of the ribeiras, wells often penetrate to sea-level depth and overpumping is thought to lead to salt water intrusion and salinity problems for sensitive crops.

A farmer has access to water from wells based on a set rotation schedule (calendario). These schedules are often enforced by an employee of the Junta de Recursos Hidricos ('JRH) because a government subsidized pump is used [9]. The

rotation schedule includes all farmers with rights to a given well. Schedules are not flexible, and the quantity of water a farmer receives depends on a set predetermined time he is allowed to irrigate when his rotation turn comes up. Irrigation allotment times apparently increase as well flow decreases, and thus, intervals between irrigations may stretch as long as 40 or 50 days during the dry season. Soil type, crop species or stage of crop development is not considered in developing these irrigation schedules [9]. Irrigation scheduling of the water from springs has apparently not been well studied. On Santo Antao, it appears that farmers with land closest to the developed springs are in position to have priority access to the irrigation water.

With restricted access to water, crops grown on partially-irrigated land tend to be those which can withstand moderate water stress such as sugar cane, sweet potato, cassava and squash. In normal rainfall years, farmers may grow one high value vegetable crop during the rainy season and double crop with a more drought-tolerant crop such as sweet potato or squash during the dry season.

Excluding irrigation frequency and pump size, other aspects of irrigation and crop management are similar on both fully-irrigated and partially-irrigated land. Water is lifted from wells using diesel motor pumps and often pumped directly to the fields. Sometimes, water from wells or spring is first pumped to storage reservoirs and then delivered to fields by gravity flow. Water is conveyed to the field in open concrete or masonry canals or, less frequently, in earthen ditches. Water pumped directly to the field from a well or storage reservoir is sometimes conveyed in flexible 100 mm diameter polyethylene tubing. Upon entering individual farmer fields, water enters earthen or lined head ditches which wind through the field. Erosion and seepage from these delivery systems are apparently minimal [8, 9]. Vegetable crops are irrigated in small, level basins varying in size from 4 m² to 12 m². Cassava and potatoes are often planted on large, widely-spaced ridges from 2 m to 5 m in length with deep furrows. Farmers divert water into each basin or furrow until it is "full", proceeding in sequence across the field.

Areas behind check dams, without access to irrigation water but with sufficiently deep soils for plentiful water holding capacity, constitute a unique category of land classified as "irrigated". Of Santiago Island farm families with access to "irrigated" land, 17% would farm this type of land [7]. Cropping systems practiced in such areas would be similar to sweet potato, cassava, squash and Irish potato cropping in humid rainfed zones not planted in the maize/bean intercrop.

On all categories of irrigated land, work is performed manually. Fertilizer use is not prevalent, although a few farmers do apply fertilizer to the high value crops. Insecticide use is also limited and at present, only Bacillus thuringiensis, a biological insecticide, is available to farmers for control of army worm and caterpillars. Fertilizers and insecticides are purchased from Fomento Agro-Pecuario (IAP), a government agency. Weeding is performed manually. Except for motorized pumps for irrigation and off-farm transport of agricultural commodities, mechanization of other crop management operations is almost nonexistent and will likely remain so. The steep terrain, small size of land parcels, and an underemployed rural population will make mechanization difficult in the foreseeable future.

3.2 Food Crop Research Project (FCRP) Activities

During the early stages of the FCRP, the participant trainees were in the U.S. working on their graduate studies. Research activities began soon after Dr. Thomas Crawford arrived to assume the Co-Director (Soil Science) position in March of 1984. Research activities have expanded as the Co-Director (Crop Science), Dr. Victoria Marcarian, arrived in early 1985 and with the return of the first trainee, Mrs. Ivone Andrade, M.Sc. in Plant Science, in October of 1985. Recently, in September 1986, three other trainees have returned after completing M.Sc. degrees. Having just returned, these young researchers are now beginning to organize their research programs at INIA.

3.2.1 Programs

The following list includes research activities which have been completed or are in progress. This information was obtained from discussions with Eng. Horario Soares (President of INIA), Dr. Victoria Marcarian (Chief of Party and Crop Scientist), Mr. Mark Burr (Soil Scientist), Mr. Carlos E. P. Silva and Mrs. Ivone Andrade (Research Agronomists at INIA), and Drs. T. Van Harten and Achim Vierech of the GTZ Integrated Pest Management Project. A second source of information was the final report submitted by Dr. Thomas Crawford at the end of his tour [10]. Major research activities of the FCRP include:

1. Complete chemical and physical characterization of nine pedons at the Chao Bom (Tarrafal) irrigation project. Data presented in Dr. T. Crawford's final report [10].

2. Chemical analyses of soil samples taken from the Mt. Genebra irrigation project on Fogo. Results are discussed in Dr. T. Crawford's final report [10].

3. Field study in farmers' fields on the reproducibility of the traditional unit for area (liter) in Cape Verde. Results presented in Dr. T. Crawford's final report [10].

4. Well water and soil sampling at Justino Lopes State Farm (JLSF) and Ribeira da Prata Formosa for chemical analyses to characterize water quality and possible soil salinity problems. Data has not yet been reported.

5. Irrigated tomato varietal trial to look for high yielding genotypes resistant to yellow leaf curl virus. Experiment completed several months ago; data not yet analyzed.

6. Common bean (*Phaseolus vulgaris*) varietal trial nursery from CIAT grown with supplemental irrigation. Data not yet analyzed.

7. Chickpea (*Cicer auretium*) and Chinese cabbage nursery trials from ICRISAT and AVRDC, respectively. Experiments finished several months ago. Data not yet analyzed.

8. Furrow tube irrigation experiment at JLSF. Tube placement at 30 cm depth, rather than at the recommended 15 cm depth [11]. Experiment still in progress.

9. Prickly pear cactus (Optunia ficus indica) and jojoba observation nurseries planted at Sao Jorge for multiplication and possible field trials at a later date.

10. Grain legume nodulation studies:

(a) Pot study of nodulation and dry matter yield of cowpea, pigeon pea, common bean, dolichos and lima bean using a dryland soil without inolculation with Rhizobium. Apparent differences noted in nodulation and growth. Data not yet reported.

(b) Pot study, same legumes as above, with and without inoculation with effective Rhizobium. Data not yet reported.

(c) Field study in progress with pigeon pea. Inoculated, uninoculated, and plus N fertilizer treatments. This is a replicated, on-farm trial.

11. Collection and characterization of local germplasm of sweet potato and cassava. Also, beginning to multiply and observe imported sweet potato germplasm resistant to Cylas sp. and cassava lines from Brazil.

3.2.2 Evaluation

The goal of the FCRP is to improve food self-sufficiency, rural employment, rural income and nutritional status of the Cape Verdean people. Expected outputs from research activities are: (a) a national research plan which addresses major constraints to food production, encourages interdisciplinary and inter-project cooperation, and provides a research framework for integration of returning trainees; (b) initiates research projects with an applied, problem-solving orientation; and (c) establishes a "research orientation" at INIA as manifested by published research reports, regular in-house seminars, and an Annual Agricultural Research Meeting which brings together all research groups and donor project research staff.

The FCRP was originally intended to begin activities in 1982, but actual implementation did not begin until late 1983. Most of the long-term trainees are still in the U.S. or have only recently begun returning. Thus, the FCRP and INIA have not had sufficient time nor in-country researchers to establish a research orientation as defined above. It is expected that regular seminars, published reports of experimental results, and the annual meeting will be undertaken before the project ends. This evaluation will focus on actual research activities and the development of a national research plan of work.

3.3 Other Major Agronomic Research Activities at INIA

INIA also has several other active research projects. Mr. Carlos E. P. Silva has been conducting an impressive field research effort on rainfed crop production systems since 1981. He has completed a large number of varietal trials with maize, cowpea and sorghum. Results have been published in several INIA publications [12, 13, 14]. Mr. Silva has identified two high yielding maize genotypes (one a local land race from Maio Island, and another from Mauritania), and two high yielding cowpea lines (again, one is a land race from Santiago Island, and the other an import from Niger). Both the maize and cowpea lines proved to be superior producers across a number of environments and with

adequate or below normal rainfall [14]. Seed of these lines are currently being multiplied for widespread on-farm trials to be conducted in 1987.

Mr. Silva has also produced notable results testing several sorghum varieties. In one trial at Sao Jorge, sorghum yield was 5,000 kg/ha. without supplemental irrigation and 500 mm of rainfall. The best maize yield was 4,500 kg/ha. on the same site, but required three supplemental irrigations. In a 1985 trial under rainfed conditions with 170 mm of rain on a deep alluvial soil, sorghum yield was 1,380 kg/ha., while the best yielding local maize genotype produced only 620 kg/ha.

A major research effort is the Integrated Pest Management Project receiving funding from GTZ (West German Agricultural Development Organization) and from USAID. The IPM funding from USAID is assured through March 1987, leaving the future of USAID-supported IPM project components uncertain. The GTZ project was initiated in 1977 and is currently funded until 1989. This continuity has permitted the development of functional, problem-solving IPM research programs. According to the present technical assistance team at Sao Jorge, significant progress has been achieved in reducing yield loss from Heliothus sp., cabbage loopers, and the sugar cane stem borer (which also attacks maize). For each of these pests, parasites or predators have been identified, multiplied in laboratory culture systems at Sao Jorge, and released in crop growing regions of Cape Verde [15]. Although formal studies quantifying the actual impact on food production are lacking, there seems to be a general consensus that many of these biological control measures are functioning.

3.4 Observations and Comments

1. While both rainfed and irrigated agriculture were indicated, the mid-term evaluation team believes the original PP should have emphasized research more for the area under rainfed and less in the area available for irrigated crop production. Somehow, the project design team did not perceive the intimate association of irrigated and rainfed agriculture in Cape Verde. A possible explanation may be that the design team visited Cape Verde in June (1982), and there is little, if any, agricultural activity in rainfed areas at that time. Likewise, at the end of the dry season, during the present period, there would be a natural tendency to underestimate the potential for increased productivity in rainfed agriculture and the need to stabilize the upland systems. It is apparent from the rural survey conducted by FCRP researchers that 71% of the farm families on Santiago Island do not have access to irrigated land [7]. Of those that do, 93% have only restricted use of water from wells or springs which dry up during the dry season or in drought years. Water retention and infiltration on hillsides, recharge of groundwater, and control of runoff are important determinants of water supply in wells and springs [5, 8]. Similarly, runoff from hillsides, cultivated under the traditional maize/bean intercrop system, causes siltation of wells and flash floods which destroy irrigated terraces and crops on the ribeira floors.

Lack of a significant research effort within the FCRP also limits the potential for linkages and cooperation with the Watershed Development Project (655-0013) which is attempting to build conservation structures and extend improved technologies for stabilizing hillside agriculture. It may be argued that all agricultural resources are in jeopardy unless improved farming systems are developed and adopted on marginal hillside land identified as rainfed agriculture.

2. The Second National Agricultural Research Plan (1985-1989), which has recently been approved by the Council of Ministers (pers. comm., H. Soares), is an admirable document. It is very broad and thorough, covering all aspects crucial to agricultural development in Cape Verde. The FCRP is now in position to define priority research areas and formulate an updated plan of work as was called for in the original PP.

The FCRP PP does emphasize the need to initiate applied research projects which have a high probability of success and which lead to increased crop production and resource use efficiency. Many projects completed or initiated thus far do not meet these criteria. Dr. T. Crawford's soil characterization work was descriptive science, and there is the need to link these soil analysis data with actual production constraints and crop production in the field. Dr. J. Strolein is serving to provide backstop support and guidance to the newly arrived soil scientist, Mr. Mark Burr. Dr. Strolein suggested two field studies to examine management of soil salinity problems in coastal areas of ribeira mouths. These may be dilutive efforts since the key issue concerns the cause of salinity problems in these areas. On irrigated soils it has been well documented that root zone soil salinity levels are primarily determined by salt concentration in the irrigation water. Thus, INIA's salinity research should continue their activity of monitoring well water depth and water salt content throughout the dry period in an effort to pinpoint the cause of salinity problems and to provide guidelines which, if identified, could prevent overpumping and salt water intrusion (5, 17). Likewise, a significant research effort on nodulation and nitrogen fixation of grain legume crops is not warranted unless simple field experiments with plus or minus inoculation with Rhizobium show a significant yield response to inoculation.

There also should be consideration afforded to INIA's long-term human resources before initiating research projects and in selection of crops for study. Who will continue to work with prickly pear, chickpea or chinese cabbage after the FCRP is terminated? In contrast, the selection of sweet potato and cassava as an area for an expanded research program is very sound. These are important traditional food crops and, with the return of Mrs. Ivone Andrade, research efforts are beginning to gain momentum. Several worthwhile subprojects are now in progress. The support provided by the short-term technical assistance of Dr. Marcio Porto is well-matched to the needs of this emerging cassava program.

3. With the return of several long-term trainees and an expanding research program, prompt data analysis will become crucial. There appears to be a long lag time from completion of research experiments to analysis of the yield data and interpretation of the results. In some experiments which have been completed for several months, simple treatment means have yet to be calculated. Turnaround time for data analysis must be improved!

4. With the major emphasis on irrigated agriculture and on crop water use efficiency in the PP, at present, INIA does not have access to research sites which have the capability to control irrigation frequency and measure the quantity of water applied. At Sao Jorge, there is insufficient water available during the dry season to irrigate field experiments as planned. This appears to result from conflicting water requirements of the crop and livestock production activities on the research station and the water needed for irrigated crop research. At the JLSF research site, the soils are saline and water quality (salinity) varies consi-derably due to overpumping of wells, again for

commercial crop production activities. Likewise, it is not possible to measure the quantity of water applied at JLSF. At the Tarrafal Irrigation project and at Mt. Genebra on Fogo, irrigation systems are archaic and water use efficiency impossible to measure for the same reasons.

5. If the FCRP is to have a measurable impact on the increase in food production, to be verified by national statistics, then it will be difficult to measure. The original Project Paper (PP), states an "increase in agricultural productivity, both irrigated and rainfed farming". The EOPS verifiable indicators list how this will be accounted for. The evaluation team suggests that if an updated plan of work is prepared, the attention should be given to the stated EOPS verifiable indicators. If these indicators are not still valid, then they should be modified to match the updated plan.

6. The FCRP has been very successful in the training program, providing a nucleus of well-educated and enthusiastic scientists who have now returned to provide the foundation on which to build. With careful reassessment of present activities and a more detailed and better-focused research work plan, the FCRP could easily make a very favorable and lasting impact on Cape Verdean agricultural research.

4.0 SOCIAL-ECONOMIC SCIENCES, TRAINING, LIBRARY, EXTENSION

4.1 Social-Economic Sciences

4.1.1 Social Science Department

The Social Science Department is charged with planning studies of the rural population and conducting fieldwork, among other duties. Technical assistance to the Social Science Department under the project has been provided by the Economic Anthropologist and by the Agricultural Economist (see counterpart descriptions in Pages F1-16, 17 of the PP). Timothy Finan, University of Arizona, has been the Economic Anthropologist throughout the project.

The Agricultural Economist counterpart position was originally filled by John Belknap, University of Wisconsin, and since mid-1985 by Mark Langworthy of the University of Arizona.

INIA staff consists of Elisio Rodrigues, who is serving as acting head until the return of Raul Varela. The latter is working towards a Master's degree in anthropology at the University of Arizona and is to return to take over as head of the department in 1987.

Mr. Rodrigues spent ten months in short-term training at the University of Arizona. He returned in July of 1985. There are, in addition, three other members of the staff of the department whose principal duties consist of interviewing and other operations in the field. They are Vladimiro Andrade (Vava), Tito Livio Andrade, and Domingos Veiga. When Mr. Varela returns, there will be five staff members.

The Social Science Department was created with part of the staff formerly attached to the Gabinete de Inqueritos Rurais of the Ministry of Rural Development. It has been in operation at INIA since March of 1986. The remaining staff of the Gabinete de Inqueritos Rurais was incorporated into the Gabinete de Estudos e Planeamento of the Ministry of Rural Development. The Gabinete de Inqueritos Rurais was responsible for conducting the census of agriculture in the late 1970's.

The department is housed in an office into which five desks have been placed. All of the staff work in it. The department does not have a budget of its own.

4.1.2 Socio Economic Survey

In the PP (Page I-7), a "comprehensive survey and analysis of the Cape Verdean rural economy [to be] carried out by the Institute in cooperation with the Economic Anthropologist and Agricultural Economist who are part of the Technical Assistance Team" is stipulated. This survey has been planned in two phases: the first, a sample interview survey of the islands of Santiago, Santo Antao and Sao Vicente; the second, an intensive study of the farming systems used on Santiago Island involving re-interviews of the same farmers over a twelve-month period.

The first phase Santiago Island survey has been completed and two reports have been written: Characteristics of Santiago Agriculture by Timothy Finan and John E. Belknap (FCRP 1984), and Family Farm Survey of Santiago, Report of the

First Annual Survey by John E. Belknap (Food Crop Research Project, February 1985). The first of these has been translated into Portuguese (Caracteristicas da Agricultura de Santiago...) and printed for distribution.

Field work for the first phase was completed on Santo Antao and Sao Nicolau Islands in September of 1985. The data are now being analyzed and reports are being written at the University of Arizona. First phase interviews were designed to gather data on family members, non-agricultural employment, labor inputs in agriculture, land area, land use, consumable inputs (irrigation, seed, water, fertilizer, insecticides), sale and consumption of products, livestock owned and several other items dealing with household characteristics and attitudes of farmers.

Elisio Rodrigues and Raul Varela, whose stays at the University of Arizona overlapped, have participated in the analysis of the Santo Antao data. Varela is also working with the Sao Nicolau data.

A second phase, now beginning, consists of farming systems research. For this purpose, eight farms in each of nine ribeiras on the island of Santiago, a total of seventy-two, have been selected for study from among those farmers who were found willing to participate. Fourteen are women; all farm full-time. Owners of large farms (by Cape Verdean standards) were excluded. Those who were selected are intended to be as representative as possible of the conditions faced by farmers in each ribeira. These farmers are to be studied through-out an entire agricultural cycle.

Initial interviews yielding background data on each farm household and on each farm have been completed. Among these data are age, level of schooling, emigration of family members, land and land use characteristics, water use, livestock, tools and equipment. Follow-up interviews are beginning. These will collect detailed data on farm operations, production, livestock, cost of production, income from production, household expenses, non-agricultural income and diet. Follow-up interviews are to be repeated every two weeks for one year. It is also intended that interviewers will weigh production, measure land and calculate its area, and verify the availability of irrigation and the incidence of pests and insects.

The farming systems research data are to be used to identify constraints on production, to identify needed agricultural research, to reveal needs that can be met by action programs, and to arrive at recommendations as to the means for transferring technologies developed at INIA. The participating farmers are expected to serve as conduits for the introduction of new agricultural practices and their farms as sites for testing and demonstrations, thus integrating social science research, technical agricultural research and extension.

4.1.3 Evaluation

The training program established for the Social Science Department staff has been, to date, successful. Training has been and is being closely tied to the skills required for their work in the department. There is a distinct need for an Agricultural Economist. This question is discussed more at length in the section devoted to the training component of the project.

The Phase I and Phase II rural surveys have been well conceived. The staff of the Social Science Department is experienced and competent at gathering data

in the field. The technical assistance provided has resulted in a sound research design for both phases of the rural survey which have been or are being conducted with skill. The farming systems research has the potential for providing significant analyses for designing research that will contribute to increased agricultural productivity and improved rural well being.

It will supply data on yields, profitability, cultivation methods and household characteristics which can serve to set research priorities and identify action programs to be undertaken by the extension service. The proposed measurement and calculation of land areas is particularly important since all data that rely on land area (e.g. yields per hectare) are compromised by uncertainties associated with the inexact folk concept of a "liter" of land. In a country for which there is very little reliable data on agriculture, the survey performs a vital function.

It is too early to say how well these results will be used. The agricultural research program is in its infancy and the extension service in the cradle. The potential, however, for significant improvements in agriculture if extension, social science research and agricultural science research work hand in hand, is great. Such a collaboration would be, to our knowledge, unique and innovative and could serve as a model for other developing countries.

The report titled Characteristics of Santiago Agriculture (1984) by Finan (anthropology) and Belknap (agricultural economics) is sound, useful and well written and an important contribution to the literature on agriculture in Cape Verde. The textual material is clear. Some of the tables, however, are difficult to understand because column and row headings are unclear. The Agricultural Economist appears to have contributed little to this analysis although listed as the junior author. The report titled Family Farm Survey of Santiago (1984), authored by Belknap alone, consists primarily of raw computer printouts of the survey data with little or no analysis or commentary. As such, it is of limited utility. To date, there is little evidence of a useful economic analysis of the Santiago survey data. A report by Finan and Langworthy (Agricultural Economist replacement for Balknap), based on Phase I data collected on Santo Antao and Sao Nicolau Islands, has been promised for delivery in October 1986. It is to be hoped that this report will contain a substantial agro-economic analysis. Technical assistance in agricultural economics has been handicapped by lack of continuity of personnel.

The Social Science Department at INIA and the rural survey component of the Food Crops project appear as step children, accepted into the family but not accorded equal privileges. The second phase of the rural survey is handicapped by a lack of gasoline and of tires for the vehicle to be used for fieldwork. Office space is crowded, and office equipment and supplies are inadequate. Pay is in arrears (this may be true of all INIA employees). These conditions are detrimental to productivity. Furthermore, although the training provided in social sciences has been sound, it has been meager. This is a design fault of the project.

The project management and INIA administration are to be commended for attempting to remedy this situation with short-term training. However, when the project ends, as things now stand, there will be only one professional trained at the M.S. level in the Social Science Department. This is not enough to develop a strong program and it leaves the department highly vulnerable should the one graduate level professional cease to function.

4.2 Training

4.2.1 Progress

The PP (Section F) provides for the training of nine persons: two at the Ph.D. level in crop science and soil science and seven at the Master level in crops, soils, irrigation, vegetable crops, fruit crops, entomology, plant genetics, social science and business administration.

This objective has been largely accomplished. Nine persons were selected for post-graduate training. Of these, five have completed their training and returned to Cape Verde. Two are still in training for M.S. degrees and two for the Ph.D. degree. It is anticipated that by the end of 1989 all of these degrees will have been completed and that the persons holding them will have returned to Cape Verde. In addition three trainees were sent to the United States for short term training lasting about one academic year. These have all returned to Cape Verde. To date, no program has been terminated prematurely and all trainees who have completed their training have returned to Cape Verde. Names of trainees, their field of study, level of training and return dates are in Table 2.

4.2.2 Evaluation

To date, the training component of the project has been a distinct success. Trainees are intelligent, motivated, and either have, or probably will, complete their training successfully and return to Cape Verde. Needed training was provided on a short term basis, even though not anticipated in the PP. The trainees complement and strengthen the INIA staff which was on hand at the beginning of the project (see Table 3), enlarging the pool of professionals with graduate degrees from three to twelve. This will prove to be a significant and lasting contribution to agricultural development in Cape Verde.

4.3 Library

4.3.1 Observation

The INIA Library is still being installed and the official opening will be held later this year (1986). Nonetheless, some loans are being made and there is a demand for library services. This demand will increase as trainees return from the University of Arizona.

Books and journals have been selected for acquisition in two ways: recommendations by consultants and recommendations by the staff. The staff has been consulted especially with regard to journals to be purchased but has also made recommendations regarding book purchases. Also, the library staff will identify titles it believes to be relevant to INIA's work and submit these to the appropriate persons for their comments. Proposed purchases are reviewed and approved by the president of INIA.

TABLE 2: TRAINEES SPONSORED BY THE FOOD CROP RESEARCH PROJECT
(ALL AT THE UNIVERSITY OF ARIZONA)

Name	Field of Study	Training Level	Return Date
Ivone Andrade	Plant Breeding	M.S.	10/1985
Julio Almeida	Irrigation	M.S.	9/1986
*Luis Alves	Agro-Climatology	Ph.D.	1989
*Jorge Brito	Soil Chemistry	Ph.D.	1989
*Julio Fortes	Field Crops and Water Harvesting	M.S.	1988
Jose Levy	Horticulture	M.S.	9/1986
Zuleika Antunes da Silva Levy	Nematology	M.S.	9/1986
Madalena Macedo	Business Administration	Short Term	8/1985
Joaquim Morais	Library Science	Short Term	10/1985
Julio Morais	Soil-Water Relations	M.S.	9/1986
Elisio Rodriques	Social Science	Short Term	6/1986
*Raul Varela	Economic Anthropology	M.S.	1987

* Still in training, September 1986

TABLE 3: INIA PROFESSIONAL STAFF WHO ARE NOT FOOD CROP PROJECT TRAINEES

Name	Field	Training
Carlos Andrade	Cartography	B.S.
Maria Manuela Azevedo	Entomology	B.S.
Maria Helena Barros	Soil Science	B.S.
Jorge Brito	Entomology	M.A.
Carlos Carvalho	Entomology	Tecnico
Carlos Coutinho	Engineering	B.S.
Rosa Correia	Agronomy	B.S.
Osvaldo Cruz	Agronomy	Tecnico
Maria Helena Delgado	Agronomy	Tecnico
Idalina Fernandes	Computer Science	B.S.
Maria Luisa Lobo	Entomology	Ph.D. (in training)
Helder Lopes	Food Technology	B.S.
Adriano Miranda	Agronomy	B.S.
Costa Rosa	Agronomy	B.S.
Joao Rosario	Agronomy	Tecnico
Maria Manuela Santos	Agronomy	Tecnico
Amadeu Silva	Agronomy	Tecnico
Carlos Silva	Agronomy	Tecnico
Maria Teixeira Vera-Cruz	Agronomy	B.S.
Daniel Agapito	Agri-Meterology	Tecnico
Alexandra Maemo	Agri-Meterology	Tecnico
Carlos Monteiro	Agri-Meterology	Tecnico
Jose Moreno	Agri-Meterology	Tecnico
Irineu Nascimento	Agri-Meterology	Tecnico
Rui Silva	Agri-Meterology	M.S.

This process has resulted in orders being placed for thirty-five journals titles. It is expected that ten additional titles may be acquired through exchanging INIA's publications Revista Investigacao Agraria and Vida Rural. A few sets of journals are already on the shelves. Back issues for the past five years are being ordered for each journal to which the library is subscribing. Reference materials that permit searches for journal and book titles and for publication data are on hand.

Books began to arrive in October of 1985. The latest shipment was received in June of 1986. About 550 books are now shelved or being processed. An additional 200 are expected in the near future.

The library does not now have a budget of its own. It is intended that it will. All acquisitions to date have been made with funds provided under the FCRP. A classification system for books devised by the librarian is in use.

4.3.2 Evaluation

A good start has been made toward the establishment of a useful research library oriented toward the needs of staff at INIA. A few steps have yet to be taken to complete the organization of the library and maximize its usefulness.

Space is adequate and well allocated. Equipment and furnishings are virtually complete. An excellent set of procedures has been adopted for the selection of books and journals for purchase that should build a library of maximum utility to the staff while conserving funds.

4.4 Agricultural Extension Service

4.4.1 Description

The extension service, Direccao-Geral de Extensao Rural, was established in 1984 and given Directorate-General status in July of 1985.

Extension workers are trained at INIA's Escola de Formacao Polivalente. The curriculum consists of three years of general agriculture courses at the high school level followed by a year of training in extension methods.

There are now twenty-one extension agents trained at the INIA school. Their training was completed in March of 1986. The extension service has but a few months of experience in the field.

The training program, the construction of buildings and the purchase of equipment was funded by an Italian government project. This phase of the project has now been completed. Consultation and professional assistance will be the principal activity undertaken during the remaining months of the project.

Continuing training for extension service personnel is to be conducted at headquarters in Sao Domingos and at the Escola de Formacao Polivalente (INIA) in Sao Jorge.

The African-American Institute is sponsoring a trainee in extension at the B.A. level at the University of Arizona.

Three kinds of programs are planned by the Extension Service. Work with community groups, with farmers and with homemakers. There is, however, only one extension worker assigned to work in this area.

Regional extension centers have been established in Tarafal, Santa Catarina and Sao Domingos on Santiago island. There are eight centers on Fogo island sponsored by a German project and two other centers on Santo Antao.

4.4.2 Evaluation

Although the Extension Service is not supported under the FCRP, the relevance of its activities to the achievement of the project's goal and purpose is obvious. The Extension Service's willingness to work in collaboration with INIA's research program is healthy, and should be encouraged.

The Direccao-Geral de Extensao Rural is still too new to have implemented programs and achieved positive results. Yet, its success will be crucial for Cape Verde's rural development particularly since its rural population is mostly illiterate and poor in resources.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Food Crops Research Project

5.1.1 Project Goals

There are probably few, if any, truly new lessons to be learned from this project, especially from an operational point of view. The operational principles that have been known for years still prevail and need only be restated as suggestions. Technical lessons learned are much more important in the FCRP in Cape Verde than might be expected in any other country in this region of Africa and will be amplified in the following sections.

A. Operational Lessons Learned

A.1. Plan of Work: The Project Paper (PP) is an imperfect working document as implied by the design team. The contractor should prepare an updated work plan upon initiation of activities that is agreeable to DONOR/COUNTRY/CONTRACTOR. This should be reviewed and amended as experience is gained or as needed.

A.2. Project Development: It became evident to the evaluation team that the socio/economic surveys should have been completed very early in the project, if not before, to provide the necessary guidance to crop selection, cropping systems and farming systems research that would increase agricultural productivity.

A.3. Consultant Effectiveness: Consultants are ineffective over the long term if National Counterparts are not involved in defining their need and in working closely with them. If a consultant is highly effective, every effort should be made to retain this individual's services over the duration of the project. The scope of work for short term consultancies should be designed to assist the INIA researcher staff to carry out research activities of the research phase of work.

5.1.2 Agronomic Research

A. Specific Research Recommendations

The FCRP should attempt to better support and integrate with the INIA dryland research program. This program has far too few resources in relation to the pivotal importance of rainfed agriculture in Cape Verde. Indeed, the Extension Specialist on the Watershed Development Project, Mr. Tom Gardner, indicated that public works conservation terrace and contour furrow construction will not provide maximum benefits unless farmers' incomes are improved through improved cropping systems so they can afford to maintain these structures. Productivity and economic viability of rainfed cropping systems has been suggested as sufficient incentive for farmers to take an active role in the protection of their land. Present low-return cropping systems offer few incentives to conserve the land.

A.1. Specific short-term recommendations include: (a) one long-term trainee (M.Sc.) in rainfed sorghum production science; (b) one long-term trainee (M.Sc.) in soil/plant/water relations for rainfed systems, with emphasis on soil fertility and soil water balance; (c) maize/bean fertilization and alternate-

row, contour furrow intercrop pattern studies for sloping land in humid rainfall zones; and (d) FCRP backstop support for Mr. Carlos E. P. Silva's rainfed research, including transportation, germplasm collection of sorghum, soil fertility analyses, coordination and linkages with the Watershed Development Project, and possible short-term technical assistance in sorghum production in semi-arid regions.

A.2. Specific long-term recommendations include: (a) one long-term trainee (M.Sc.) in Range Science, with emphasis on management of arid and semi-arid, marginal, sloping land for stable forage production, including introduction of adapted cacti, legume, grass and shrub plant species; (b) socio-.pa economic research on marketing and end-use possibilities for sorghum; and (c) testing of pearl millet and other crops adapted to semi-arid rainfall zones.

B. Basic Operational Recommendations

Over the short-term the FCRP should strive to establish a functional balance between irrigated and rainfed crop research programs withia INIA which better reflects the relative importance of irrigated and rainfed agriculture in Cape Verde. Thus far, FCRP sponsored training has emphasized irrigated agriculture with six of the eight long-term trainees specializing in research areas related to irrigated crop production. Only one trainee is working in research areas related to rainfed crop production. If possible, the FCRP should consider supporting the development of an expanded rainfed agricultural research team via long-term training at the M.Sc. level in rainfed sorghum production and soil/plant/water relations for rainfed systems.

Although it is recognized that sorghum is not a traditional human food crop in Cape Verde, initial goals of an expanded sorghum research program could target other uses such as increased forage production for goats, and grain for increased poultry production. The net effect of substituting sorghum for maize in the driest regions would be to reduce the need for imported grain, increase farm income, and to help stabilize erosion on these marginal lands. For example, egg production has increased nearly four-fold to 3.3 x 106 eggs/year and broiler production two-fold to 200,000/year in the 4-year period from 1981 to 1985 [6]. Annual feed requirements for egg and broiler production at 1985 levels would be about 1200 tons of grain which represents over 33% of the average annual in-country maize production over the past 12 years [6]. Initial in-country field trials have clearly demonstrated that sorghum yields are more than double those of maize in low rainfall areas [12] and yield stability and stover production for goats and cattle could greatly exceed that of maize under drought stress. This should be pursued to increase farmer income and improved nutrition status of the rural sector.

Over the longer term, experimenting with different cultivars of grain sorghum as a human food may lead to the development of cooking methods and recipes which provide an acceptable food for the Cape Verdean people. It is, however, important to note that nearly all reviews of the agricultural sector in Cape Verde have strongly recommended an expanded research effort on sorghum [2, 5, 17, 18]. Indeed, after four years work in Cape Verde, the last sentence in the Final Project Report from the USAID Tarrafal Water Resources Project (1979-1982, Contract No. AFR-C-1401) states..."The Food Crop Research Project should also have a major emphasis on rainfed agriculture, especially on factors to make maximum use of limited rainfall including water harvesting, cultural practices, planting dates, plant population, and fertility variations" [5]. The importance

of an increased sorghum (and millet) research effort was also emphasized in that report. The team suggests that the potential benefits of grain sorghum and Pearl millet as animal and poultry feed to enhance rural income be investigated. The evaluation team also suggests enlisting the services of the AID-sponsored small-ruminant and sorghum-Pearl millet CRSPS projects.

The project staff should prepare and publish in a formal report a detailed research plan of work and activity schedule through to the end of the present FCRP. All research projects and research experiments should be described in sufficient detail to identify objectives, methods and personnel involved. Priorities should be given to applied, problem-solving research as has been suggested elsewhere in this evaluation. Suggested criteria include projects which: (a) address known or likely production constraints which presently exist; (b) sort out, know technology, transferable technology and research needs; (c) have a high probability of success and will lead to identification of improved and feasible crop management technologies; (d) availability of INIA researchers who will continue to work in related areas after the FCRP is terminated; and (e) provide opportunities for interdisciplinary and inter-project cooperation such that human and institutional resources are focused, not diluted.

Care should be taken to avoid complex experimental designs (e.g. 3³ factorials, etc.) or long-term rotational studies during the early development stages of these research projects. Similarly, attempts should be made to carefully select research sites in an appropriate agroecozone for the crop to be studied.

The FCRP should work to develop a logical framework and the baseline data required to identify specific crops for expanded research activities. Thus far, the rural survey studies have not provided basic information on costs of labor, inputs, water, actual yield (in standard units), and farmgate prices received for important Cape Verdean crops. Only rough estimates are presently available. Phase II of the rural survey will focus on obtaining these important data. Returning trainees in the production sciences should be encouraged to participate in the design and interpretation of Phase II socio-economic studies as a means to better understand actual constraints and present crop management practices. This will lead to an improved focus in the applied research projects. Selection of crops for expanded research efforts will depend on a combination of the following parameters:

B.1. For irrigated crops: Caloric and nutritional value per unit water applied, net return to farmers (C.V.E.) per unit water applied, and market dynamics if production of a specific commodity were to greatly increase. These parameters should also be considered with respect to crop duration from planting to harvest since annual production and net return will depend on the number of crops produced per year. The potential for increased yields with reasonable improvements in input use or crop management technology is also important. For example, rough estimates of irrigated sweet potato and cassava yields range from 6 to 10 t/ha and tomato yields from 8 to 12 t/ha. Yields of these crops could be easily doubled with improvements in planting methods, plant density, fertility, irrigation and pest management.

B.2. Before serious work on irrigation management and water use efficiency can begin, INIA must have access to research sites with year-round availability of irrigation water and the ability to measure the quantity of

water applied. It is strongly recommended that improved irrigation systems and field leveling be established in Sao Jorge, Tarrafal, Mt. Genebra on Fogo, and at one research site on Santo Antao. High technology drip irrigation and sprinkler systems should be avoided. Instead, traditional open masonry or concrete canal delivery systems and flow meters will suffice. Several reports have suggested that complex irrigation systems are not appropriate or that increased water use efficiency by farmers could be best achieved with better irrigation scheduling, improved ridge and furrow design and field layout, and by better matching the quantity of applied irrigation water with actual crop demand [8, 9, 17, 19]. Short-term technical assistance to help design appropriate and efficient irrigation systems at these four research sites may be helpful.

B.3. Several microcomputers are already on hand at INIA's Sao Jorge headquarters. If statistical software is not available for data analysis, these should be obtained immediately. Data from field experiments must be analyzed and interpreted before follow-up experiments are initiated.

B.4. Field experiments on management of soil salinity or crop/cultivar salt tolerance should not be undertaken. Instead, efforts should concentrate on correlating water table depth and electrical conductivity in coastal wells where salinity is a problem. Salt water intrusion barrier dams might also be helpful in certain ribeiras [19]. The only pragmatic solution for salinity in these coastal areas will be to regulate pumping such that salt water intrusion is stopped [16]. Without regulated pumping, soil salinization will continue and will threaten the productive capacity of these lands.

B.5. There should be increased emphasis on the rainfed crops in a cropping system research approach because the evaluation team believes, for socio/economic reasons, that the low nutrition value sugar cane and bananas grown on some of the best irrigated land will not be shifted to food crops. This concludes that major increases in agricultural productivity, farm income and higher nutrition status must occur with rainfed agriculture.

5.1.3 Social-Economic Sciences, Training, Library, Extension

5.1.3.1 Social Science Department at INIA and Socio-Economic Survey

The goals of AID and of the Government of Cape Verde for the agricultural development of the nation will only be realized through the joint efforts of agricultural research, social science research and agricultural extension. Future assistance should explicitly recognize this interconnectedness and provide for the strengthening of agricultural research, for the enhancement of social science research capabilities and for the increased effectiveness of the agricultural extension service. In the absence of a symbiotic relationship between these elements, the general goal of raising levels of living and of well-being of the population will suffer.

A. The staffing of the Social Science Department and of the extension service are exceedingly thin. Additional training and technical assistance for these two areas of endeavor is essential. Equally essential is effective communication and collaboration among these groups. Specifically, the Social Science Department and the rural survey require additional resources, i.e. transportation, office space, office equipment and supplies.

B. Training should be provided at the M.S. level in agricultural economics focusing on farm economics (see Training). Consideration should also be given to training in rural sociology.

C. Data from the first phase of the rural survey conducted on Santiago Island should be analyzed from an agricultural economic perspective.

D. Analysis of the data from the Santo Antao and Sao Nicolau Phase I survey should reflect the contribution of the Economic Anthropologist and of the Agricultural Economist.

E. Short-term technical assistance by the Economic Anthropologist and Agricultural Economist should be made available for the analysis of the farming system survey data in collaboration with the Social Science Department's professional staff.

F. Technical assistance by the Agricultural Economist should continue until a person can be trained in agricultural economics.

G. Upon the return in 1987 of Raul Varela to assume the leadership of the Social Science Department, a long-term coherent research plan should be developed outlining and justifying the direction and goals of research for the next five years. This plan should receive the moral and financial commitment of the INIA administration and be developed in consultation with persons responsible for extension and agricultural science research.

H. Farming systems research should be developed to test two hypotheses which, stated generally, are: (1) a re-allocation of existing resources can improve the welfare of farmers; and (2) the adoption of new adaptive agricultural technology can increase productivity. [See Agronomic Research 5.1.2.]

I. The role of women in agricultural production should not be overlooked. Quinto [21] found that, in 40 percent of rural households, decisions concerning the spending of money were made jointly by husband and wife. Nationwide in 1980, 26 percent of rural family heads were female [18]. Women supplied 43 percent of the labor on rainfed plots [7] which account for 96 percent of all cultivated land [18]. On Santiago Island, women manage 39 percent of rural families [7].

J. The farming systems research presently underway focuses on farmers who own irrigated land. These are among the most privileged. This decision is not being faulted. The research also needs to be conducted among farmers without access to irrigated land, even though farmers who own irrigated land may also farm rainfed land. Seventy-one percent of all farm households do not have access to irrigated land [7].

K. Constraints and allocation of resources are different for farmers who do not have access to irrigated lands. Data in Table 4 reveal that on Santiago Island in 1984 (a year of low rainfall), seven times as much labor was expended per unit of rainfed land as per unit of irrigated land (718 versus 101 hours), and that men provided nearly 3.5 times more labor in proportion to the total on irrigated than on rainfed parcels (87 versus 26 percent). Other sources of labor, children and mutual aid, were far less important on irrigated than on rainfed land.

TABLE 4: SOURCES OF LABOR (HOURS) IN RAINFED AND IRRIGATED AGRICULTURE, NUMBER AND PERCENT, SANTIAGO ISLAND, REPUBLIC OF CAPE VERDE, 1984

	Rainfed		Irrigated	
Sources of Labor	Number of Hours*	Percent	Number of Hours*	Percent
All Sources	101	100	718	100
Supplied by Men	26	26	622	87
Supplied by Women	43	43	63	9
Supplied by Children	13	13	18	2
Supplied through Mutual Aid**	19	19	15	2

Source: Based on data in Timothy Finan and John E. Balknap, Characteristics of Santiago Agriculture. Food Crops Research Project/AID, 1984 (mimeo), p. 16.

*Number of hours expended per "liter" of land during year

**"Djunta-mon"

L. Farmers who rent or sharecrop should also, in the future, be studied. They constitute 43 percent of all farmers in Cape Verde and 51 percent of farmers on Santiago Island [18].

M. Working with owners of irrigated lands can produce greater economic returns. Working with farmers who cultivate rainfed land only and/or who are landless can yield greater social benefits. Both are worthwhile.

N. The willingness of research and extension to work in collaboration is positive and should be encouraged and institutionalized. Regular meetings between departments at INIA and the extension service for the exchange of information and plans should be held. When internal evaluations are made of the performance of INIA and Extension Service departments, inter-disciplinary communication and collaboration should be a criterion. Reliance on informal contacts and goodwill alone, although important, will not assure collaboration.

5.1.3.2 Training

The need for training in agricultural economics was not anticipated in the PP except as referred to under Item 8, "Research Agricultural/Economist-Anthropologist" [page F1-10]. Since this refers to two distinct fields, anthropology and agricultural economics, the decision to train a person in "economic" anthropology was a reasonable one. This person should not, however, be expected to do the job of an anthropologist and of an agricultural economist as the PP implies [pages F116 and F1-23].

INIA has a distinct need for a person trained in agricultural economics with an emphasis on farm economics. A professional with this training will be able to examine the economic effectiveness and feasibility at the farm level of recommended agricultural practices and, in collaboration with the anthropologist, make a distinct contribution to agricultural development in Cape Verde. Provision for such training should be made.

5.1.3.3 Library Development

A. A standard, internationally recognized classification system such as Dewey Decimal or LC should be implemented. If not on hand, the appropriate classification manuals should be acquired. While the current scheme may be adequate for a small collection, it will become more and more inadequate as the collection grows. The cost of converting from the present system to a new one increases every time a title is classified under the present system.

B. Understandably, given the methods used for the selection of titles for acquisition, virtually every title is in English. There also is a significant appropriate bibliography in Portuguese published principally in Brazil. Annual research reports from EMBRAPA national centers are generally free for the asking. These reports and books should be acquired. To be sure, most members of the professional staff, if not all, read English. However, this may not always be true. Books in Portuguese will be more readily used and understood and will be accessible to anyone in Cape Verde who may wish to use them regardless of foreign language skills. There are professionals in other sections of the Ministry of Rural Development for whom the INIA library could be an important resource. Books in Spanish which can be read without great difficulty by persons literate in Portuguese should be considered as well. To have holdings written in Portuguese is especially important in light of the goal of

encouraging the training school (Escola de Formacao Polivalente) students to use the library's resources as stated in the project paper's monitoring and evaluation plan [page IV-3]. It is unlikely that many of the training school students will be able to read English. The training school staff should be consulted concerning titles to be ordered.

C. If the library is to develop as an efficient tool for facilitating significant research, its present quarters will soon be too small. Steps should be taken to secure more space in the not too distant future.

D. The library has few, if any, Cape Verde titles and no social science titles. Much valuable material on Cape Verde has been published in "fugitive" form, that is, mimeographed in report format. The library should make an effort to acquire these. They are free of cost. A list of some relevant titles recommended for acquisition is presented in Table 5.

E. To date all book, journal and equipment purchases have been handled by AID and the FCRP. Provision needs to be made financially and administratively for the acquisition of materials on a continuing basis upon termination of the project. The library should have its own earmarked budget with funds designated for acquisitions as soon as possible.

5.1.3.4 Agriculture Extension

An effective extension service can convert INIA's food crop research into increased agricultural productivity and personal social well-being.

A. To be effective, extension service personnel will need additional training at the B.S. and M.A. level. Such training should begin after extension service personnel have had two or more years experience in the field. It should be targeted toward imparting extension skills that are relevant to resource-poor Third World physical and social environments.

AID's overall development strategy for maximizing productivity and revitalizing the agricultural sector resource base [22] in Cape Verde should not ignore this essential activity.

Extension will be difficult with farmers who do not own land or who do not have long term leases for the land they farm. Owner operators or farmers with leases that last long enough so that they may expect to reap the rewards of improvements on the land have incentives to adopt new practices than those who do not. If, in addition, the farmer is illiterate, the task becomes even more difficult. Only the exceptional person will try out new practices and accept risk under these circumstances.

B. Extension should be seen as a two-way process for the flow of information. Not only should the extension service inform farmers, but it should also be informed by them. The choice of extension methods, of practices to be promoted and of agricultural research most likely to serve the needs of farmers should all take into consideration the conditions under which farming is practiced and the characteristics of those who farm. Those who farm, it should be noted, frequently are women. It also appears that for many farmers in Cape Verde, farming is a part-time occupation. An assessment of these factors should precede the choice of practices to be diffused and of the methods employed for their diffusion.

TABLE 5: RECOMMENDED LIBRARY ACQUISITIONS

Cape Verde Titles

Carreira, Antonio, Cabo Verde: Aspectos Sociais, Secas e Fomes do Seculo XX, 2a. Edicao. Lisboa: Ulmeiro, 1984.

_____, Cabo Verde: Formacao e Extincao de Uma Sociedade Escravocrata, (1460-1878). Porto: Imprensa Portuguesa, 1972.

_____, Estudo da Economia Caboverdeana. Lisboa: Universidade de Nova Lisboa, 1982.

_____, Migracoes nas Ilhas de Cabo Verde. Lisboa: Universidade de Lisboa, 1977.

Finan, Timothy e John Belknap, Caracteristicas da Agricultura de Santiago, Relatorio de Inquerito a Agricultural de Santiago. Praia: Projecto Food Crops Research/USAID, 1985.

Freeman, Peter, Victor E. Green, Robert B. Hickok, Emilio F. Moran and Morris D. Whitaker, Cabo Verde: Assessment of the Agricultural Sector. McLean, Virginia: General Research Corporation/USAID, 1978 (mimeo).

Graetz, Heinz A. E. and John Van Dyke Saunders, Cape Verde Agricultural Sector Assessment Update. Washington, D.C.: Multinational Agribusiness Systems/ USAID, 1985 (mimeo).

Quinto, Marylin, Some Effects of Emigration and Remittances on the Lives of Rural Women in Selected Areas of the Cape Verde Islands. Consortium for International Development, Women in Development, Final Report, 1984 (mimeo).

Republica de Cabo Verde, Estatisticas Agricol s. Gabinete de Estudos e Planeamento, Ministerio de Desenvolvimento Rural e Pescas, 1984 (mimeo).

Soares, Horacio da Silva, "National Report: Cape Verde," Vol. III of Assessment of Agricultural Research Resources in the Sahel. Washington, D.C.: Devres, Inc./USAID, August 1984 (mimeo).

Farming Systems

Harwood, Richard R., Small Farm Development: Understanding and Improving Farming Systems in the Tropics. Boulder, Colorado: Westview Press, 1979.

National Research Council, "Supporting Papers," World Food and Nutrition Study, Vol. II. Washington, D.C.: National Academy of Sciences, 1977.

TABLE 5: Continued

RECOMMENDED LIBRARY ACQUISITIONS

Farming Systems (Continued)

Rhoades, Robert F., The Art of the Informal Agricultural Survey. Lima, Peru: Centro Internacional de la Papa, Social Science Department Training Document, 1981-1982.

Shaner, W. W., P. F. Phillips and W. R. Schmell, eds. Farming Systems Research and Development: Guidelines for Developing Countries. Boulder, Colorado, Westview Press, 1982.

Zandstra, Hubert, Kenneth Swandberg, Carlos Zulberti and Barry Nostel. Capueza: Living Rural Development. Ottawa: International Development Research Center, 1979.

Diffusion of Innovations

Crouch, Bruce R. and Shankaria, Chamala, Extension Education and Rural Development, 2 vols. New York: John Wiley and Sons, 1981.

Rogers, Everett M. and F. Floyd Schoemaker, Communication of Innovations: A Cross-Cultural Approach, 2nd ed. New York: The Free Press, 1971.

Journals

Human Organization

Journal of Developing Areas

Rural Sociology

Third World Studies

C. It may be necessary for the extension service to assume risk if the farmer is expected to try out a new practice. The farmer, however, should also assume a part of the risk. Otherwise, he or she will not have as great a stake in the success of the innovation.

Demonstration farms or plots can be useful devices for the diffusion of agricultural practices. Care needs to be exercised in the choice of owner of the plot or farm. He or she should be as similar as possible to the group which it is hoped will adopt the practice, a person with whom the target population can easily identify. If the owner or operator of the demonstration plot or farm is regarded as endowed with superior resources, superior training or other advantages not widely shared, the success that he or she has may be attributed to these endowments and not the superiority of the practice being demonstrated.

D. Two considerations should govern the choice of practices to be diffused to the farm population.

D.1. The first are the characteristics of the practice itself. Principal among these are complexity, the degree to which a practice is difficult to understand and use; divisibility, the degree to which a practice may be tried on a limited basis; and communicability, the degree to which results can be communicated to others.

D.2. The second is the "fit" of the practice with social and technical constraints. Consideration should be given to relative advantage, compatibility and feasibility. Relative advantage is the degree to which a new practice is superior to that which it is intended to replace. Changing circumstances can affect the relative advantage of a practice. Compatibility is the degree to which the practice is consistent with existing values and past experiences of the farmer. Feasibility refers to the consequences for adoption of the practice that are presented by existing conditions of climate, soil, infrastructure and marketing.

Each agricultural innovation needs to be evaluated with regard to acceptability by the ultimate consumers, the willingness of farmers to adopt it, and the adequacy of the infrastructure that supports it. The latter includes means for the delivery of necessary inputs, technical information and capital investment.

5.2 Recommendations Regarding Future Aid Investment in Cape Verde Agriculture Research

5.2.1 Background Assessments

During the 511 years of colonial rule, Cape Verde was a base for supplying agricultural commodities and other activities which served the ruling country, signs of which are still visible in the rural areas today. In many ways the culture and social structure in Cape Verde is more similar to that found in Central and South America than to Africa. However, Cape Verde has been placed in the Sahelian African nation group in the AID plan for supporting agricultural research. The technologies to be developed in the lead African country, Senegal, may not be easily nor directly transferable to Cape Verde. The high level of soil erosion presently visible is testimonial to 511 years of inappropriate agricultural technology transfer, which has led to the degradation of the natural resource base. The effects of the present 18 year drought may, in part,

be attributed to the misuse of this resource base with inappropriate agricultural technology. Much of the limited land with access to irrigation is devoted to crops not high on the nutritional quality list, but its economic return is high.

At the time of independence, 5 July 1975, there were no secondary schools with an agricultural emphasis nor an agricultural research institute in Cape Verde. Both of these institutions were established at a single location in 1977. There is still no College or University in Cape Verde and all degrees (B.S., M.S., and Ph.D.) are earned outside the country. The lack of education infrastructure has been a constraint to developing crop and livestock production systems which would conserve the fragile landscape as well as advancing the industrial base. At present Cape Verde imports 90% of its food requirements, there is a shortage of water for all purposes, and there is a dire need to address the rapid deterioration of its land resources. Population growth is estimated at only 1% annually because of the high level of emigration, especially to the United States and Portugal. Limited educational opportunities will curtail emigration as a population control mechanism in years to come. Since independence, AID and other donor countries have sponsored a number of projects with varying success. There is presently a $2.7 million Food Crop Research Project (1983-87) and a $5.6 million Watershed Development Project (1984-88) assisting agriculture development in Cape Verde. Other AID discretionary funds are available as well as funds under PL-480. This briefly defines the present status on which suggestions for future development will be based.

5.2.2 Observations to the Future

Future agriculture projects in Cape Verde should include project goals explicitly targeted for relative food self-sufficiency, farmer income enhancement, rural employment and improved nutritional status. They must address (a) Research Institutional Building for stability and continuity; (b) a systems approach to production agriculture, i.e., crop mixture adaptations to watershed development and soil stabilization; (c) development of infrastructure to deliver production inputs; (d) removal of problems associated with marketing as a constraint to agricultural production; (e) improved access to primary education in rural areas and increased availability of secondary education; and (g) parallel agro-industry development. Several past agricultural development projects of USAID, FAO and other donors involved high technology and are not cost-effective to maintain. Future programs must be particularly sensitive to that technology that Cape Verde will have a reasonable chance to operate and maintain after these projects terminate and the external support ends. Adaptive agricultural technology generated within the country is required because technology transfer alone has been a contributing factor to the present misuse of land resources and has not resulted in increased self-sufficiency in food production.

5.2.3 General Recommendations

The AID project goals in the agricultural sector must continue to develop the capability of the country to increase its food crop production, stabilize the deteriorating natural resource base, and improve the income and nutritional levels of rural families. Projects should be designed to develop those elements of the institutional infrastructure which are necessary to maintain these desired outputs and lead to the creation of a self-sustaining agriculture. The following developmental issues must be considered with respect to the development of more productive agricultural systems:

1) Soil conservation, water harvesting and environmental rehabilitation.

2) Development of integrated crop production-soil conservation-water harvesting systems for hillside, rainfed agriculture into farming systems.

3) Increased production of high quality food crops from the available water in the scarce lands where controllable, continuous irrigation is available.

4) Development of forestry, tree crop and agro-forestry production systems to maximize productive capacity and minimize degradation of the land.

5) Integration of livestock systems into crop production systems to utilize those crops best suited to the environment and to soil conservation practices.

6) Development of the necessary agro-industry infrastructure that can support a program geared to increasing crop production.

7) Development of the complementary social, economic, and extension components necessary to evaluate, guide, and implement the programs.

8) National coordination and planning responsibilities for research, extension, and extension education may be most efficient when coordinated through a single institution rather than fragmented through a series of parallel institutions. With the two AID agriculture projects presently scheduled to end in the not too distant future, the FCRP in 1987 and the WDP in 1988, program integration appears feasible within the next 2-3 years. This would need to be designed in line with anticipated achievements or End of Project Status (EOPS) from the FCRP and WDP.

5.2.4 Suggested Future AID Investment in Agriculture

5.2.4.1 Introduction

Past AID Development Projects have focused on environmental rehabilitation through the WDP, and institution building through the IPM and FCR Projects. These programs need to continue. To accomplish this goal, environmental rehabilitation would require a large engineering component, particularly on the Island of Santiago. The institution building needs to include watershed development as an integrated soil stabilizing and cropping systems component. To insure continuity, institutional development must proceed at a rate which is compatible with economic development in Cape Verde. Continued improvements of research facilities at INIA's central research station at Sao Jorge and at the outlying substations will be required to develop those improved crop production technologies that will be most acceptable to Cape Verdean farmers.

5.2.4.2 Technical Justification

Institution building in Cape Verde would best continue in line with AID's long-term strategy for supporting agriculture research in Africa. Cape Verde

would continue in its role as a technology adapting country with special consideration given to its unique circumstances, minimal natural resource base, and limited human resources. The archipelago is located about 420 kilometers west of Senegal, which is designated to become the technology generating country for the region. However, landscape and climatic differences present many special and unique problems that will require the in-country research capability to develop and refine new technologies to local conditions. Distance and cultural differences also add to the challenge.

Approximately 95% of the land in agriculture is in rainfed cropping systems while only 5% has adequate and controlled irrigation and will not be planted to high quality food crops. The 95% of the agricultural land in the rainfed zones is primarily steep upland slopes mainly planted in annual crops such as corn, cowpea, common beans, lima beans and dolichos lablab which are planted together, and pigeon pea, which is grown alone. Corn, because of the erratic rainfall patterns, is considered a high risk crop. This is a major reason for planting corn as an intercrop with beans. The annual planting of these crops on steep slopes is the principal factor contributing to soil erosion, siltation of check dams and wells, and flash flooding of irrigated lands. Due to the need to develop the best possible production systems for these uplands one must consider; (a) perennial food legumes; (b) lower risk cereal crops; (c) some permanent forages; (d) tree crops and agro-forestry; (e) animal production farming systems; and (f) structured soil and water conservation systems. This will add stability to the landscape and to the production systems, lower the risks, improve the return from purchased inputs, and enhance the economy of rural areas.

Analysis of rainfall data and history of famines caused by the droughts recorded since 1719 suggests that the present 18-year drought is the longest and most severe during this 267 year period. Old landscape photographs of Santiago and the vegetation observed on hillsides protected from grazing indicate that nearly all the native trees, shrubs and other vegetation have been removed during the past 25 years, although these trends have been accelerated during the present drought. The cause and effect of whether the barren mountainous landscape substantially changes the microclimate of the islands, rendering them more drought-prone offers an interesting hypothesis to be tested. Past and present projects are slowly revegetating some hilly areas with suitable perennial species. The islands of Santiago, Fogo, Santo Antao, Brava and Sao Nicolau all offer models with definable parameters related to the issue of whether adapted vegetative cover can increase rainfall over these islands. The unique characteristics of small size and isolation of these Cape Verde Islands does not exist on the continent of Africa and offers unique climatological research. If the hypothesis should prove true, it could serve as a model that might be transferable to other low rainfall areas. The size and isolation of these five Cape Verde islands are ideal for the collection of this baseline data by monitoring revegetation and weather conditions which are necessary to test this hypothesis.

Problems with saline soils have been reported (reports of T.W. Crawford and W.G. Matlock) to exist at the mouths of some ribeiras (valleys), where irrigation from wells is continued throughout the year. The hypothesis is that salt water intrusion is a result of the extended drought and fresh water draw-down in existing wells. Salt water is pumped as irrigation water onto the lands causing a problem for sensitive crops. Well monitoring, i.e., bi-weekly, depth and water analyses modelled with annual rainfall, would reveal the conditions under

which salt water intrusion might occur. The monitoring program would also serve to determine if other systems of water conservation in the watershed unit actually help reverse or reduce the incidence of this problem that would render these lands more productive in the future.

Regions with 100-200 mm mean annual rainfall exist on most islands. On some islands this constitutes the entire land mass and others only the flat coastal regions. These areas are now commonly treated as waste lands. Recent plantings of plant species tolerant to extended periods of drought are an initial step in revegetating these areas. Range management with drought tolerant, forage-type trees, shrubs and cacti offer potential to enhance production of milk and meat from small ruminants as well as to set the stage to determine if vegetative cover will change the rainfall patterns. Revegetation would also add stability to the fragile environment. These adaptive technologies offer a model development opportunity ideal to serve as a demonstration area transferable to other regions in anteterrestrial Africa.

5.2.5 Phase I Suggestions

A.1. The first phase would combine cropping programs-farming systems with soil stabilization in a watershed development context through a process of institution building. The total process, to insure sustainable development of Cape Verde, would require 15-20 years with technical assistance changing and phasing down over time. The engineering requirements to outline the water impoundment and landscape stabililization requirements cannot be addressed in this project evaluation/design because such expertise was not included on the team.

A.2. The socio-economic surveys are generating some very useful information that will be important in developing the rainfed crop production systems. To continue this effort and develop the cropping systems-management programs, it will be necessary to continue to support and strengthen the Social Science Department of INIA. The Extension Service, being relatively new, is just starting to develop programs that will operate at the farm level. Because of the higher than normal level of female heads-of-households in the rural areas, especially on rainfed lands, there is a special need to bring new, acceptable, production technology to this segment of the rural population. It is important in these formative stages of the Extension Service that training and education be a major component of their activities.

A.3. The evaluation team suggests a long-term step-phase project design for future development of INIA be conducted based on the recent INIA elevation in institution status and added changes.

APPENDIX A

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APPENDIX B

ARTICLE I - TITLE

Food Crop Research Project (655-001); Mid-project evaluation.

ARTICLE II - OBJECTIVE

The objective of the work order is to perform an evaluation for the above-referenced project through an analysis of the project's accomplishments and an assessment of the role of agricultural research in Cape Verde in order to make detailed recommendations for future AID involvement in agricultural research as warranted.

ARTICLE III - STATEMENT OF WORK

This work order requests the services of an Agricultural Research Administrator, an Irrigation Agronomist, and a Social Scientist to work through the USAID Mission and the Government of Cape Verde (represented by the Secretariat for Plan and Cooperation) in carrying out this evaluation. Although project activities are centered on the island of Santiago, the evaluation team will visit the islands of Fogo, Santo Antao and Maio to observe other interventions in agricultural research. Seven to ten days of inter-island travel are anticipated.

Below are the individual specialist's requirements as they relate to preparation of the evaluation report.

Agricultural Research Administrator

1. Present a brief discussion of the need for agricultural research in developing countries, referencing the AID agricultural research strategy paper;

2. Describe and analyze the rationale for establishment of agricultural research facilities in Cape Verde as set forth in the project paper;

3. Comment on the established INIA research strategy and areas of priority, and describe present long-term objectives;

4. Assess the GOCV commitment to agricultural research;

5. Describe the technical assistance provided toward establishment of an agricultural research capacity and evaluate its effectiveness-to-date in achievement of that purpose;

6. Describe the various agricultural research initiatives currently in progress in Cape Verde with an assessment of the potential of each to provide increased food supply; and

7. Make specific recommendations regarding future AID investment in Cape Verdean agricultural research, estimated costs of these interventions and technical justification.

(Irrigation) Agronomist

1. Describe Cape Verdean irrigated food crop production and rainfed agriculture systems and the nature of the support provided by agricultural research;

2. Describe the various mechanisms utilized for irrigated agriculture in Cape Verde;

3. Present the rationale for the selection for the food crops to be irrigated in Cape Verdean agriculture;

4. Discuss and evaluate the relative importance given to irrigated vs rainfed agriculture in the established research priorities;

5. Present detailed recommendations (both long- and short-term) regarding the soils/plant/water irrigation aspects of the project that would help to achieve its objectives in food crop production.

Soil Scientist

1. Describe the role of rural surveys and extension in agricultural research;

2. Describe and evaluate the planning and implementation of the survey and its effectiveness relative to other developing country experience;

3. Describe the progress made toward extending results of agricultural research to farmers;

4. Describe ways in which the rural survey results are being (or will be) used to influence research priorities;

5. Describe the extent to which staff training has taken place through the technical assistance in this area;

6. Make detailed recommendations for the remainder of the project, as well as longer-term recommendations in strengthening the linkage between research and extension to farmers.