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MOISTURE UTILIZATION IN SEMI-ARID TROPICS

(Summer Rainfall Agriculture)

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I. NARRATIVE SUMMARY

A. Accomplishments

1. Reporting Year

In this fourth year of the grant the computerized bibliographic information data base has been expanded to more than 15,000 entries, and about 5,000 additional entries are being processed. The information network (CIDNET), established in cooperation with the Consortium for International Development (CID), and with the reference center located at Riverside, is now completely computerized. The bibliographic data base has 29,000 entries and is searchable. The areas of interest cover a broad spectrum of soil-water management in crop production, such as: crop production in semi-arid regions, on-farm soil water management, water delivery systems to and from the farm, small watershed management, and many items on development and planning in various developing countries.

The "Proceedings of an International Symposium on Rainfed Agriculture in Semi-Arid Regions" is now available. Copies without cost can be obtained from the following address: MUSAT:sra Information Center, Soil & Environmental Sciences, University of California, Riverside, CA 92521. "Agricultural Research in Semi-Arid Regions: a resource directory," was completed and will be published in early 1979 by G.K. Hall & CO., 70 Lincoln Street, Boston, Mass. 02111. The "State of the Art: Acacia albida as a complementary permanent intercrop with Annual Crops" has been completed and a few copies of this are available (use address given above).

2. Life of Grant

Accumulative accomplishments of the grant are summarized as follows:

- 1) Development of the Centralized Information Center, using a computerized bibliographic information base, and the Center is one of excellence. The addition of CIDNET has broadened the base and makes the Center more diversified and user oriented on both a local and international basis. The geographical bibliographic index, "A Bibliography of Moisture Utilization and Agricultural Development in Semi-Arid Tropics: summer rainfall agriculture" was published by G.K. Hall & Co. This is a good indication of the success and usefulness of the Information Center as a tool to outside users.
- 2) The crop selected by the MUSAT:sra research committee as one in which the total program at UCR could have an impact on production in the semi-arid tropics and other semi-arid regions of developing countries is cowpeas. An extensive applied research program has evolved at Riverside, including studies on symbiotic N fixation, soil physical properties and their effect on cowpea root development, cowpea breeding for drought resistance, soil-water management on crop production and soil-water balance and modeling. Considerable expertise concerning cowpeas has been developed which can be applied in developing countries. Cooperative exchange programs have been continued with ISRA in Senegal and the French research organization ORSTOM. Exchange of scientists with these groups has proved to be a strong linkage in developing expertise on common problems in semi-arid regions. The International Symposium on Rainfed Agriculture, and the resultant "Proceedings" which have been distributed on a wide geographic basis, have increased the information exchange and developed a wide range of worldwide linkages with scientists and government leaders.

II. DETAILED REPORT

A. General Background and Description of Problem

Life requires food, and the production of food depends upon the understanding of the effects of weather, soil, and man/plant/animal relationships. The interrelationships of these factors allow us to develop reliable plans for the development of food production techniques as they affect land use. This needs to be accomplished without damage or loss of natural resources. Agencies of the United Nations, governments of developed nations, private foundations, and research institutes have done much to improve food production and alleviate hunger. Among significant breakthroughs were hybrid corn in the 1930's; grain sorghum, pearl millet and hybrid monogerm sugar beets in the 1950's; and the Green Revolution, which introduced new wheat and rice varieties in the 1970's. Yet all of these achievements have constituted only a few small steps in the fight against hunger.

At present almost 85 per cent of the cultivated lands of the world depend entirely upon precipitation to supply soil moisture for plant growth. The Sahelian and Sudanian zones of Africa, where acute drought conditions resulted in great human suffering the early 1970's, have refocused attention on the urgent need for developing new programs to make underdeveloped or marginal lands productive and to reclaim deteriorating grasslands.

The potential for increasing crop production and restoring grasslands in these regions of Africa, and solving similar problems in many other semi-arid areas of the world, involves the essential component of water management. Although considerable attention has been given to development of crop varieties and agricultural practices under adequate moisture conditions, research leading to the development of an arid-farming technology for the developing countries has been virtually non-existent. Principles and practices developed for dryland agriculture in the United States cannot simply be transported to other regions of the developing world, for many reasons. If farming productivity in these regions is to be increased, it will be necessary to employ integrated systems approaches to developing crop manage-

ment practices for specific crops, soils, and climatic conditions. Such practices must make efficient use of available resources (such as precipitation, fertilizers, levels of mechanization, etc.) and they must be economically and culturally feasible for application in the developing countries.

Given this perception of the problem and the direction for approaches to a solution, the University of California, Riverside was able to measure its ability to work toward that solution. UCR, through its Citrus Research Center and Agricultural Experiment Station, has been continuously involved since 1907 in problems related to research and management of agriculture in arid and semi-arid lands. The Agricultural Experiment Station has as one primary mission the development of knowledge of plants of importance to agriculture in semi-arid tropical climates. This mission relates primarily to agricultural production in semi-arid Southern California, but the AES has acquired an international reputation in sub-tropical horticulture and semi-arid land crop production that goes back to the early 1920's. Members of its research staff are involved in many international organizations relating to agriculture and have frequently served as consultants in many foreign lands.

It was evident, therefore, that UCR already had strength in this area, and could increase that strength with the support of the grant. Other aspects of UCR's present strength and capacity for growth include:

(1) Instructional Resources: UCR, with its various divisions and colleges, offers a solid core of academic courses, and degrees in fifty-six majors. Of particular strength is the College of Natural and Agricultural Sciences. One hundred twenty-seven staff members of the Agricultural Experiment Station hold appointments with the College of Natural and Agricultural Sciences and thus share their expertise in crop production, soil-water problems, pest management, plant disease protection, pollution problems, and other research areas related to semi-arid ecosystems. UCR already offers a variety of multi-disciplinary degree programs, setting a valuable precedent for new programs of this type which would deal more specifically with grant-related topics.

To complement and enlarge its present Instruction resources, under the 211(d) grant UCR proposes to: (1) increase the graduate program and add an international dimension in dryland farming; efforts would be made to increase the number of students from developing countries in the field of dryland farming; (2) initiate Outreach Training Programs, short-term courses designed for developing country personnel; (3) institute special non-degree programs designed to train groups for work in semi-arid tropical regions of the developing countries.

(2) Research Resources: Staff members are encouraged to devote research efforts to grant-related projects. In the course of the State of the Art review, specific problem areas have been identified and research projects undertaken. These research projects include dissertation research by graduate students as well as staff research.

(3) Informational Resources: the UCR Library has a collection of over one million volumes in open stack arrangement. One of its specialized branches is the Bio-Agricultural Library, which contains an outstanding collection of more than 86,000 books related to agriculture, sub-tropical horticulture and the biological sciences. It currently receives some two thousand fifty-five serial publications. Through contracts with commercial purveyors of bibliographic data bases (Lockheed and Systems Development Corporation) the UCR Library offers computer literature searches on a number of data bases, including CAIN, NTIS, and BIOSIS. Under the grant the UCR Library is enlarging its collection in the topics of agriculture in the semi-arid tropical regions, geographic, social and economic works on the Sahel area of West Africa, and all material related to grant problems. This collection is recorded on a computerized data base that provides quick and easy access to any of the material through indexes of title, author, source, subject and geographic areas.

(4) Consulting Services: Already experienced in consultation services, the staff of the Agricultural Experiment Station and of the College of Natural and Agricultural Sciences is increasing its expertise in problems of the semi-arid tropics to provide a core of personnel available for advisory tasks for the developing countries.

B. Purpose of the Grant

The grant is being used by UCR to develop an institutional response capability to deal with dryland moisture conservation, utilization and farming problems in arid and semi-arid tropical regions in developing countries with summer rainfall. This capability requires building a core of experienced faculty with expertise in advising and training, knowledge of the research field, and the ability to implement adaptive research or training programs in the developing countries, and contribute to upgrading their capabilities for improved crop production and moisture utilization through integrated crop-management systems. As an outgrowth of this program UCR can be expected to become a center of U.S. competence in dryland farming for semi-arid tropical regions.

C. Objectives of the Grant

1. Objectives Restated - The proposed program will strengthen the competence of UCR in selected areas of knowledge and improve its communications with appropriate institutions here and abroad so that an institutional response capability can be achieved in dryland farming in arid and semi-arid tropical regions. The three primary thrusts in strengthening UCR's competence will be as follows:

- (1) Improvement of UCR's understanding of the current status of present and proposed practices in moisture conservation and utilization in dryland farming and their applicability to developing countries in semi-arid tropical regions. This will include an improved understanding of dryland farming systems and environmental conditions in the developing countries.
- (2) Development of mechanisms which make possible effective interdisciplinary research, advisory and Extension capabilities relating to dryland farming.
- (3) Improvement of educational capabilities at UCR for students and staff to acquire greater knowledge of the principles and practices of dryland farming throughout the world.

The time sequence of activities related to the grant objectives is moving at a rate compatible with the output. Emphasis has been placed on involving French researchers from the Sahel in the State of the Art report and other project activities.

2. Review of Critical Assumptions - Assumptions were made that will have a negative impact on the productivity of the program if they should prove to be incorrect. The assumptions are as follows:

Assumption No. 1. It is assumed that AID/W will provide assistance in the initiation of linkages with the developing countries, in identifying training needs of institutions and individuals and sites for cooperative activity in the developing countries, and in the exchange of information as part of the linkage network.

Assumption No. 2. It is assumed that U.S. and developing country institutions will cooperate with UCR in regard to the initiation and strengthening of linkages, exchanges, and visits by staff and students, information exchange, and other cooperative activities.

Assumption No. 3. It is assumed increasing numbers of students, both from the U.S. and the developing countries, will be interested in graduate programs at UCR and the educational offerings that are relevant to dryland agriculture in low rainfall regions of the world.

III. ACCOMPLISHMENTS

General or Introductory Statement

The team concept selected as a means of developing an interdisciplinary relationship among faculty involved in the program has proven successful in achieving each objective/output in the grant program. Effectively used in agricultural research, this method has adapted well to use in the project, and the teams that were selected during the first two weeks of the program have remained stable except for a few changes or additions in personnel. Guideline materials were also developed in the early stages of the project and have been revised as progress has been made. The teams remain as identified in the previous report and have been active in developing programs to satisfy each objective/output in a sequence to meet the timetable of the grant. The team responsibilities are as follows:

- | | |
|------------------------------------|------------------------|
| 1. Information Resources Team | Objective/Output 1 & 2 |
| 2. Research Team | Objective/Output 3 |
| 3. Educational Training & Advisory | Objective/Output 4 |
| 4. Curriculum & Development Team | Objective/Output 5 |

A. Objective/Output No. 1: Central Information System

1. Narrative Description - The Information Resources Team identified two major targets for the term of the grant within this desired objective/output: (1) to provide project team members with the information needed for them to prepare a State of the Art report and to embark on the cooperative research projects which will constitute their work in the overall project; and (2) to establish at UCR an Information Center on agriculture in the semi-arid tropics. This latter target would make existing information, as well as the results of the project research, accessible to interested researchers and other groups the world over.

A major undertaking in establishing this Information Center was the preparation of a computerized bibliographic data base using TRIM (Technique

for Report Index Management), a program developed specifically for the organization of small special collections by Everett Wallace, Associate University Librarian at UCR and head of the Library's Systems Department. This data base is now comprised of 12,000 items, including journal articles, monographs, reports, and reprints from a wide variety of sources. Procedures were initiated and tested with the acquisitions and cataloging departments of the UCR Libraries for integrated efforts in building the collection according to the grant objectives. Liaison with the Serials and Monographs departments of the Library have been effected and, since the grant involves interdisciplinary research, cooperation was sought and received from the diverse branches of the University Libraries. Gladys Murphy, Head of Sciences Acquisitions, has proved exceptionally resourceful in developing procedures for locating and purchasing material from sources ranging from U.S. distributors to remote research stations in West Africa.

Use of the bibliographic resources and collection have increased during the reporting year as awareness of project services continues to grow. Due to increased information demands from national and international requestors it was determined that microfiche copies of the data base would be most cost-effective. As a result microfiche readers have been purchased for use by the Information Center, students, faculty and visitors.

Intensive information-support was provided for the completion of the State of the Art papers. Completion of the Resource Directory for Agricultural Research in Semi-Arid Regions was also accomplished in this reporting year. Project staff needs are given high priority, and new areas of collection-building have been developed to support the scope of the State of the Art and the initiation of research projects.

2. Targets for the Reporting Year - To continue the development of MUSAT:sra information services by:

(a) Selection of current and retrospective material from bibliographies, publication lists, other data bases, recommendations of project staff and suggestions from other libraries, and to acquire copies of these items for the UCR Libraries collection, or for the Information Center collection.

- (b) Review and revision of collection development guidelines.
- (c) Establishment of working relationships with publishers, dealers, documentation centers, research centers, etc. to facilitate not only the acquisition of material, but also the development of cooperative linkages.
- (d) Continued evaluation of input procedures to the TRIM system and revision of the subject thesaurus.
- (e) Completion for publication of the directory of individuals and organizations having expertise in agriculture in the semi-arid tropics and/or African agricultural development.
- (f) Provision of reference assistance and other research aids to Project members, graduate students, and other persons using the data base and collection.
- (g) Provision of reference assistance in response to requests from outside the University, especially those from developing countries.
- (h) Introduction and training in use of microfiche and microfiche readers.
- (i) Preparation for the fourth year comprehensive review, and proposal consideration of service operations beyond the life of the grant.
- (j) Coordination with UCR Libraries reorganization plans and objectives.
- (k) Centralization plan for the operation of CIDNET services.

The magnitude of progress toward these targets depends largely on the nature of the targets themselves. Target (a) is of course a continuing activity. The bulk of retrospective acquisitions was planned for the first two calendar years of the grant, after which the budget allocation for purchase of books and other library materials drops to a level compatible with continued acquisition of newly published materials and selected retrospective material.

The computer profile for ASCA (Automatic Subject Citation Alert) and other data bases as appropriate has been reviewed and revised, along with the African Imprint Library Services approval service.

Targets (b) and (c) are in response to the stabilization of acquisitions and a need for refinement. Target (d) is also a continuing project.

The initial adjustment of the TRIM format for the MUSAT:sra Information Center was accomplished during the first reporting year, and minor revisions and adjustments have occurred during the current reporting year. Target (e) was accomplished in this reporting year and will be available in December of 1978. Targets (f), (g), and (h) are ongoing in nature and are handled as appropriate.

There has been a measurable increase of assistance to all categories of users. The receipt of information requests takes priority over other ongoing projects. Target (i) was accomplished in the reporting year. Target (j) is also ongoing and relates to a closer liaison with the University library administration and an increased emphasis on integration of materials into the UCR libraries. Target (k) is ongoing in nature and involves the development of a centralized cooperative and effective service unit.

Assumptions were made in the drawing up of these targets that would have a negative impact if they should prove to be incorrect. The assumptions, unchanged since the first reporting year, are as follows:

(1) It is assumed that U.S. and developing country institutions will cooperate with UCR in regard to the initiation and strengthening of linkages, exchanges and visits by staff and students, information exchange, and other cooperative activities.

(2) It is assumed that existing University staff and facilities will be able to absorb increased workloads from project tasks (i.e. keypunching, ordering of materials, cataloging), or that project funds can be used to augment these facilities as needed.

(3) It is assumed that material ordered and requested for the collection will prove to be available.

The means of verifying progress made in this category include on-site visitation, reference request statistics, inspection of the data base printout, the project Annual Reports, and descriptive articles prepared by the Project Librarian and appearing in information science and agricultural development literature, trade publications, and CIDNET brochures.

3. Accomplishments

a. Accumulative - The data base now contains 12,000 entries of accessible information and is progressing at a steady rate of acquisitions and processing. Current acquisition procedures involve the current awareness services of ASCA and other data bases as appropriate and the African Imprint Library Services approval program. Gifts, exchange publications, and the scanning of all current agricultural bibliographical materials remains part of the ongoing procedures. Awareness of and publicity about the project continues to expand as a result of publications, personal and organizational contacts, correspondence, referral/exchange systems (as exemplified by CIDNET) and involvement in professional meetings. The Research Team has developed numerous projects, and library support of these activities has significantly increased. The number of visitors to the Information Center, both national and international, has also continued to increase.

b. Reporting Year - At the end of the reporting year the MUSAT:sra data base had 12,000 entries and some 5,000 still in process, made up of both the backlog of scanned journal articles from the UCR holdings and new acquisitions and orders.

Expenditures at the end of the reporting year totalled \$29,011.37. This figure represents serial subscriptions, African Imprint Library Services approval plan, maps, purchase of computer current awareness services, monographs, reports, etc. In the philosophy of the grant concept and of the Information Center, the Project Librarian has worked with the UCR Library's Collection Development Department in drawing up guidelines that define and describe the kinds of material being purchased. Because the project crosses a number of discipline lines, continued coordination is necessary to avoid duplication or conflict with other collection development consultants for the academic disciplines.

In accordance with University-wide library policy, the UCR Serials Decision Committee reviews each new serial title proposed for addition to the MUSAT:sra Information Center; there is also a Serials Deselection Committee which oversees the elimination of expendable serials from the collection in

order to meet the problem of increasing journal costs and decreasing budget allocations. Although the serials selected for the MUSAT:sra collection by the Project Librarian are automatically approved, the Project Librarian has been working closely with these groups to forestall any conflict and to ensure the maintenance of the collection after the term of the grant.

Material for the MUSAT:sra Information Center collection is ordered from a wide variety of sources. A good deal is produced by U.S. publishers or other organizations, but the bulk is published abroad, either in Europe or in the developing countries. U.S. dealers can be called upon for acquisitions from many European publishers, and African Imprints Library Services, a New York based firm, has provided excellent service in acquisition of a large number of African publications. For the most part, however, ordering must depend on direct correspondence with the publishers or agencies overseas; the large volume of orders involves the Acquisitions Department in a great deal of clerical work, and necessitates procedures for dealing with foreign languages, currencies and billing conventions. In addition, special attention must be given to following up on orders since they are prone to go astray in the mail or in bureaucratic snarl-ups.

A vital objective of the grant was accomplished in this reporting year through the completion of the Resource Directory of Agricultural Researchers in Semi-Arid Regions. Contract negotiations have been completed and the publication will appear from G. K. Hall in December of 1978. This Directory complements the previous project publication of the geographic index of the project data base which has been well received, as evidenced by favorable reviews in the literature and sales by the publisher.

The Resource Directory of Agricultural Researchers contains over 1,500 citations accumulated through the correspondence files of the project, references from researchers and research organizations, and international visitors. The organization of the Directory is based on the principle of a telephone directory and the citations are retrievable by name, organization, subject, geographical area and physical location. Thus, one wishing to locate other researchers working in a particular subject field or geographic locale would look under the appropriate topic and also under the geographic location--i.e. Nigeria, for example. It is hoped the Directory will promote an expanded

awareness of and cooperation among individuals and organizations engaged in similar agricultural research in semi-arid regions.

The Project Librarian has been involved in a wide range of activities during the reporting year. In November the 20th annual meeting of the African Studies Association (ASA) was held jointly with the Latin American Studies Association (LASA) in Houston, Texas. This type of cooperative meeting reflects an awareness of similar problems in developing areas irregardless of geographic location. It also complements and supports what our project experiences have been in relation to information requests.

CIDNET has continued to operate with cooperation and increasing efficiency, and CID member universities have increased with the addition of Idaho University and Washington State University in this reporting year. Member universities report increased usage of materials and the referral system is operating smoothly.

A CIDNET meeting was arranged and hosted at Riverside in November 1977 to review progress and to plan future objectives. The first day of the program included update presentation by each university member representative, a presentation by Information Handling Services from Colorado, and a demonstration of a compact microfiche reader by U.S. Datacorp of Los Angeles. Meeting participants were given copies of the entire UCR data base on microfiche in the spirit of cooperation and accessibility to our resources. The Information Handling Services group explained their services and purpose to provide information systems to specific user groups and to acquire and market information.

The second day program included a presentation by Kanti Rawal of Information Sciences/Genetic Resources (ISGR), a Colorado organization, relating their experiences with communication functions to make planning more effective.

This CIDNET meeting served to raise and discuss questions and problems related to sustaining an ongoing network and the potentials for expansion. A need for document delivery is evident, as well as the need for funding to support it. UCR is researching the alternatives and hopes to put together an acceptable proposal.

In February of 1978 the project Information Center participated with Southwest Research Institute of San Antonio, Texas in a project exploring the scope and content of our computerized information retrieval system. In addition, much of our directory resources were utilized for an AID-related project by Southwest Research Institute.

Preparations were made for AID's fourth year comprehensive project review on May 2-4, 1978 in anticipation of the end of the project. The assessment of the accomplishments and performance were beneficial to both sides, and the Information Center was well received.

An exhibit entitled "Glimpses of Traditional Agriculture in Upper Volta" was placed by the Project Librarian at the campus building housing the College of Natural & Agricultural Sciences. The display included agricultural implements, household utensils and color photographs illustrating various aspects of village life. The inspiration, interest and materials for the exhibit were provided by the project research of Robert Ford, Project Leader in Upper Volta.

A regular column for the UCR Libraries newsletter entitled "Memos from MUSAT:sra" was initiated by the Project Librarian to relate notable acquisitions, special events or projects and to convey awareness of international visitors.

Microfiche copies of the project indexes are now available and this facilitates the acquisitions and references processes, while providing a compact listing tool for our 12,000 entries. The Information Center currently houses 4,500 items, as well as providing reading space for users and working space for the Information Center staff to handle reference questions, locate materials and process acquisitions. This reflects a decrease in the number of items housed since approximately 1,500 items have been transferred to the main campus library collections and a designated area in the Bio-Agricultural Library to provide the Information Center with vital working space.

The State of the Art on Agriculture in Semi-Arid Environments is in the final stages of completion and the authors have drawn heavily on the Information Center for research aid. Such assistance, whether for local staff or distant inquiries, may consist of specially generated bibliographies from the MUSAT:sra data base or wider reference searches which yield citations subsequently added to the data base and collection. Referrals of complex questions to other CIDNET resources or to other institutions were also done. The Project Librarian prepared the index for publication in consultation with the editor. Information Center staff also assisted in final publication preparations for the Proceedings of an International Sym-

posium on Rainfed Agriculture in Semi-Arid Regions held at the University in April of 1977 and now readily available.

Other activities of the Project Librarian have included an article on MUSAT:sra for the National Agricultural Libraries Information Notes and a directory listing of the project for the revised 5th edition of A Comprehensive Guide to Centers of Specialized Information, published by Gale Research Company.

c. Total Expenditures - Expenditures for the reporting year were \$29,011.37.

B. Objective/Output No. 2: Network of Worldwide Linkages

1. Narrative Description

The establishment of an Information Center and a network of worldwide linkages are closely connected. As can be seen in the discussion of targets and accomplishments above, the formation of linkages has been an important means of acquiring new sources of input for the data base.

In the reporting year there has been continued personal and professional ties with the French research organizations of Institut de Recherches d'Agronomie Tropical (IRAT), Centre National de la Recherche Scientifique (CNRS), l'Office de la Recherche Scientifique et Technique Outre Mer (ORSTOM), and West African counterparts, such as Centre National de Recherches Agronomiques (CNRA) in Senegal and the International Institute of Tropical Agriculture (IITA) and the Institute for Agricultural Research in Nigeria and other organizations in Upper Volta, Mali and Niger.

These linkages were further strengthened by the following activities:

- 1) Visitation by the Program Director at ORSTOM and IRAT headquarters in Paris, and with their scientists in Senegal and Upper Volta. Meetings were also arranged with various government agencies in Senegal and Upper Volta and with scientists at their research stations in these countries. Visits were made with the AID Missions and with ICRISAT's West African headquarters at Dakar and their research station in Upper Volta.

- 2) A staff member visited Paris and Senegal in search of information on Acacia albida, providing new contacts and strengthening existing ones.
- 3) A meeting was held and a proposal on cowpea production developed with representatives from Senegal, IITA, Cornell University, Boyce Thompson Institute and UCR in Dakar in June. This was a very productive meeting and has greatly strengthened UCR's linkages with Senegal and IITA. Through these meetings a strong interest was created for developing a cowpea project to be conducted in Senegal that would have application to other semi-arid regions.
- 4) The scientist exchange program was continued with ORSTOM. A nematologist from ORSTOM's research laboratories in Dakar spent the year at UCR doing research on nematode population problems in semi-arid dry soils. This was a cooperative study with nematologists at UCR. Plans were formulated to continue the exchange program with ORSTOM during the fifth year of the grant when scientists from both institutions would take part in the program.
- 5) The 18 month project in Upper Volta--an indigenous approach in studying farming methods and systems on a village level--provided an opportunity for many visiting scientists to gain knowledge of the Ouahigouya region by visiting and touring the area with the project director. The study provided ICRISAT with assistance in their plant breeding testing program for sorghum and cowpea. The Upper Volta project director located sites and recorded data for each of the sites located within the village areas of his project. These linkages and those with visitors provided a base for extending worldwide linkages and strengthening existing ones.
- 6) Visitors to MUSAT:sra from many agencies have provided a base for various worldwide linkages with developing country governments, including embassy personnel, research scientists, agricultural and rural development officers and others.

7) Consortium for International Development (CID) has provided many contacts and opportunities in establishing worldwide linkages.

Contacts and information exchanges have continued with the Centre Regional de Formation et d'Application en Agrometeorologie et Hydrologie Operationelle (AGRYHMET) in Niger, Comite Inter-Africain d'Etudes Hydrauliques (CIEH) in Upper Volta, Comite Permanent Interetats de Lutte Contre la Secheresse (CILSS), the Agricultural University at Wageningen in the Netherlands, and the International Irrigation Information Center and the Volcani Center in Israel.

Information exchange linkages have been maintained with the consulting agency Societe Africaine d'Etudes et de Developpement (SAED), the International Institute for Tropical Agriculture (IITA), and the Institute of Agricultural Research at Samaru, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and All-India Coordinated Research Project for Dryland Agriculture (ICAR).

Additional contacts and exchanges have been made with key regional units such as the International Livestock Centre (ILCA) in Ethiopia, Institut Senegalais de Recherches Agricoles (ISRA) in Senegal, and West Africa Rice Development Association (WARDA) in Liberia.

New contacts and cooperation for information distribution have been established with the International Food Policy & Research Institute (IFPRI) in Washington, D.C., the Institut National de Recherche et de Documentation de Guinee in Guinea, the Casamance Project in Senegal, the Djibelor Research Station of ISRA in Senegal, Soils & Water Research Institute in Egypt, and the Department of Agricultural Technical Services in the Republic of South Africa.

CIDNET, the information network for CID, has provided contacts from various countries where CID projects are being conducted, such as Niger, Chad and Egypt.

The goal of providing a document delivery system to researchers in developing nations is making progress. Extensive discussion, research, literature review and analysis have taken place that will lead to formulation of a proposal; in the process some meaningful statistics have been

compiled by the Project Librarian which provide an overview of actual services provided in terms of numbers over the past four years. The figures indicate that over 2,000 requests have been handled by the Information Center. Details and a breakdown of the statistics are included in the appendices for reference. The established cooperative reference service linkages continue to be maintained and further developed and will provide the foundation for the model document delivery system.

2. Targets for the Reporting Year

- a) Publication of the Resource Directory for Agricultural Research in Semi-Arid Regions by G. K. Hall.
- b) Continued active correspondence with linkages and new contacts through an exchange of publications, information and ideas.
- c) Sponsor a CIDNET conference to update members on activities, share problems and discuss potentials and future directions.
- d) Active documentation support of research project publications and activities.
- e) Increase awareness and demand for Information Center services by a broader base of publicity including articles, exhibits and participation in national/international meetings.
- f) Exploration of inexpensive approaches to document retrieval and delivery.
- g) Continue personal contacts with scientists and government leaders in the developing countries, international organizations, AID Missions and other institutions.
- h) Completion of the State of the Art on Acacia albida.
- i) Develop with cooperation from other organizations a preliminary proposal for a project in cowpea production and related activities to be conducted in Senegal.
- j) Continue the scientists exchange program with developing countries.
- k) Complete the MUSAT:sra project in Upper Volta.

The magnitude of accomplishment of these targets has been determined by responses received from the accomplishment of the targets:

- a) The resource directory is in the final stages of publication.
- b) Correspondence continues to be active and effective, and the duplicate exchange system has been broadened.
- c) A CIDNET conference was initiated and hosted at UCR to share ideas on the collaborative networking system.
- d) Information Center staff assisted in preparation of the State of the Art on Agriculture in Semi-Arid Environments and the Proceedings of the International Symposium on Rainfed Agriculture in Semi-Arid Regions.
- e) The Project Librarian produced and distributed project services information through articles in national/international newsletters, exhibits and meeting participation.
- f) Copies of the entire computerized data base and updates are now issued in microfiche. Information Center users at UCR have been trained to use the microfiche readers that are provided and are able to easily identify and retrieve needed information.
- g) Visits to France, Senegal and Upper Volta were made by the Project Director to strengthen existing linkages and to develop new contacts for the State of the Art Acacia albida project leader.
- h) The State of the Art for Acacia albida was completed and copies were sent to AID/Washington for distribution as appropriate.
- i) A preliminary proposal was developed in cooperation with Senegal, IITA, Cornell University and Boyce Thompson Institute.
- j) An ORSTOM scientist from Dakar spent the year working in the UCR Department of Nematology.
- k) The collection of data in the Upper Volta project was completed in March and the project terminated.

Assumptions were made in the drawing up of these targets as follows:

1. It is assumed that AID/W will continue to provide assistance in the initiation of linkages with developing countries in identifying

training needs of institutions and individuals, and sites for cooperative activity in the developing countries, and in the exchange of information as part of the linkage network.

2. It is assumed that institutions in the U.S., other developed countries and less developed countries will cooperate with UCR in the initiation and strengthening of linkages, exchange of information and visits by staff and students and other cooperative activities.

The means of verifying progress made in this category might include on-site visitations, review of correspondence files and computerized indexes, the project Annual Reports and other in-house and external reports, including publications in professional literature by the Project Librarian and other Project staff.

3. Accomplishments

a. Accumulative

During the first reporting year bulk mailings were made to research institutions listed in a number of directories covering arid lands, agricultural development and African studies. Nearly 1,000 letters and descriptive brochures were sent out, opening up several hundred files of active correspondence. Often, inquiries about publications we desired to order netted replies that led to further linkages. Additional references were added to the preliminary bibliography during the second reporting year and another mass mailing was made to research projects identified through the Smithsonian Scientific Information Exchange which, because of its input from CARIS, was able to provide a large number of African research project contacts.

During the first reporting year the TRIM program was tailored for use in developing a directory which was then indexed by name, organization, location, subject field and geographic area of interest. Complete

addresses are printed but are not a searchable field of information. Searches can be made on any of the fields or combinations thereof. The directory is keyed to the correspondence files which yield fuller information than that recorded on computer.

The second reporting year involved expanded travel and personal contacts for cooperative linkages through joint research and training projects. Attendance at professional meetings and communication with colleagues aided progress and successful results and valuable contacts were obtained.

The project hosted several visitors as a result of contact with the African American Institute's visitor program and the Institute of International Education. Excellent progress was made in the area of organizational linkages with ISRA and CNRA in Senegal, and IRAT, IITA, ORSTOM, OMVS and ICRISAT to name a few. The project played an active role in the activities of the Consortium for International Development (CID) and provided background information for travel teams. In September of 1975 CIDNET emerged as a new dimension of CID, and the MUSAT:sra Project Librarian was designated as the CIDNET reference coordinator. CIDNET has provided closer affiliation with both national and international research organizations and individuals.

Direct communication through visitation with FAO personnel in Rome resulted in a cooperative desire to link both Bureau Inter africain des Sols (BIS) and AGRIS TROPICAL to the CID network. As CIDNET develops this linkage has application potential since MUSAT:sra and CIDNET are both interested in cooperative projects with centers in the developing countries and in providing information services to researchers in these countries. BIS, located in Bangui, Central African Republic, provides information on soil sciences for Africa by analyzing and disseminating the information through the periodicals "Bulletin Analytique Mensuel" and "Sols Africains" and they participate in the AGRIS TROPICAL soil sciences sub-network to cover the soils and natural resources literature for Africa.

During the third year the International Symposium on Rainfed Agriculture in Semi-Arid Regions provided many new personal contacts worldwide. Participants visited with faculty and staff at UCR and toured research facilities. Among the participants in the Symposium were key

contacts affiliated with MUSAT:sra projects at Riverside and in the developing countries. Several of these individuals remained for a short time following the meetings and this provided a cementing of relationships and planning for new and continuing projects in cowpea research and in the scientist exchange program.

Cooperation and exchange of information with the Niger River Commission and Comite Interfricaine des Etudes Hydrauliques (CJEH) have continued. Initial contacts on the basis of an exchange of materials have been made with the newly formed CLSS/WHO Sahel Program, AGHYMET Center (Agriculture, Hydrology and Meteorology), a linkage which provides an excellent complement as it adds the dimension of meteorological sources. Valuable personal contact and potential linkage was developed at the Symposium with the Niger Institute for Agronomy Research and the INRAN Laboratoire de l'Elevage in Niamey, Niger. These organizations deal with areas of range management and livestock production and can provide another area of agricultural interest to our linkage program.

As a result of linkages previously developed with the Central Treaty Organization (CENTO), which represents seven leading agricultural institutions in Iran, Turkey and Pakistan, and scientists from that region attending the Symposium, requests for research information continue to be received.

A major affiliation was developed with the Volcani Institute of the Agricultural Research Organization in Bet Dagan, Israel in the first year of the program. This center deals with various aspects of dryland farming, but of particular interest to the project is the concentration on sorghum drought stress studies and various other crop and irrigation projects. In consideration of the project's concern for increasing the adaptive research capability of UCR faculty, two Postdoctoral Fellows from the Volcani Institute have been supported by MUSAT:sra to work on research activities related to the program. This linkage was further extended by a visit to MUSAT:sra by the Managing Director of the International Irrigation Information Center (IRRIC) of the Volcani Institute. IRRIC is a member of the International Development Research Center (IDRC) in Canada and publishes the Current Annotated Bibliography on Irrigation (IRRICAB).

This center utilizes seven data bases and cites 1,250 journals. The Managing Director expressed particular interest in affiliating with CIDNET. Since IRRICAB deals with agriculture in developing countries this linkage is highly desirable.

New Central American linkages were initiated as a result of inquiries from the Centro de Investigaciones Agricolas de Tamaulipas (CIAT) in Columbia. CIAT is an international research center dealing with tropical agricultural research and cooperates with the Colombiano Agropecuario (ICA) and other research organizations. There are 40 experimental stations involved and numerous projects are being conducted in dryland farming; CIAT's willingness to cooperate offers an additional resource to the world-wide network linkage system.

As a result of the project's International Symposium a new professional linkage was achieved with the Agricultural University Wageningen of the Netherlands, whose tillage laboratory conducts projects on tillage systems and soil management for semi-arid regions, with special reference to the Sahel. Information has been exchanged and reference assistance supplied and many original publications received in turn which have been very useful and reflect some of the latest technical and modelling aspects of agricultural research.

The Scandinavian Institute of African Studies (SIAS) operates as a documentation and research center on African affairs in the Sahel region. Exchange of information and documents provided a useful linkage as SIAS became involved in a major project of the present state of knowledge, future implications of research on water use, and water needs and resources in Africa. The MUSAT:sra Information Center was contacted by the Documentation Center on Science and Technology for National Development in Africa of the Research Policy Program at the University of Lund, Sweden. They expressed interest in exploring alternative approaches to better utilization of science and technology to meet basic human needs and provide a publications exchange program. They also publish a newsletter and are interested in creating an informal and open-ended network as an "information exchange."

Vital linkages were achieved through an Information Exchange for Development in the Sahel Conference at Michigan State University. Conference

participants included L. B. Guindo, head of the Documentation Center for West Africa Rice Development Association (WARDA) and Ouamane Silla of the Comité Permanent Interétats de Lutte Contre la Sécheresse dans le Sahel (CILSS). WARDA utilizes the computer programs of the FAO Documentation Center. Although the main objectives are to provide an information service on all aspects of rice production to member nations, the structure of WARDA is such that it can be utilized as a document delivery system for all types of research material in addition to rice-related information. The member nations include Benin, Gambia, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo and Upper Volta. Services which could be utilized for document delivery include computer facilities, microfiche production, and microfiche readers at all centers in the member countries. An exchange program was initiated.

As the Institute of the Sahel is established through the Club des Amis du Sahel, mechanisms for coordinating and sharing information can be utilized through the organizational structure. The Institute is attempting to identify, encourage and support information services already in existence in Africa, and to establish cooperation between a network of Sahelian information services and information centers of international agencies. This linkage could establish a large network of referral services accessible to meet the requests of users. One of the goals mentioned by CILSS involves network sharing among users of the information services. A recipient of information from centers within the network would in turn be encouraged to supply appropriate centers with copies of reports, records of data, etc. In addition, there would be no limitation on the kinds of information or the format to be collected or provided for dissemination; this recognizes that a wide variety of media is necessary for the success of development efforts.

While in some cases initial contacts had already been made through correspondence, continued and strengthened linkages have been obtained through personal research and project contacts, which seems to be the most successful means of maintaining and furthering linkage interests. Linkages in themselves indicate an on-going and meaningful exchange of ever-expanding possibilities.

Activities and continued linkages with the Consortium for International Development (CID) have continued to be a strong part of the MUSAT:sra program. CIDNET linkages have involved providing information for CID travel teams. Reference questions as a result of CIDNET activities have continued to increase from national and, in the form of Society for International Development (SID) referrals, from international sources. MUSAT:sra has been designated and is functioning as a major U.S. source of information for this service and new linkage sources have resulted from this cooperative effort.

Another affiliation resulting from CIDNET activities is with Midwest Universities for International Activities, Inc. The Program of Advanced Studies in Institution-Building and Technical Assistance Methodology (PASITAM) has initiated an exchange of materials with the MUSAT:sra Information Center such as the PASITAM Newsletter and other resources of the Documentation Center at Indiana University.

b. Reporting Year

Accomplishments in this Objective/Output have included the continuing process of research and personal contacts, linkages formed by project correspondence, cooperative projects, publications, CIDNET and AID referrals and continued participation in the African-American Institute and the Institute of International Education visitor programs. As evidenced by the cumulative accomplishments report, excellent prospects continue to point toward the development and establishment of an international document delivery program. This, however, implies expansion to cover developing areas in Africa, South and Central America, the Mideast and other applicable climatic regions.

Some new contacts established during the reporting year involved the International Council for Research in Agroforestry (ICRAF) through the Royal Tropical Institute in Amsterdam. The Council addresses itself to problems in agroforestry, which is defined as a sustainable management system for land which increases overall production, combines agricultural crops, tree crops and forest plants and/or animals, and applies management practices compatible with local population cultural patterns. ICRAF has expressed

great interest in services cooperation since they will be permanently located in a developing country where access to information is difficult.

The Société d'Etudes et de Développement Agricoles (SEDAGRI) in France supplies information and documentation for rural development in Africa. Services cover a question and answer service, an indexing service and a specialized information service of subject profiles. This will prove to be a valuable contact since SEDAGRI deals primarily with franco-phone Africa and plans also to cooperate with established African information centers. Information was exchanged with Miss Simone Argoud, Head of Documentation Services at the Institut de Recherches pour les Huiles et Oleagineux (IRHO) in France. Miss Argoud felt that IRHO activities overlapped ours in the fields of dryland farming, drought, irrigation and the oil crops of jojoba, peanuts, safflower and sesame. They will continue document exchanges in the future.

Through the African-American Institute (AAI) visitor program contacts were made with Mr. Koly Kourouma of the National Institute of Documentation and Scientific Research in Conakry, Guinea and Mr. Sekou Sissoko, Director of Agriculture, Ministry of Rural Development in Mali. Both visitors desire to maintain contact and to participate in our exchange program. The Institute of International Education (IIE) sent us Mr. Kamil Ali Mohamed, Press Relations Director for the Office of the President in Djibouti. Mr. Kamil is to be Djibouti's first representative to the United States. Djibouti, in northeast Africa, has a population of 100,000 with a dry and bare geography and sparse and erratic rainfall. The interest in our agricultural activities and information services is obvious, and we anticipate continued exchanges.

The Embassy of South Africa in Washington, D.C. arranged for a 2 day visit at UCR and our project for the study tour of C. P. Beyers and J. Volschenk, who are, respectively, Director of the Department of Agric. Technical Services, Soil Science Section, Winter Rainfall Region in Stellenbosch and Director, Dept. of Agric. Technical Services, College of Agric. and Research Institute in Potchefstroom. Mr. Beyers and Mr. Volschenk were interested in information on soil and plant nutrition and were genuinely interested in the organization and operation of our Information

Center. They will be utilizing our services in the near future as well as informing colleagues of our services.

An extension worker from Botswana, Mr. Timothy Mahlanza, consulted the Information Center to further his extension activities in the areas of dryland agriculture, crop production of cowpeas, and livestock production. Materials were sent to him on these topics.

Through CIDNET affiliation we were able to provide varied and numerous services such as for the recent 2 year livestock project in Upper Volta. It was also rewarding to note the increasing number of repeat clientele, that is organizations and individuals who have received information, specialized bibliographies and reference services in the past and are requesting new information.

Representative new associations made on a national basis included the Earth Satellite Corporation (EarthSat) of Washington, D.C. with search requests on groundwater and geology for projects in Upper Volta and Ghana. The Information Center has become a primary resource for this country for a new Mauritania project. The documentation phase of the research project is headed by Juliana Heyman for RAMS-Mauritania (Rural Assessment/Manpower Study). Most of our materials on Mauritania were filmed for reproduction by Ms. Heyman for utilization in a specialized documentation package. We also were provided with microfiche copies in the process.

The Southwest Research Institute in San Antonio, Texas is involved in a program to review and synthesize AID-sponsored research in the field of water resources management for agriculture. We were involved, along with the project research program, in interviews explaining and demonstrating our technical information systems. The team was supplied with information concerning the scope and content of our computerized information retrieval system and the preliminary run of the Resource Directory was used for their mailing list.

This past year has seen a marked increase in the number of inquiries from U.S. universities requesting detailed information on our data base and retrieval systems. Numerous specialized research projects with supporting documentaion systems are being established throughout the nation and, as a result of our publicity efforts, our activities are being reviewed as a

model. This has occurred with Kansas State University for grain storage literature, Ohio State University for expanding its programs to dryland agriculture in the Middle East, the University of Missouri-Columbia with a research project in atmospheric science for the Sahel and other semi-arid tropical regions of Africa, and the University of Dayton's Strategies for Responsible Development (SRD) group with an integrated agricultural development project in Niger.

Various national inquiries related directly to our network activities and resulted in additional service requests. The University of Pittsburgh included us in a major study of library resource-sharing networks to determine how networks may operate. The paper has been published and is available as "Resource Sharing Networks: Functions." Indiana University's International Development Institute Documentation Center director, Mr. Richard A. Steele, was particularly interested in our data base and Thesaurus.

In early May 1978 AID conducted a comprehensive four year review of our program. Materials and a Logical Framework Matrix were organized for the evaluation process and a discussion of and tour of the project Information Center was included. Results of the review have been favorable and, as a result, extensive planning is underway to prepare a new grant proposal focusing on the Information Center, objectives of which would include international document delivery through microfiche format and the full utilization of the resource collection of the CIDNET member universities.

This reporting year has seen the Information Center operating at peak level of services, and many of its potentials were realized through a wide variety of activities. In reviewing the statistical breakdown of services requested and delivered (see Appendix III-A) we are convinced that an expanded program based on a document delivery system will utilize the data base and retrieval services to utmost capabilities and outreach potentials.

A formalized working conference with CIDNET was initiated by the Program Director in September of 1977 to review and discuss CIDNET progress and to formulate plans for future activities and objectives. Discussion centered on the data bases which are continuing to be developed by each of the CIDNET member universities. All five data base conversion

procedures are completed and machine-readable search capabilities are available. CID provided funds to Arizona University and Utah State University to assist in getting their information on the TRIM system; Colorado University has been able to increase their TRIM output as a result of funds made available to them from local sources; Oregon State University has continued to develop its data base from AID 211(d) grant funds that will be available through 1980. Since the five data bases are completely searchable, means are being explored to use the total data base of CIDNET for a document delivery system designed for the developing countries. A microfiche system is being investigated for that system and a microfiche of the MUSAT:sra data base has been made and copies of it presented to CIDNET. This is a beginning point in developing a future program for an information delivery system to the developing countries.

c. Total Expenditures for the reporting year were \$21,967.00.

Bibliography for Objective/Output No. 2

Current Agricultural Research Information System (CARIS). Directory of Agricultural Research Institutions and Projects in West Africa, Rome, FAO, 1973.

A.I.D. A Directory of Institutional Resources Supported by Section 211(d) Grants - U.S. Centers of Competence for International Development. January, 1975.

African-American Institute. African Colleges and Universities: A digest of Information, New York, 1970.

C. Objective/Output No. 3: Improved Research Capability and Increased Knowledge Base

1. Narrative Description

During the fourth year, progress toward fulfilling this Objective/Output remains closely tied to progress in Objective/Output No. 1. The State of the Art review is one of the primary concerns of the project during this period, and this involves a survey of research done to date; the rapidly growing collection and bibliographic data base are vital to its

success. The overall problem of agricultural improvement in the semi-arid tropics has been divided into specific areas, each of which will constitute the focus of study by project team members. At present the foci comprise: the history of dryland farming systems; principles relating to dryland farming; climatology; soil characteristics (physical, chemical, morphological and microbiological); crop adaptation; soil-plant-atmosphere continuum of water; crop management; soil management; water harvesting; erosion control and windbreaks; pest management (including entomology, disease control and weed control).

From study of these problem areas specific topics of research in cowpeas have emerged which present themselves as areas of particular importance and/or areas where little research has been done to date. Emphasis will be placed on the investigation of techniques feasible for adaptation to Sahelian conditions.

2. Targets for the Reporting Year

- a. To complete the State of the Art Review and submit it to the publisher.
- b. To continue research problems on cowpeas identified and implemented in the third year, and to begin some new studies relating to cowpea production.
- c. To continue identification of research projects based on the State of the Art and from information gained from projects underway at UCR and in the development countries as well as other sources related to program objectives.

The magnitude of accomplishment expected from the research studies are the beginning steps of what will be a major part of the project's long term work in the developing countries. The State of the Art review is expected to be complete at the 48-month mark, and all of the targets for this reporting year are in a maturing stage.

Assumptions critical to the success of these targets were:

- 1) that the Information Resources Team would be able to assemble in usable form the bulk of published and report material essential for the State of the Art review;
- 2) that practical and feasible research problems whose solutions are likely to make a real impact on the overall problem would become

evident in the course of making the State of the Art review and in team program efforts.

The means of verifying progress made in this category would be the initiation of projects both on-campus and in the Sahel, and completion of the State of the Art review and other publications. However, on-site visitation, discussion with appropriate staff members, and the Annual Report, coupled with various in-house reports give evidence of progress.

3. Accomplishments

a. Accumulative - The reporting year is the fourth of the program and accumulative accomplishments must be based on initial Project planning during the first year.

1. The Research Team is using information gained in the literature review, visits with foreign country scientists, and a methodology approach to graduate student training in field research planned field programs centered on cowpeas (Vigna unguiculata L.). Two projects were planned and initiated on the UCR campus in the third year under the topic title "Research and Training in Crop Response to Water and Evaluating Drought Resistance." The projects entitled "Evaluating drought resistance of cowpeas," and "Soil water use, evapotranspiration and root development of cowpeas under varying stress" are continuing. Some of the field studies were repeated during the summer of the fourth year. A study to determine vigor and efficiency of cowpea root systems initiated in the third year in greenhouse and field studies is continuing and a new greenhouse study on root systems and soil barriers is underway.
2. During the team trip into France and West Africa, discussion focused on cooperative projects with French researchers and ministers of agriculture and development in Mali, Senegal and Upper Volta, with IITA in Nigeria, and with IAR in Nigeria. From these discussions and those later with the Program Director, two cooperative projects were planned and initiated; these are entitled "Perception and management of semi-arid indigenous agricultural systems," and "Quantitative analysis of

of dryland farming systems in semi-arid regions of Africa," and were located in Upper Volta and Senegal respectively. The study in Upper Volta was completed in December 1977 and the data from this study is now being processed into publications and a Ph.D. thesis.

3. Other types of exchange projects involving faculty and French researchers are continuing with the aim of broadening the knowledge of UCR faculty.

b. Reporting Year - Although it is difficult to quantify gains in research capability, an indication can be gained from implementation of projects, faculty involved, and graduate student project progress and publications as follows:

1. The project in Upper Volta was initiated in early June 1976; studies were centered north and east of Ouahigouya and focused on three tribal groups: the Fulse, which is the oldest farming group in Upper Volta, the Peulh, a mixed sedentary-nomadic group, and the Mossi, the largest farming group in Upper Volta.
2. Project plans were completed for the Senegal project with ISRA in early 1976 and implemented in October with CNRA-Bambey, Senegal. Cooperation in this study involves French and Senegalese researchers and the Senegalese government. This is a continuing study and will result in future programs in Senegal if funding is available.
3. Projects designed to study cowpeas on the UCR campus that have relevance to crop production in the semi-arid tropics were initiated in May 1975 and continued in the summers of 1976 and 1977. Six faculty and six graduate students are conducting the studies and the information resulting from these studies will be applied to projects in the Sahel.
4. Studies are continuing with the graduate course "Modeling soil-Plant-Atmosphere Relations," with the objective on a research basis to improve the models to be used in conducting the Senegal studies.

Another aspect of Objective/Output No. 3 (linked with Objective/Output No. 5) is comprised of the dissertation research proposals of graduate students in the program. At present seven graduate students--two in the Department of Botany and Plant Sciences and five in the Department of Soil and Environmental Sciences, are working on project-related dissertation research. Each student is involved in the field research on cowpeas which provides him with a background in applied research, and each must also satisfy the UCR requirements and complete a basic research study. The field study and basic components of the research are designed to meet the training and research capabilities to be applied to crop production in the semi-arid tropics.

c. Total Expenditures for the reporting year were \$105,874.02.

D. Objective/Output No. 4: Increased Advisory Capacity

1. Narrative Description - Advisory functions were defined by the Educational Training and Advisory Team to include problem identification and analysis, program or Project design, and Project operation, which may include education, training, research, technical services, and evaluation. The Educational Training and Advisory Team works closely with the Information Resources Team, and in this reporting period most requests have been answered with bibliographic data. It is expected that as the research competence in the area of semi-arid tropical zone agriculture grows, and as the UCR faculty become known as a talent pool for this region, agencies in the developing countries and elsewhere will call upon this project for advisory purposes.

Another aspect of advisory capacity is the training of personnel on this campus. Much of the fourth year has been spent in orientation of the Project team members and other affiliated personnel on-campus to conditions and problems of the Sahel region and of the semi-arid tropical areas in general. In the past four years several seminars and lectures have been held, films have been shown, general reading suggested, and visiting professors and post-doctorals have added to the training. These activities

are largely introductory in nature, outlining to those attending the various aspects either of agriculture in the semi-arid tropics, or specific conditions and problems of the Sahel area. Projects in the Sahel and visits to these and other areas by several faculty have increased the knowledge base on problems in the semi-arid tropic regions.

Training of Project personnel also has included instruction in the French language, beginning with a crash course for the travel team which went to West Africa in the first year. Graduate students who intend to pursue research overseas, and all Project staff, are encouraged to work toward verbal and reading ability in French and teaching materials in the form of the Living Language cassette tape and book system were purchased and a collection of French-African agricultural materials is being accumulated.

2. Targets for the Reporting Year

- a. Orientation and training program personnel through on-campus activities and with projects in the semi-arid regions.
- b. Fulfillment of information requests as received.
- c. Publicizing and using advisory capacity as these capabilities increase.

Magnitude of progress toward reaching these targets is necessarily low because of the nature of the targets and the individual faculty time that can be assigned to the program. As was intended, beginning and preliminary steps in these directions have been taken, with maturing of the efforts to take place at later stages of the program.

An assumption critical to the fulfillment of these targets is:

- 1) that developing countries and organizations working in these regions will in fact seek out and accept advice from UCR.

Means of verifying progress made toward these targets could include evidence of the programs held and requests fulfilled, as indicated in in-house reports and records, as well as the Annual Report.

3. Accomplishments

a. Accumulative - The reporting year is the fourth year of the Project and accumulative accomplishments include: seminars, lectures, film programs and informal meetings with visitors recorded below.

- 2 December 1974 - Mr. Volney M. Douglas, Range Ecologist, Seminar: "An Ecologist's View of the Sahel."
- 5 December 1974 - D. Wynne Thorne, Vice President for Research and Director of Utah State University Experiment Station, Seminar: "Research Programs of International Crops Research Institute for Semi-Arid Tropics."
- 2 May 1975 - Bert A. Krantz, Agronomist, ICRISAT, Hyderabad, India, Seminar: "Farming Systems Research for the Semi-Arid Tropics of the World."
- 27 May 1975 - Film: The Bend of the Niger.
- 28 May 1975 - Films: The Fulbe of M'Bantou; Maninka Villages; Trade and Markets in West Africa; and short anthropological films.
- 13 August 1975 - Captain Sekou Ly, Major of Bamako, Mali. Informal seminar with Project members and other faculty of the Soil & Environmental Sciences and Botany & Plant Sciences departments.
- 8 September 1975 - Josephine Guissou, Rural Sociologist of the Société Africaine d'Etudes et de Développement (SAED), Ouagadougou, Upper Volta: Informal seminar with Project members and faculty of the departments of Social Sciences, Botany & Plant Sciences, Anthropology, and Black Studies and the Women's Resource Center.
- 24 September 1975 - Dr. William O. Pruitt, Water Science & Engineering, UC Davis, Seminar: "Predicting Crop Water Requirements--Worldwide and Southern California."
- 23 October 1975 - Dr. E. A. Hurd, Senior Research Scientist, Agriculture, Saskatchewan, Canada: Slides and lecture-seminar on "Agriculture in East Africa."

- 17 February 1976 - Dr. Howard M. Taylor, USDA-ARS, Iowa State University, Seminar: "Soil moisture utilization in semi-arid tropics from summer rainfall."
- 15 April 1976 - John Buursink, CIEH, Ouagadougou, Upper Volta: visited Information Center and met with Project members.
- 17-19 June 1976 - Soumana Traore, Director of SAED, Ouagadougou, Upper Volta. Met with Project members, consulted Information Center, visited drip irrigation projects, groves, chicken ranches and vegetable production areas.
- 15 May 1976 - Al Levinson, Giannini Foundation, UC Berkeley: consulted Information Center.
- 3 May 1976 - John Pearson of Cal Poly Pomona: consulted Information Center.
- 5 May 1976 - Charles Rosenberg, Giannini Foundation, UC Berkeley: consulted Information Center.
- 27 July 1976 - Peter Felker, Dept. of Botany & Plant Pathology, Michigan State University, Seminar: "The Potential of Leguminous Trees for Food Sources in Semi-Arid Countries."
- 21 November- 3 December 1976 - Dr. J. F. Poulain, IRAT, Upper Volta visited and consulted the Information Center collection at length. He donated many valuable research papers and documents to the collection.
- 3 December 1976 - Dr. J. F. Poulain, Agronomist, IRAT, Upper Volta, Seminar: "Overview of French Research in the Sahel-Sudan Zone."
- 9 December 1976 - Dr. J. F. Poulain, Agronomist, IRAT, Upper Volta, Seminar: "Soil Fertility Studies in Crop Production in the Sahelian-Sudano Zone of West Africa."
- 16 December 1976 - Dr. J. F. Poulain, Agronomist, IRAT, Upper Volta, Seminar: "A Systems Approach to Soil Mapping and Agronomy."
- 6 January 1977 - Mr. Fred R. Weber, Consulting Engineer, International Resources Development and Conservation Services, Boise, Idaho, Seminar: "Physical and Cultural Constraints of Irrigation in the Sahel."

- 15-16 January 1977 - Ms. Emily Candelmo and Mr. Krissiamba Ali of the Tippetts-Abbett-McCarthy-Stratton Agricultural Development Group for information regarding our resources and procedures. As a result the exchange of information has aided the work of TAMS to develop a major documentation center in Upper Volta for the Interafrican Committee for Hydraulic Studies.
- 3 March 1977 - Dr. Michel Luc, National Museum of Natural History of Paris, France: Seminar "Crop Protection in West Africa."
- 14 March 1977 - Dr. A. E. Hall, UCR Department of Botany & Plant Sciences, Seminar: "Improving the stability of crop production in semi-arid West Africa."
- 28 April 1977 - Dr. Michel Luc, National Museum of Natural History, Paris, France: Seminar "Nematode Problems in West Africa."
- 22-23 April 1977 - Dr. Gora Beye, Centre National de Recherches Agronomiques (CNRA in Senegal, attended Project Symposium, met with researchers and consulted Information Center.
- 15 June 1977 - Koke Dembele, Governor, Region of Gao, Mali; consulted Information Center and expressed a desire to participate in document exchange program.
- 25 June 1977 - Mrs. Janina H. Bard, International Irrigation Information Center, Volcani Center, Israel, consulted Information Center.
- 20 October 1977 - Mr. Peter Shouse, graduate student in the UCR Department of Soil & Environmental Sciences: seminar "The Effects of Systematic Water Deficits on Blackeye Peas."
- 27 October 1977 - Mr. Robert Zablotowicz, graduate students in the UCR Soil & Environmental Sciences department - seminar: "Field study of nodulation in California-grown cowpeas."
- 7 November 1977 - Mr. David Gipson, graduate student in the UCR department of Soil & Environmental Sciences - seminar: "Interaction between salinity and plant roots."
- 28 November 1977 - Mr. Peter Shouse, graduate student in UCR's department of Soil & Environmental Sciences - seminar: "Field studies of chemical transport."

- 15 November 1977 - Mr. Peter Shouse, graduate student, UCR Department of Soil & Environmental Sciences. Seminar "Effect of Systematic Water Deficits on Yield of Blackeyed Peas," at the American Society of Agronomy meeting in Los Angeles, California.
- 17 November 1977 - Mr. Robert Zablotowicz, graduate student, UCR Department of Soil & Environmental Sciences. Seminar "Field Study of Nodulation in California-grown Cowpeas under Normal and Drought Conditions" at the American Society of Agronomy meeting in Los Angeles, California.
- 7 December 1977 - Mr. Koly Kourouma, Director of Division of Exact Sciences, National Institute of Documentation and Scientific Research, Conakry, Guinea, consulted Information Center and toured campus citrus groves and field activities.
- 26 January 1978 - M. Yves Demeure of ORSTOM, Dakar, Senegal - Seminar "Effects of soil temperature and moisture on nematodes in the root zone."
- 9 February 1978 - Mr. Sekou Sissoko, Director of Agriculture, Ministry of Rural Development in Mali, visited Information Center and discussed campus research activities and information exchange.
- April-June 1978 - Mr. Moctar Toure of the Institut Senegalais de Recherches Agricoles (ISRA), Rice Research Station of Djibelor, Senegal, consulted the Information Center collection at length.
- 30 May 1978 - M. Yves Demeure of ORSTOM, Dakar, Senegal: Seminar "Anhydrobiosis in nematodes."
- 20 June 1978 - Marion DeBossu of the World Health Organization (WHO) in Switzerland, consulted Information Center
- 28 June 1978 - Dr. D.P. Taylor, Head of Nematology Laboratory, ORSTOM, Dakar, Senegal, consulted Information Center and met with Project Director.

Through this part of the program the program staff has had the opportunity to learn of the research being conducted at various international centers within the West African countries and to see a vivid picture of the problems concerned with semi-arid regions. The State Department's International Visitor List has been helpful in locating visitors from the Sahel who have considerable relevance to the program. These visitors have participated in an informal lecture/question-answer type of program and have thus provided a broad spectrum of the problems and living conditions in the Sahel.

Introduction to French conversational language courses for the travel team into West Africa included the Living Language French course, extracts of French texts on agronomy and related activities, and manuscripts acquired from IRAT and ORSTOM. Tutors and the opportunity to attend specialized French language training are made available to faculty and staff.

The team travel into France and West Africa during the second program year proved to be a very worthwhile experience for increasing the knowledge base, establishing worldwide linkages, developing project ideas, and learning firsthand the agricultural and educational problems facing the Sahel countries.

Perhaps the most appealing aspect of this travel has been the encouraging, cooperative attitude of the French headquarters staff in Paris, their researchers in West Africa, the Ministers of Agriculture and Development of the Sahel countries, IITA, and the USAID Mission staff in Senegal and Upper Volta.

The following programs, originated in the second year of the program and implemented in the third year, indicate the linkage support previously mentioned, and give the project a strong base for improving and increasing the Advisory Capacity:

1. Two exchange-type projects were arranged with IRAT and ORSTOM. The first brought Dr. F. Poulain, an Agronomist of IRAT-Upper Volta, to the UCR campus in November 1977. He presented a series of seminars on soil fertility studies in the semi-arid tropics and the material presented will be published as part of the cooperative project. The second exchange-type program involved Dr. M. Luc, ORSTOM, Museum National d'Histoire Naturelle, Laboratoire de Zoologie, Paris. A nematologist, Dr. Luc

has spent many years in West Africa and is head of the Nematology and Microbiology overseas section of ORSTOM. He spent a six-month sabbatical leave at Riverside, providing a teaching element and an information base on nematology in the semi-arid West Africa region.

2. Project team members have been involved in the Soils Benchmark Project headquartered at the University of Hawaii at Manoa, coordinating activities in surveying soils in West Africa as part of the Benchmark program global plan.

3. "An International Symposium on Rainfed Agriculture in Semi-Arid Regions" was jointly sponsored by UCR and Oregon State University and the Consortium of Arid Lands Institutes (CALI). UCR was responsible for the semi-arid tropics with summer rainfall, OSU for the mediterranean-type regions with winter rainfall, and CALI in a supporting role. The Symposium was held April 17-22, 1977 in facilities adjacent to the UCR campus and included some activities on-campus and a two-day field trip in Southern California.

4. Three faculty members were supported on trips; two attended and presented papers at the International Soil Science meetings in Israel and then visited in the Sudan, and the third initiated a cooperative program with ISRA in Senegal on water balance studies in crop production.

5. Miss Claire Hill, a former UCR student, worked as a translator for the MUSAT:sra program, working part time translating needed materials for various projects, assisting with the Information Center collection of materials and maps, and assisting staff members on particular problems involving projects in Upper Volta and Senegal. She worked closely with ORSTOM staff on translation of their papers for the Symposium.

6. Slide sets and other audio-visual materials are being compiled of material taken during various trips to West Africa and these have been duplicated, recorded and arranged to provide the basis for lectures

and other presentations. Film catalogs have been collected and lists of films dealing with the Sahel region have been compiled from these catalogs. Several films have been shown on campus and others will be arranged as time and circumstances permit.

b. Reporting Year

The worldwide linkages previously established that relate to program advisory activities have been strengthened with exchange of information, visits to various areas for program planning, presentation of materials at national and international meetings of material developed at UCR and in the developing country projects, a continuation of the scientist exchange program and other activities. These are summarized as follows:

- 1) MUSAT:sra staff travel for program planning. The Program Director has traveled to Senegal, Upper Volta and France to discuss and further develop program planning with ORSTOM, ISRA/CNRA, ICRISAT (West African Headquarters at Dakar and Research Station at Kambose, Upper Volta), IRAT in Upper Volta and the AID Missions in Senegal and Upper Volta, and various other organizations within these countries that had access to information on Acacia albida. (See Appendix V).
- 2) Cooperative plans previously arranged with ORSTOM and the UCR Department of Nematology were completed and Dr. Yves Demeure of ORSTOM Laboratories at Dakar spent the year working at UCR on nematology problems related to semi-arid soils. A copy of Dr. Demeure's study report is in Appendix V. Plans have been made to continue the scientist exchange program during the fifth program year and as a result a UCR Nematologist will spend a year at Dakar and an ORSTOM Nematologist will come to UCR.
- 3) Dr. S. Van Gundy attended and presented materials at a meeting in Cairo, Egypt. (See report in Appendix V).
- 4) Several UCR graduate students have presented papers at national society meetings on cowpea studies. (See listing of Seminars, Films and Visitors.)

5) Program staff visited Senegal to develop a cowpea project in cooperation with ISRA/CNRA, IITA and UCR.

6) Editing has been completed on the "Proceedings of an International Symposium on Rainfed Agriculture in Semi-Arid Tropics" and publication has been arranged. Plans are to distribute these Proceedings on a wide scale in late summer of 1978. Copies may be obtained through the UCR Department of Soil & Environmental Sciences, Riverside, California 92521 or through Dr. Stanley Miller, 211(d) Grant Director, Oregon State University, Corvallis, Oregon 93711.

7) The State of the Art review on Agriculture in Semi-Arid Environments has been completed and submitted to Springer-Verlag & Co. for publication. This will appear as part of their Ecological Studies Series.

8) "State of the Art: Acacia albida as a complementary permanent intercrop with annual crops" has been completed. A condensed summary is in Appendix V.

9) A film of the MUSAT:sra program, entitled "New Directions in Dryland Farming," was completed by the International Communication Agency (ICN) in the summer of 1978. ICN (formerly U.S. Information Agency) has produced the film in English and French and it is now available for showing in the developing countries. A good part of the film centers on cowpea field research being conducted as part of the MUSAT:sra program. In particular, it shows how U.S. universities can fit into a research program that is adaptable to the developing countries. Much of the data obtained from the applied field research conducted at UCR is adaptable to the semi-arid tropic regions because of the hot, dry summers of the UCR area, and this allows use of a simulation technique of sprinkler irrigation to study plant growth and fruiting characteristics under various soil-water conditions. Because of the equipment, facilities and research personnel available at U.S. universities, basic research relative to production problems in the developing countries can be carried out simultaneously with the field research.

c. Total Expenditures for the reporting year were \$46,696.09.

E. Objective/Output No. 5: Educational Capabilities in Dryland Moisture Conservation and Utilization

1. Narrative Description

At an early meeting of the Curriculum Development Team, a core of curriculum courses already offered at UCR which deal with problems related to the Project, or which could be modified to fit into Project-related areas, was itemized. Two new courses have been added to this list: an introduction to soil science, and a field study of California soils, mapping and classification, in cooperation with the University of California at Davis.

Soil Science 100	Introduction to Soil Science
Soil Science 104	Soil Chemistry
Soil Science 105	Summer Field Course
Soil Science 107	Soil Physics
Soil Science 111	Soil Microbiology and Biochemistry
Soil Science 118	Soil Morphology
Soil Science 103	Soil Fertility
Soil Science 206 (A & B)	Principles and Theories Relating to Arid Zone Soils
Soil Science 208	Soil Physical Conditions & Plant Growth
Plant Science 103	Ecology of Crop Plants
Plant Science 104	Physiology of Crop Plants
Plant Science 120	Grasses & Grasslands
Plant Breeding 150	Plant Breeding

Discussion has been underway for the possible addition of new courses to the present curriculum, or the presentation of special topics within existing course structures, in order to widen the education element of the Project. Care is being taken in planning so that such courses would be

appropriate to UCR's overall program goals and would fit in with University-wide curriculum planning. General topics of new courses or modifications of existing courses are:

1. irrigation and drainage
2. soil management, with emphasis on field crops
3. agricultural resources development
4. field crop production (cereals, legumes, oil seed crops)
5. field plot design (enlargement of Plant Sciences 149)

Several graduate students began their studies in Project-related research topics during the second and third years of the grant; no new students were selected for graduate studies during the fourth year because of the time limit in finishing the graduate degree before the grant ends during the fifth year.

2. Targets for the Reporting Year

a. To encourage the graduate students that were accepted into the program during the second year to complete their research, present materials at society meetings, and to prepare materials for publication.

b. To continue expansion and modification of the course offerings at UCR to include course work related to agriculture in the semi-arid tropics.

c. To continue obtaining and evaluating curriculum information from other universities in the semi-arid dryland regions of the U.S. and in the developing countries. When faculty members visit areas where contacts can be made with universities or other institutions in the developing countries that relate to education training, information will be exchanged and encouragement given to consider the graduate program being developed at UCR for training their students.

The magnitude of fulfillment of these targets is progressing on a satisfactory basis: good graduate students with an international interest, and a few with international experience have been selected; all are conducting research oriented to the Project objectives, and each is being guided by an established faculty member with interest in the Project.

At this point only one new course has been established: "Modeling soil-plant atmospheres." Modifications of existing core courses or new courses to strengthen the existing ones have been made, and meetings involving the departments of Botany & Plant Sciences and Soil & Environmental Sciences are continuing toward this goal. Information gathered from various U.S. universities (semi-arid zones) on course structure indicates that students interested in dryland agriculture are being served by core structure courses rather than by a separate curriculum; a report by one of our faculty who visited the University of Khartoum shows the same trend. Careful evaluation of courses and their value in training students from the developing countries is the desired target for the reporting year.

An assumption critical to the success of the targets is that increasing numbers of students both from the U.S. and the developing countries will be interested in graduate programs at UCR and the educational offerings that are relevant to dryland agriculture in low rainfall regions of the world.

Means of verifying progress made would include on-site visitation, including sitting in on classes, and in-house reports as well as the Annual Reports.

3. Accomplishments

a. The reporting year is the fourth of the Project. One new course, entitled "Modeling Soil-Plant-Atmosphere Systems" was developed in the second year of the grant and jointly offered as Plant Science 205 and Soil Science 205. In this course students conduct analyses on the computer with mathematical models programmed by the instructors on the quantitative treatment of water relations, temperature relations, and gaseous exchanges in soil-plant-atmosphere systems. Students develop and program their own mathematical models that are related to crop production in the semi-arid tropics.

The core of courses now available to graduate students and the experience gained through field research on cowpeas has given the MUSAT:sra faculty a new dimension in training foreign students to fit into an applied research program on their return home. In the past foreign students have

received basic training in research often not related to research needs in their home countries. A field research program will eliminate this negative aspect of graduate training which had been mentioned by visiting scientists from the developing countries.

b. For the Reporting Year

Of considerable importance in developing a curriculum for training students in dryland agriculture is the design of field courses that will give the student maximum exposure to practical problems. Discussion of team members has centered on approaches and methods, and some priority in development of the curriculum has been given to this aspect.

Specific courses have not been developed for field studies in training of students; for the design of experiments the general approach is obtained in courses in statistics and a field approach is provided in Plant Breeding 150. With these courses and field experiment design provided to the student by his advisor, a tested and satisfactory method of training students in experimental design has been developed. A good example of this is the M.S. thesis completed in the fall of 1976 by one of the students in the program entitled "Root growth of cowpeas as affected by soil physical properties and water stress." The student gained field experience in experimental design, soil physical properties and their measurement, experience in developing a root washing device and a root counting instrument, measurement of root lengths, soil root distribution and aeration and, finally, evaluating the factors related to root growth of cowpeas in a field situation involving several variables. This person is now working with a church organization in Upper Volta on a development project.

Each graduate student in the program is involved in a field research program and is gaining valuable experience in applied methods in crop production. This field research approach was incepted during the second year of the program. Research data from these studies and completion of theses and publications are being evaluated to determine its use as a model in curriculum development for foreign graduate students and future training in research for dryland farming.

It has been the contention of the Curriculum Development Team that key members of the faculty of Botany & Plant Sciences and Soil & Environmental Sciences should have the opportunity to visit other universities in the U.S. and appropriate developing country universities that may have curricula that relate to MUSAT:sra program objectives. Following written communication with universities in the semi-arid regions of the U.S., visits were made by faculty to several universities to discuss curriculum development. There were no prescribed curricula at these institutions that dealt directly with students interested in dryland agriculture; each university relied on their basic courses in soils, agronomy, plant sciences or other curriculum in areas to fulfill the needs of students.

A visit was made to the University of Dakar in connection with the Acacia albida State of the Art study as a follow-up to suggestions by the Director of CNRA in Senegal that some biological science students interested in graduate training may have an interest in an agricultural program at Riverside. There is some interest but nothing concrete has developed from this approach.

C. Total expenditures for the reporting year were \$1,450.04.

IV. IMPACT OF GRANT SUPPORTED ACTIVITIES IN ACHIEVING GRANT PURPOSE

A. Objective/Output No. 1: Central Information System

Bibliographic information resources are the backbone of research and educational activities. In order to support grant efforts in building institutional capacity for research and consultation, MUSAT:sra has accumulated a large and comprehensive collection of material dealing with all facets of agriculture in the Sahel and in other semi-arid tropical regions. Members of the UCR academic community and visitors to UCR have access to this collection through the indexes of the computerized bibliographic data base; access is supplied by subject, geographic area, author and title. Computer searches can be run to compile lists of material dealing with specific combinations of topics; for instance, insect pests of sorghum in

West Africa. UCR users and area visitors can browse in the Project Information Center which houses the collection of reports, reprints and special maps. Other materials are available in the campus libraries.

The immediate evidence of the impact of the information system on grant purpose can be identified with the following:

1) Completion of the State of the Art on Agriculture in Semi-Arid Environments which has been accepted for publication by Springer-Verlag & Co. This study involved eighteen faculty as authors, and three of these acted as editors. The Information Center was directly responsible for assembling information on the semi-arid regions for the authors. Most of this information was readily available from materials compiled during the first three years of the program, and supplemented by new material compiled during the reporting year.

2) The research program on cowpeas, participation by MUSAT:sra staff in the International Symposium on Rainfed Agriculture in Semi-Arid Regions, and publications related to the research.

3) MUSAT:sra publication covering the Geographical Index developed by the Information Center and published by G. K. Hall Publishing Co. The effect of the publication as a result of its purchase and use on a worldwide basis has been a strong influence in developing worldwide linkages and in providing useful information to many organizations through the services provided by the Information Center.

4) CIDNET. The development of this organization through the continued efforts of the MUSAT:sra Director and the program Librarian in its development has provided a much broader based information base than the MUSAT:sra Information Center can provide. This added dimension can have a strong impact on many developing countries provided future funding can be obtained to continue CIDNET as a center to provide information to these countries. Proposed projects by MUSAT:sra staff are being developed to make possible document delivery to the developing countries.

5) Statistical data accumulated in the Information Center. The number of requests for information, their origin, types of information needed, organizations requesting information, outside visitors and local

staff use of the Center are a direct indication of the impact on achieving grant purpose. (See Appendix I, II, III, and IV).

6) The growth of the Information Center as indicated by the number of entries. The entries are selected through cooperation with the MUSAT: sra staff in defining areas as well as valuable publications that fit into the objectives of the projects. The collection also has many research reports, symposium publications and many other materials not usually found in a general library. These, along with a significant map collection and scientific publications, comprise a collection at present of about 15,000 entries. With the CIDNET entries, a data base comprising 29,000 entries is available and completely searchable.

B. Objective/Output No. 2: Network of Worldwide Linkages

There is considerable interest in the United States and internationally in the problems and development potential of the semi-arid tropics. The specific targets of the grant in this area are: developing cooperative liaison with governments and organizations and, where applicable, their parent organizations in the developed countries. The dual role of the Information Center and personal contacts with governments, organizations, institutions and other groups is an indicator of development of worldwide linkages.

A composite listing of the linkages is given in Appendix IV . The following are other indications of the impact of the grant in achieving the grant purpose:

1) Projects in developing countries. One project in Upper Volta, entitled "Perception and management of semi-arid indigenous agriculture systems," has been completed. This project has been used as a means for training of staff through visitation to the villages sites and as an information source to plan future projects in the West African semi-arid tropics. A second project, entitled "Quantitative analysis of dry-farming systems in semi-arid regions of Africa" was undertaken in Senegal in 1976. This is a continuing project with research input being contributed by scientists from both Senegal and UCR.

2) Exchange scientist program with ORSTOM and the developing countries. A solid linkage with UCR has been established by this program which will be helpful in implementing needed projects in the semi-arid tropics of Africa. Reports, publications, and letters from ORSTOM headquarters indicate an impact from these activities on the grant purpose and their research programs in Africa.

3) International Research Centers, ICRISAT and IITA, have continued to be a part of the linkage developed early in the grant. Cooperation with ICRISAT in Upper Volta in 1977 on cowpea and sorghum plots, and with IITA on program planning with cowpeas, shows a continued interest by these organizations in a cooperative relationship with UCR in project design, information exchange, and project development and implementation in the semi-arid tropics.

4) Development of a directory entitled "A Resource Directory for Agricultural Research in Semi-Arid Regions." This publication will be available worldwide, and provides an outlet for linkages with UCR and research scientists, research centers and organizations concerned with international development. The previous publication, a geographical bibliographic index entitled "Moisture Utilization in the Semi-Arid Tropics," has had a worldwide impact on the purpose of the grant in developing linkages.

The linkages developed by contacts, and projects originating from these linkages, come closest to the underlying philosophy of the grant purpose: to develop means of improving conditions in this area in a way that directly involves the people living there, that takes into account the reality of life there in its many facets, and does not simply present theoretical or technical recommendations which are in fact impractical and unacceptable.

The first three years of the grant paved the way for close and cooperative linkages, and many of these have matured in the fourth year. These linkages provide the basis for future progress in all other program areas for future projects.

C. Objective Output No. 3: Improved Research Capability and Increased Knowledge Base

Although each of the objective/outputs serves as a link in overall development of the grant purpose, the improvement and development of a core of program research staff that will be involved in projects in the semi-arid tropics is the key to reaching the grant purpose.

The selection of cowpeas as a major crop in which to build competence of the research staff for development purposes has proved to be a valuable training base. The breadth of cowpea projects related to the interests of the program staff have involved: soil-water-plant relations, symbiotic nitrogen fixation, cowpea breeding, cowpea root systems as a function of variety and soil conditions, and modeling studies related to plant growth and yield at Riverside and in Senegal.

The cowpea studies have been supplemented with information gained from the indigenous studies conducted in Upper Volta on farming systems and methods. Although the data from these studies have not been completely analyzed, information on planting dates, soils within the village areas where cowpeas are planted, insect and disease damage, and yields will be available.

The graduate students projects with field and basic research studies have greatly aided in the training of grant program staff. New approaches to research have been gained from data obtained in the graduate programs and new projects were undertaken from this source during the fourth year. These studies will be extended into the last year of the grant.

The experience gained from the research projects has had a strong impact on the grant purpose. A research and development draft proposal prepared in June 1978 with representatives of the Senegal government and IITA as the major cooperators with UCR was made possible through research in Senegal, with IITA in Upper Volta and at UCR. IITA is located with ICRISAT in Upper Volta and is testing varieties in many areas of Upper Volta under various rainfall and soil conditions.

Research publications, faculty and graduate student activities in presenting research data at society meetings, participation in the Interna-

tional Symposium on Rainfed Agriculture in Semi-Arid Regions held at Riverside, and completion of the State of the Art on Agriculture in Semi-Arid Environments and its acceptance for publication attest to the impact of research on the grant purpose.

D. Objective/Output No. 4: Increased Advisory Capacity

Progress has been made in several directions in developing program staff in advisory capabilities. Program research staff and others have been provided opportunities with grant funds to learn about agricultural conditions in semi-arid tropic climates through travel, by attending and participating in international meetings, and by other activities in development programs. Reading lists, lectures, films, and special materials (made available through the Information Center) have provided a learning base for program staff concerning the semi-arid tropic regions.

The scientist exchange program developed in the second year of the grant with ORSTOM and IRAT and developing country organizations has proved to be a fruitful means for increasing advisory capacity. The cooperative programs with Senegal and Upper Volta and with ICRISAT and IITA in those countries have provided program staff with advisory opportunities in developing countries.

Although the various methods described for increasing advisory capacity have been beneficial, the desired impact on the grant purpose of preparing scientists for advisory purposes has not been met. The assumption was made in the grant that AID would provide opportunities for program staff to attain experience through assignments in the developing countries, and thus improve their advisory capacity. Only two opportunities have been provided by AID--to attend meetings--and no opportunities with teams that are sent into the developing countries to assess problems and prepare proposals. CID has provided some opportunities for increasing advisory capacity and experience in developing proposals for projects in developing countries.

Some Title XII programs are now in operation. The planning grant for the bean and cowpea CRSP (Cooperative Research Support Program) is

being developed, and proposals will be accepted in the near future. UCR plans to submit a proposal to include production of cowpeas in the semi-arid tropics of West Africa. Some opportunities may be provided for increasing advisory capacity in developing programs for these areas.

E. Objective/Output No. 5: Education Capabilities in Dryland Moisture Conservation and Utilization

With the addition of some new courses and revision of other courses in soil science and plant science, and with the development of field research studies, UCR is now in a position to train graduate students from semi-arid regions in agriculture. Since the grant does not support foreign students in graduate work at UCR the program has not had an opportunity to work with students from the dryland farming areas. This aspect will be developed in Title XII projects.

The program staff, with experience gained in the field research studies, is prepared for special training of foreign scientists on short term assignments. Offers for this type of training have been made to Mali, Senegal and Upper Volta; nothing has transpired from these offers because the number of scientists in these areas is extremely limited and their positions are vital to their programs, and arranging for a time when they can be at UCR for special training is difficult.

The curriculum as it is now constituted, including the field research program, is considered to be developed sufficiently for graduate training of foreign students. The practical aspect of the program should be appealing to the governments of the developing countries, since this is the greatest need in implementing their agricultural programs. We believe the objectives for this part of the grant have been met and that the impact on grant purpose will be realized in future years.

V. OTHER RESOURCES FOR GRANT-RELATED ACTIVITIES

See Section IX, page 66 for use of other resources.

VI. UTILIZATION OF INSTITUTIONAL RESPONSE CAPABILITIES IN DEVELOPMENT PROGRAMS

A. Requests for Assistance

Because of increased publicity of the Project, and because of the unique nature of the Information Center's collection and services, many requests for bibliographic and reference assistance were received during the reporting year. These requests covered a wide range of topics, and sometimes dealt with geographic areas outside of MUSAT:sra's scope. All requests were acted upon, however, and many were circulated among the CIDNET centers for further reference efforts.

In addition to these formal requests for materials and bibliographies, a number of exchange programs have been established. In any library collection duplicate copies of books and articles are often unavoidable, and these are offered on exchange to other institutions. In addition, publications can sometimes be ordered specifically to provide MUSAT:sra's part of the exchange agreement. This can be particularly helpful in the case of developing country libraries, who often experience difficulties in obtaining some U.S. publications. Exchange agreements have been established with the University of Ibadan, IITA, and the Institute of Agricultural Research at Samaru, among many others.

Only a few requests for problem evaluation and planning-type programs in developing countries were received during the reporting year. These were concerned with programs such as agricultural economics, range management, animal science, etc. that are not part of the research program at UCR. Several projects are being sponsored by CID, and some of the newer ones are in the semi-arid regions. UCR will cooperate on these projects where possible. For itemization of requests received in the Information Center and those fulfilled in development by faculty, see Table III-A and B at the end of this report.

B. Specific Information

The University of California, Riverside has over the years attracted a large number of foreign students because of its program in agricultural

science and programs in liberal arts and the sciences. There are 140 foreign graduate students at UCR, counting all foreign countries. Developing country students in the departments of Botany & Plant Sciences and Soil & Environmental Sciences are as follows:

Graduate Students from Developing Countries

<u>Country</u>	<u>Botany & Plant Sciences</u>	<u>Soil & Environmental Sci</u>
Brazil	1	3
Chile	1	
China, Republic of	1	
Dominican Republic	1	
India	1	
Indonesia	1	
Iran	4	
Iraq	1	1
Libya		1
Korea	1	
Mexico	1	1
Nigeria		2
Spain	2	
Sudan	8	1
Tanzania		1
Venezuela	<u>1</u>	
Totals	24	<u>10</u>

These students, along with the entire graduate student body, are invited to attend the seminars and lectures sponsored by the Project. The entire group often benefits greatly from the questions and discussion offered by graduate students from the developing countries at the Project seminars, and the free exchange of ideas and experiences offers education in its best and truest sense.

Foreign students comprise a small percent of the graduate enrollment in the departments of Botany & Plant Sciences and Soil & Environmental Sciences, the majority of whom return to their home countries to assume key posts in universities and governmental research organizations; although there is often personal correspondence with professors, the University does not keep an ongoing record of such students' careers.

C. Linkages

Important elements in the establishment and maintenance of linkages, both international and domestic, are personal visits and travel by program staff. Travel was undertaken by various project staff during this year to meet Program objectives in training, in project development, to reinforce existing linkages, to establish new linkages, and to extend the knowledge base. A resume of this linkage activity follows:

Glen H. Caneill - MUSAT:sra Program Director

8-9 July 1977 - Davis, California to attend UC International Agricultural Coordinating Committee meeting, Title XII discussion.

12-14 July 1977 - Salt Lake City, Utah. CID semi-annual Board meeting.

20 July 1977 - San Diego State University to present seminar: "An Approach to Agricultural Development and Food Production in the African Semi-Arid Tropics."

13 October-1 November 1977 - Travel to ORSTOM and IRAT headquarters in Paris, France; to ISRA, ORSTOM and CNRA headquarters in Dakar, Senegal; Bob Ford project in Ouagadougou, Upper Volta. Work was also done in Senegal and Paris to assist P. Felker on his Acacia albida SOTA. (See Appendix V).

11 November 1977 - Denver, Colorado. CID special board meeting.

28-29 November 1977 - CIDNET meeting at UCR to familiarize the network member universities with the TRIM indexing process and to discuss with them information retrieval systems that could be used by CIDNET.

5 January 1978 - El Paso, Texas. CID semi-annual board meeting.

18 January 1978 - Denver, Colorado. CID meeting to discuss Iran project planning.

2-4 April 1978 - Logan, Utah. CID Finance Committee meeting.

15 May 1978 - Salt Lake City, Utah. CID Executive Committee meeting.

30 May-12 June 1978 - Dakar, Senegal. Discussion and planning with ISRA, IITA, Cornell University and Boyce Thompson Institute for Plant Research concerning cooperative project proposal on cowpea improvement.

(See Appendix V).

Other MUSAT:sra Program Staff Linkage Activities

9 December 1977 - Y. Demeure, program faculty exchange participant, visited with Drs. Lownsbery and Viglierchio, Dept. of Nematology, and Dr. Crowe, Dept. of Zoology, at UC Davis, California.

25 January-10 February 1978 - Dr. Semour Van Gundy, UCR Nematologist, was a session chairman at the Regional Planning and Training Conference on Root-knot Nematodes in Northern Africa and Mediterranean areas, at the University of Cairo, Egypt. He then spent time in Paris, France conferring with ORSTOM about exchange of researchers and prospects of a workshop on pest management. (See Appendix V).

5-8 February 1978 - Y. Demeure visited with faculty of the Dept. of Chemistry, Dept. of Plant Pathology, and Dept. of Physics at the University of Arizona, Tucson, Arizona.

27-29 April 1978 - Y. Demeure visited Imperial Valley and Coachella Valley, California and a nematology field trip.

29-31 May 1978 - Y. Demeure visited with faculty of the Dept. of Plant Pathology, North Carolina State University, Raleigh, North Carolina.

1-2 June 1978 - Y. Demeure visited with faculty of the Department of Entomology and Nematology and the Division of Plant Industry at the University of Florida, Gainesville, Florida.

2 June 1978 - Y. Demeure visited with Dr. Atilano at the Agricultural Research Center, Ft. Lauderdale, Florida.

30 May-12 June 1978 - Dr. Tony Hall, Dept. of Botany & Plant Sciences, UCR, participated in the cooperative project proposal planning with ISRA, IITA, Cornell University and Boyce Thompson Institute for Plant Research in Dakar, Senegal.

3-10 June 1978 - Y. Demeure to Mayaguez, Puerto Rico to attend 10th Annual Meeting of the Organization of Tropical American Nematology.

Two kinds of linkages are being developed: Information Center linkages and personal or contact linkages that fit in with the other MUSAT:sra program areas. The two are interrelated but not necessarily overlapping. Great progress has been made in establishing both types of linkages (see Appendix IV). The development of a directory, started in 1975 and to be published in late 1978, is an indication of the extent of linkages related to the MUSAT:sra program.

D. Utilization of Institutional Response Capacities on Solution of Developing Country Problems

MUSAT:sra is working towards solutions of two major problems in the Sahel and other semi-arid tropical regions. The first of these problems is the need for information for development. This need is felt in the developed nations focusing attention on international development and in the developing countries. Many of the activities of the Information Center have been directed toward the solution of this problem beyond its primary goal of supporting MUSAT:sra research.

Although MUSAT:sra can serve a limited clientele in the semi-arid tropics with information related to the program, its effectiveness in document delivery is limited by lack of funds and a concentrated program for the region. The formation of CIDNET as a functioning unit could greatly enhance the MUSAT:sra document delivery program while broadening the information base.

MUSAT:sra has devoted a considerable time in promoting CIDNET and at present the bibliographic index data base for each of the five universities comprising CIDNET is on a computer printout system (TRIM) and is completely searchable. A proposal for delivery of documents was made to AID in 1976

by MUSAT:sra, but not all CIDNET member universities had their data bases complete and operative. Since this problem has now been solved a proposal for a document delivery system for the developing countries is again being resubmitted.

The second major problem MUSAT:sra is working on concerns research projects and technical training that can be used to increase food production in these regions. The areas covered by present research include soil-water crop relationships, farming systems and management of soil, water and crop production. The research in Upper Volta is designed to provide basic information for planning and developing farming system approaches, and to provide information on erosion and run-off. The simulation modeling project initiated in Senegal is designed to test data available at CNRA Bambey. The results of these studies can be applied to large areas in the Sahel as well as other semi-arid tropic areas, thus broadening the significance of this research and its influence on crop production.

Because these research projects are being conducted within the Sahel region they can be continued by researchers within the region if desired, data is applicable without adaptation, and projects can be continued with cooperative assistance from Project faculty members at UCR during the life of the Grant.

One of the major problems in the drier areas of the Sahel (300-500mm rainfall) concerns management of soils and the available water to provide consistent and stable crop production. A very large part of the population lives in the drier regions, and little progress has been made in assisting the farmers in maintaining stability in crop production. MUSAT:sra, IITA and representatives of Senegal as major cooperators met in June 1976 and developed a draft proposal applicable to the drier regions. This would be a beginning to assist the farmers in developing a stable production system through research and application.

VII. WORK PLAN JUNE 1978 - JUNE 1979

1. Objective/Output No. 1: Central Information System

A. Information Storage and Retrieval/Dissemination. Continued processing of items for the computerized data base is ongoing; 15,000 items are

presently retrievable and approximately 5,000 additional items are in process. The present workload will continue, with the emphasis now placed on current materials. Reference services will continue to play a major role in the operation of the Information Center. These services include campus research projects, CIDNET affiliation, and national and international requests. The expansion of information services will be complemented by advanced methods of dissemination such as computer searches, possible on-line retrieval, and microfilm and microfiche copies.

B. Acquisition of Library Materials. Revised information profiles of new and expanded research interests have been developed, and projected acquisitions will reflect more specific and in-depth areas of concentration. Because of recently developed UCR library centralization activities involving some major changes, new systems and procedures were devised by the MUSAT:sra Project Librarian to ensure a smooth and efficient flow of materials. Collection development guidelines will continue to be reviewed and coordinated with the campus libraries' newly formed Collection Development Department.

Since the MUSAT:sra program is entering into its last year of grant operation the acquisition part of the project will be carefully reviewed. Many difficult-to-obtain articles, periodicals, and books, etc. have been on order for rather long periods of time. In order to balance out the acquisition part of the account by the grant closing date many of the requested purchases will need to be cancelled. Procedures are being developed in cooperation with the appropriate campus library departments for this phase.

C. Information service to the developing countries. There has been a rapid increase in new and developing information centers in the developing countries, particularly in Africa. Many of these contacts have been made through correspondence, exchange of materials attendance at workshops and conferences where African representation has increased, and by continued support through African development programs and projects. Continued service will be provided during the last year of the grant, and a document delivery system proposal will be developed using a microfiche approach.

2. Objective/Output No. 2: Network of Worldwide Linkages

A. Directory - During the third reporting year the directory started in 1975 was reviewed and updated, which required reverifying and updating changes of personnel or addresses. All new directory entries from this reporting year will be merged into the data base and an updated directory issued to provide current information to requestors. Publication of the directory was explored with G. K. Hall Publishing Company and a contract signed. Publication of the directory is expected in December 1978. "The Directory for Agricultural Research in Semi-Arid Regions" lists individuals, organizations and projects in the area of agricultural development in Africa. Entries are listed alphabetically by personal name, organization or project title, geographic area (noting geographic scope of activities), subject field, and location (physical location of organization or permanent address of individual). With its extensive international listings, wide geographic concentration, and comprehensive subject coverage, the present work supersedes the few existing directories aimed at African development.

B. Linkages - Contacts accomplished through expanded affiliations, the Project's International Symposium on Rainfed Agriculture in Semi-Arid Regions, visitation programs, professional meetings and correspondence will be continued and strengthened during the next year. The joint research and educational exchange program will continue through the next year and be expanded to include MUSAT:sra staff to be stationed in Dakar, Senegal. As awareness of newly developing information organizations in the developing countries continues contact for information exchange will be made. Personal contacts, however, will continue to be the most fruitful and enduring affiliations.

3. Objective/Output No. 3: Improved Research Capability and Increased Knowledge Base

A. SOTA - A contract for publication of the State of the Art on Agriculture in Semi-Arid Environments has been signed with Springer-Verlag and this publication will appear as part of the Ecological Studies Series, and will be available in the early part of 1979.

B. Research

1. An 18 month cooperative research project entitled "Perception and Management of Semi-Arid Indigenous Agricultural Systems" was completed in December 1977. The project was located in the vicinity east and north of Ouahigouya, Upper Volta. A Peace Corps volunteer helped survey fields in the study in Banh and Toulfe. This work was completed in March 1978 and conversion of the data to an area basis for each field used in the study is underway. Processing the remaining data into usable forms is now underway, and the following is a projection of time for completion of the study:

January 1979 - Section I. Introduction

Chapter 1. The Sahelo-Sudanian Scene

- a) Introduction
- b) Theoretical & Practical Considerations
- c) Choice of Field Study Sites
- d) The Sahel in Relation to the World's Dry-Lands

Section II. YATENGA: THE BIOPHYSICAL BASE.

Chapter 2. Geology, Landforms, and Hydrology

- a) Geology
- b) Landforms
- c) Hydrology

Chapter 3. Agro-climatology, Soils, and Vegetation

- a) Agro-climatology
- b) Soils
- c) Vegetation

June 1979 - Section III: YATENGA: THE PEOPLE

Chapter 4. Culture History, Population, and Settlement

Chapter 5. Regional Expression of Livelihood: Farming and Herding

September 1979- Section IV. YATENGA: THE SUBSISTENCE ECONOMY

Chapter 6. The Rhythm of Life (Seasonal Calendar of Activity)

Chapter 7. Agricultural Technology & Subsistence Strategy

Chapter 8. Land and Labor

Chapter 9. Consumption & Distribution

Section V. YATENGA: CHANGE AND CONTINUITY

Chapter 10. The Environmental Predicament

- a) Desertization & Conservation
- b) Famine & Drought
- c) Population/resource Imbalance

Chapter 11. Prognosis & Recommendations

Section VI. APPENDICES & BIBLIOGRAPHY

December 1, 1979 - Final copies of materials; projected length 300 pages

The MUSAT:sra library staff and the contact in Paris, France have been very helpful in obtaining the necessary information materials needed for this study. Dr. Michel Izard of Paris has been particularly helpful with supplying anthropological and historical literature materials on the Yatenga region.

2. Completion of arrangements with Senegalese and French researchers at CNRA Bambey, Senegal was made to conduct a cooperative study entitled "Quantitative Analysis of Dryland Farming Systems in the Sahel Zone." This cooperative program was initiated in October 1976 and will continue through the life of the grant as new information is developed at CNRA and UCR.

3. On-campus field research projects on cowpeas were initiated in May 1975 and will continue through the life of the grant and involve graduate students and faculty. These four projects are entitled: "Soil Water Use, Evapotranspiration and Root Development of Cowpeas Under Varying Stress Conditions, " "Evaluating Drought Resistance in Cowpeas (Vigna unguiculata L.)" , "Characterization, Ecology and Physiology of the Cowpea Rhizobium," and "Root Growth of Cowpeas as affected by soil physical properties and water stress." Four other studies being conducted by graduate students are projected for completion during the last year of the grant.

Studies with cowpeas will be continued during the last year of the grant and will involve plant breeding and selection of drought resistant varieties, soil physical properties, and cowpea root systems and fertilizer and nutrition relationships.

4. Objective/Output No. 4: Increased Advisory Capacity

The main emphasis has been to make use of the information gained by the team trip into France and West Africa in 1975 and implementation of projects in 1976. The research projects and worldwide linkages for both the Information Center and for faculty are a strong indication of the effectiveness of the team trip and follow-up visits during 1977-78.

A. Strong emphasis has been placed on the scientist exchange program between research organizations in the Sahel countries and UCR. These types of arrangements are conducive to gaining firsthand knowledge of problems and to rapidly increasing advisory capacity. The exchange program with ORSTOM and the UCR Department of Nematology will be continued through the life of the grant.

1. Following the visit to ORSTOM at Dakar by the Program Director in February 1976, and a later visit by Dr. S. Van Gundy, Nematologist at UCR, to West Africa, arrangements were made to have Dr. Michel Luc visit UCR. He spent a six-month sabbatical on-campus, beginning in January 1977, doing research and teaching. This exchange visit by Dr. Luc was followed by a visit by Dr. Yves Demeure, who arrived from Dakar in the fall of 1977 and remained through July 1978. Dr. Demeure's studies dealt with nematode populations in soils, simulating the wetting and drying conditions of the semi-arid tropic regions.

2. It is proposed during 1978-79 that Dr. Prot, Nematologist with ORSTOM in Dakar, will spend the year at UCR and that Dr. R. Mankau, Nematologist at UCR, will spend a year at the ORSTOM laboratories in Dakar.

3. Visits by three of the younger staff in the UCR soils and plant sciences departments will be made during the year to increase their knowledge of agriculture in the semi-arid tropics.

B. Seminars and Campus Visitors

Seminars will be continued on a limited scale. Selection is based on need and research progress. Foreign visitors supported by various agencies, including the State Department, and with interests in the grant objectives will continue to be invited to the UCR campus. Costs are small in having these visitors on campus, but their contributions to the program are large.

C. Post Doctoral Positions

Dr. Peter Felker, PH.D., Michigan State University, 1976, joined the MUSAT:sra program in January 1977, and has been partially supported by funds available in the Plant Sciences Department at UCR. Dr. Felker's field of interest is plant physiology, with a special interest in leguminous trees. He completed a State of the Art on Acacia albida and is now a member of the UCR Soil & Environmental Sciences department. He is working on a project concerning Prosopis, a leguminous tree commonly referred to as mesquite.

5. Objective/Output No. 5: Educational Capabilities in Dryland Moisture Conservation & Utilization.

A. Team meetings will continue with the program that was initiated early in the grant program. The grant Executive Committee voted to establish a working committee between the departments of Soil & Environmental Sciences and Plant Sciences to address itself to courses related to development of practical field-type agricultural courses that could be developed for training students from the developing countries.

Serious consideration is being given by the committee as to whether to develop degree programs in dryland farming or simply to add a few new courses, restructure other courses, and rely on these and the basic courses for training graduate students.

VIII. INVOLVEMENT OF MINORITY PERSONNEL AND WOMEN

All positions of employment in the Project are recruited through regular University procedures, following UCR's guidelines for Affirmative Action and Equal Employment Opportunity.

Because of the nature of the Project, and the geographic area of concern, MUSAT:sra has always been active in involving minorities in its activities. Efforts have been particularly strong in effecting liaison with the Black Studies Department so as to create an employment pool of minority applications for student and general assistance positions as they open.

During the reporting year Project staff personnel has included the following:

Project Office Staff	2 women
Information Center Staff	2 women
Students/general assistants	3 women, one of whom is of Mexican-American extraction
Research Assistants	7 men, one of whom is black

IX. OTHER

In a project of this nature there is always a rather large University contribution in program space, and in faculty and staff time, that is involved in cooperative activities such as planning, evaluating, and directing program activities. UCR has been particularly helpful to the grant program by providing space at the beginning of the program to house the Information Center, and office space for the Program Director, Librarian and secretary. Excellent cooperation has been extended by all units connected with the project, but in particular by the UCR library staff. It is not the intention to delineate complete University support, but rather to point out the significance of this aspect in the 211(d) Project. Some estimate of faculty and staff time may be made using the Objective/Output method as a basis. Time involved by the UCR Accounting Office is not included.

1. Objective/Output No. 1: Central Information Center	Man Hours
a. Information Resources Team - composed of five UCR staff and four faculty - 10 meetings and individual consultation	250
b. Executive Committee	30
c. Soil & Environmental Sciences Dept. office services (budget, etc.)	40
2. Objective/Output No. 2: Network of Worldwide Linkages	
a. Part of the Information Resources Team activity	50
b. Executive Committee	30
c. Soil & Environmental Sciences office services (budget, etc.)	40

	<u>Man Hours</u>
3. Objective/Output No. 3: Improved Research Capability and Increased Knowledge Base	
a. Research Team (consisting of four faculty) - meetings, graduate student committee, individual attention to graduate students by six faculty	2,000
b. Executive Committee	30
c. Soil & Environmental Sciences office services (budget, etc.)	40
4. Objective/Output No. 4: Increased Advisory Capacity	
a. Educational Training and Advisory Team - consisting of three members - two meetings and individual consul- tation	20
5. Objective/Output No. 5: Educational Capabilities in Dryland Moisture Conservation and Utilization	
a. Curriculum Development Team - consists of five members - Two meetings, travel to other universities, consultation, teaching	20
b. Executive Committee	30
c. Soil & Environmental Sciences office services (budget, etc.)	40
	<u>TOTAL MAN HOURS</u> <u>2,690</u>

TABLE 1

Distribution of 211(d) Grant Funds and Contributions from Other Sources of Funding

Reporting Period - July 1, 1977 thru June 30, 1978

Grant Objective/Outputs	Period Under Review	Cumulative Total	Projected to End of Grant	Non-211(d) Funding
Central Information System	29,011.37	180,596.37	25,645.48	
Network of Worldwide Linkages	21,967.00	81,305.00	20,152.00	
Improved Research Capability & Increased Knowledge Base	105,874.02	391,732.02	76,025.80	7,182.50
Increased Advisory Capacity	46,696.09	126,453.09	79,118.40	7,182.50
Educational Capabilities in Dryland Moisture Conservation and Utilization	1,450.04	16,243.04	2,728.80	
TOTAL	\$204,998.52	\$796,329.52	\$203,670.48	\$14,365.00

Table II-A

211(d) Expenditure Report
 Actual and Projected Summary
 Reporting Period: 7-1-77 thru 6-30-78

	<u>Expenditures to Date</u>		<u>Projected 78-79</u>	<u>TOTAL</u>
	<u>Reporting Period</u>	<u>Cumulative Total</u>		
1. Salaries & wages	\$122,785.64	\$400,935.64	96,176.00	497,111.64
2. Student Stipends	43,325.02	108,629.02	30,000.00	138,629.02
3. Library	5,316.37	55,682.37	6,494.48	62,176.85
4. Research (not applicable as a separate item)				
5. Travel				
Domestic	5,142.16	39,112.16	5,000.00	44,112.16
Foreign	13,756.51	54,325.51	30,000.00	84,325.51
6. Equipment	-	25,408.00	5,000.00	30,408.00
7. Publications	579.73	579.73	11,000.00	11,579.73
8. Other §	14,093.09	111,657.09	20,000.00	131,657.09
	<u>\$204,998.52</u>	<u>\$796,329.52</u>	<u>\$203,670.48</u>	<u>\$1,000,000.00</u>

§ Includes fringe benefits (average of 12%), honoraria for guest lecturers, Consortium membership fees, Symposium (translation arrangements, bus, audio-visual equipment, etc.), Xerox and duplication, scientific illustration, shop labor, repair, agricultural operations, mail, photo and mailers, maps, field experiment purchase and supplies, computer use and tape, office supplies, chemicals and lab supplies, equipment items under \$2,500.

Table II-B

211(d) Expenditure Report
7-1-77 through 6-30-78

I. Salaries		
A. Academic		
G. H. Cannell (100% July thru June)	29,000.04	
D. Illes (100% July thru June)	14,268.00	
A. Hadas (100% July)	1,187.00	
R. Ford (100% July-Dec., plus term vacation)	<u>9,812.88</u>	54,267.92
B. Clerical/Technical		
S. Roderick	8,166.19	
A. Truslow	6,223.89	
P. Copeland	13,296.00	
P. Wilke (106 hrs at \$5.98/hr)	<u>633.88</u>	28,319.96
C. Student Help		22,901.97
D. Employee Benefits		17,295.79
II. Student Research Assistants (L. Gipson, D. Grantz, G. Mayfield, D. Rempel, K. Stevens, R. Zablotowicz)		
		29,264.00
Student Fellowships (P. Shouse, K. Turk)		12,603.02
Student Stipends (P. Shouse, K. Turk)		1,458.00
III. Consultants - none		
IV. Travel		
Domestic (13 trips)	3,352.32	
Garage	1,789.84	
Foreign (14 trips)	<u>13,756.51</u>	18,898.67
V. Equipment over \$2500 (none)		
VI. Library Acquisitions -		
Books	3,333.06	
Special Items (TRIM support, etc.)	<u>1,983.31</u>	5,316.37
VII. Publications (Two papers by A. Hadas, "Evaluation of Theoretically Predicted Thermal Conductivities" and "Simple Laboratory Approach to Test Seed Germination.")		
		579.73
VIII. Other		
(telephone, mail, repair, audiovisual, insurance, agricultural operations, Consortium fees, photo, Xerox and duplication, scientific illustrating, UCR computer use, electrical shop labor and parts, office supplies, field experiment supplies, VYDEC, microfiche reader.		
		<u>14,093.09</u>
TOTAL		\$204,998.52

INFORMATION REQUESTS BROKEN DOWN INTO BROAD SUBJECT CATEGORIES

Acacia albida - 3	Lakes/Dams - 2
Agricultural Development - 5	Land Use/Tenure - 20
Agricultural Systems - 20	Livestock Production - 12
Agroforestry - 6	Legumes - 19
Algeria - 2	Mali - 1
Aridity/Arid Regions - 6	Maps (all types) - 28
Cassava - 3	Mauritania - 4
Climatology/Meteorology - 20	Mechanization - 4
Cowpeas - 17	Millet - 7
Crop Production - 33	Moisture Utilization/Rainfall - 8
Cropping Systems/Rotation - 17	Modelling - 6
Crops Under Rainfed Conditions - 4	Natural Resources/Environment/ Ecology - 9
Crop Adaptation/Improvement - 15	Nematodes - 2
Desertification - 4	Niger - 6
Development Planning - 16	Nitrogen-Fixation - 3
Dew - 1	Oil Crops - 3
Documentation/Information Systems, Services - 19	Pedology - 3
Drought (all aspects) - 27	Pastoralism - 5
Dryland Farming/Agriculture - 28	Pest Management - 11
Economic Development - 8	Plant Breeding - 2
Egypt - 3	Plant Protection - 5
Energy Resources (solar, wind, etc.) - 12	Plant-Water Relationships - 44
Erosion (all aspects) - 13	Planting Date - 2
Extension/Training - 3	Prosopis - 4
Farm Management - 7	Range Management - 19
Fertilization/Fertilizers - 14	Resettlement/Migration - 2
Fire - 1	Rice - 3
Fodder/Forage - 8	Root Systems - 4
Groundwater - 4	Runoff - 4
India - 2	Rural Development - 8
Irrigation (all types) - 30	Sahel - 18
Jajoba - 7	Salinity/Leaching - 10

APPENDIX II (continued)

Seed & Grain Storage - 2
Senegal - 6
Silt/Flood Control - 4
Savannahs/Grasslands - 5
Socioeconomic Development - 15
Soil Management - 56
Soil Fertility/Moisture/Chemistry - 12
Sorghum - 12
Technical Assistance - 19
Tillage - 3
Upper Volta - 5
Village Studies - 7
Water Conservation/Harvesting - 20
Water Management/Hydrology - 23
Weed Control - 2
West Africa - 17
Wheat - 15

Requests for Assistance Received during Reporting Period June 30, 1977 to June 30, 1978

A. Requests Attended

Description of Request for Assistance	Whom Did You Assist?	Requestor	Who Funded Assistance	Size of Effort Dollars Man Days	Results of Assistance
Biblio, bulletins, etc: fertilization of cocoa to increase/maintain production under no shade, light or heavy shade.	Mr. Harvey P. Newton, ESCAZU, Costa Rica	SID Develop. Reference Service	Project	2.20 0.3	Aided research project.
Info on groundwater and geology in Benin, Upper Volta & Ghana.	Dr. Linda Zall, Earth Satellite Corp., Wash, DC	same	Project	3.65 0.4	Aided project research.
Info on seeds & seeding in relation to water, inoculation for moisture stress to enable seedling survival.	Jim Estes, Oregon St. U. Farm Crops Developmt	same	Project	1.75 0.02	Aided research.
Biblio & citations from Proj. Thesaurus: soil & water management.	Dr. L. Stroosnijder, PPS Project, Bamako, Mali.	same	Project	5.30 0.80	Aided tillage research & field project.
Biblio: erosion, irrigation, water quality, conservation.	R. B. Ridinger, National Univ. of Lesotho, Afr.	same	Project	4.20 0.60	Aided director of hydrology project.
Biblio: cowpeas, dryland agriculture, livestock production, extension.	Timothy Mahlanza Research Station Botswana, Afr	same	Project	3.50 0.25	Aided research work and extension
Biblio: Livestock production, breeding, grass varieties, dryland farming.	Dr. Enrique Cerda Servicio Tecnico Algodonero, Managua, Nicaragua	same	Project	2.00 0.3	Aided research.
Update drought info problems, State of Art publication.	M. J. Watts Katsina, Nigeria	same	Project	1.10 0.2	Aided research; updated info previously sent.
Biblio: irrigation, root crops rainfall simulation, drip irrigation, fertilization & herbicides.	Selcuk Kayimoglu Seker Institute Etimesgut, Turkey	same	Project	2.65 0.3	Aided research

APPENDIX III-A

Requests for Assistance Received during Reporting Period June 30, 1977 to June 30, 1978

A. Requests Attended

Description of Request for Assistance	Whom Did You Assist?	Requestor	Who Funded Assistance	Size of Effort		Results of Assistance
				Dollars	Man Days	
Info: genetics of sesame.	S. Osman, UCR Dept Botany & Plant Science	same	No cost			Consulted collection at length for research project.
Biblio: agricultural economics relating to economic development in developing countries	Dr. Thi-Tzang Shih, Institute of Economics, Taipei, Taiwan	SID Develop Ref. Service	Project	1.90	0.2	Aided research
Info, publications on prosopis (mesquite)	Peter Felker, UCR Soils Dept	same	Project	2.50	0.3	Consulted collection; aided research project.
Comprehensive listings of info on cowpeas	Ken Turk, UCR, Botany & Plant Sciences	same	No cost			Consulted collection at length in preparation of Ph.D. thesis
Info: soil management in Senegal.	G.V.V. Rao, Development & Planning Advisor, State Dept.	same	Project	1.00	0.2	Exchange of materials; aid to research
Biblio: trickle irrigation	Ms. Cathy Eobiak DSB/agr-SWM, AID Washington, DC	same	No cost			Exchange of information.
Biblio: livestock, range management for the Sahel	Scotty Deffendol, Ouagadougou, Upper Volta	CID	Project	3.75	0.5	Aided 2 yr livestock research project.
Info: project computerized data base system & services	Simone Argoud, IRHO, Paris, France	same	Project	2.20	0.3	Cooperation; awareness of dryland farming activity overlap; document exchange.
Info on computerized data base & computer search services	Harriet Rinne, UN Environment Programme, Nairobi, Kenya	same	No cost			Exchange of information.

APPENDIX III-A

Requests for Assistance Received during Reporting Period June 30, 1977 to June 30, 1978

A. Requests Attended

Description of Request for Assistance	Whom Did You Assist?	Requestor	Who Funded Assistance	Size of Effort		Results of Assistance
				Dollars	Man Days	
Biblio: water use, efficiency & consumption	Bob McBride Friends of the Earth, San Fran- cisco, Ca.	same	Project	1.10	0.3	Aided research
Info on agricultural-rural development projects	Bruce Kratka Agricultural Training Bd., Cairo, Egypt	same	No cost			Provided reference/referral to additional appropriate resources.
Biblio/info for Masters Thesis: environmental problems facing developing countries, with emphasis on Africa.	George Hgugi, Sch of Architec- ture & Urban Planning, UCLA	same	Project	2.75	0.4	Aided research
Biblio: soil moisture conser- vation, soil erosion/control, soil fertility, vegetation dynamics.	Jake Greene Eaux et Forets Gaya, Niger	same	Project	3.50	0.5	Aided Peace Corps volunteer serving as forester & land use planner
Biblio: fodder trees and <u>Acacia albida</u> .	M. Trevor Chand- ler, ICRAF, Amsterdam, Netherlands	same	Project	4.20	0.6	Exchange of info, materials & established linkage.
Info on CIDNET member collec- tions and services.	Barbara Bird U. of Hawaii, Manoa, Hawaii	same	No cost			Exchange of information
Biblio: documentation, infor- mation networks & systems	Richard Steele International Devel. Institute Indiana Univ. Bloomington, Ind.	same	Project	2.10	0.2	Exchange of information

APPENDIX III-A

Requests for Assistance Received during Reporting Period June 30, 1977 to June 30, 1978

A. Requests Attended

Description of Request for Assistance	Whom Did You Assist?	Requestor	Who Funded Assistance	Size of Effort		Results of Assistance
				Dollars	Man Days	
Riblio and borrowing of materials on new agroclimatology projects for Sahel & other semi-arid regions of Africa.	Raymond Motha CCEA, Unv. of Missouri, Columbia, Miss.	same	Project	7.50	1.5	Aided research project.
Info, biblio: agricultural development in Niger; project services.	Bernard Ploeger SRD, Unv. of Dayton, Ohio	same	Project	1.50	0.2	Aided new research project.
Info: project data base and retrieval system	Cherie Geiser Grain Storage Lit. Project, Kansas State U Manhattan, Kansas	same	Project	1.00	0.4	Aided establishment of new project for documenting grain storage literature.

APPENDIX III-B

Requests for Assistance Received During Reporting Period June 30, 1977 to June 30, 1978

A . Requests Not Fulfilled

Description of Request for Assistance	Name/Organization/ Location	Requestor	Who Funded Assistance	<u>Size of Effort</u> Dollars Man Days	Why Request Not Fulfilled
Biblio & research findings on cassava.	M.K. Falode, Univ. of Ibadan, Niger	same	No cost		No research being done on cassava. Referred to CIAT Cassava Info Cntr; provided 5 references on publications dealing with cassava.
Info on watershed management; project system & services	Dr. G.P. Verma Indo-UK Dry Farm- ing Project (ICAR) Indore, India	same	No cost		Not our information system; ltr forwarded to Linda White, University of Arizona.

U.S. ORGANIZATIONS & UNIVERSITIES (a representative selection)

ACTION Library

Washington, D.C. 20525

(Duplicate exchange listing)

AFRICAN-AMERICAN INSTITUTE

1201 Connecticut Ave., N.W.

Washington, D.C. 20036

(Visitor program)

AFRICAN STUDIES ASSOCIATION

218 Shiffman Center

Washington, D.C.

(National awareness & professional participation)

FORD FOUNDATION

320 East 43rd St.

New York, New York 10017

(Reference support, research inquiries, project documentation)

INTERNATIONAL FOOD POLICY & RESEARCH INSTITUTE (IFPRI)

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MUSAT:sra

Moisture Utilization in Semi-Arid Tropics:

summer rainfall agriculture

Trip & Project Reports:

Yves Demeure

Peter Felker

Seymour Van Gundy

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STUDY LEAVE REPORT

YVES DEMEURE

October 23, 1977 - August 22, 1978

Cooperators: Laboratoire de Nématologie
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Department of Nematology
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NSF Grant DEB 7702593 and USAID Grant No. AID/ta-c-1234
Saheal Project
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INTRODUCTION

The Department of Nematology at the University of California was chosen as a site for a research study leave because they were conducting research in survival of nematodes in dry soils and because they have a USAID program in the Sahel of Africa. The conditions of the Sahel in Senegal are very similar to the arid conditions of the California deserts so that our research could have practical application to both regions. Our studies concentrated on the processes by which nematodes are able to enter the state of anhydrobiosis in dry soils and survive long periods of hot dry conditions.

Research: Our research concentrated on four approaches: the induction of anhydrobiotic nematodes singly in the laboratory, the induction of anhydrobiotic nematodes in soil, the resistance of anhydrobiotic nematodes to extreme drying and to the nematicide, methyl bromide, and the importance of stored food reserves on survival during anhydrobiosis.

1. Induction of anhydrobiotic nematodes in soil.

Three nematode species, Acrobeloides sp., Aphelenchus avenae, and Scutellonema brachyurum were induced to coil and enter anhydrobiosis in two types of drying soil: sandy loam and loamy sand. The coiling of these species was studied in relationship to soil moisture characteristics. Coiling and the physiological state of anhydrobiosis began long before sandy soils reached a permanent wilting point of 15 bars. Maximum coiling occurred at 3-6 bars depending on the soil type and nematode species. It appeared that the induction of coiling and anhydrobiosis was determined by the physical forces created by the water film surrounding the nematode which in these three species was 6-9 monomolecular layers of water, rather than the moisture content and relative humidity of the soil.

2. Induction of anhydrobiotic nematode on Millipore filters.

Anhydrobiosis was induced in small quantities of nematodes (± 100) by slow desiccation on Millipore filters using a modification of Simon's technique and dehydration schedule. Nematodes were pipetted onto the synthetic filters over vacuum and suspended in glycerine humidity chambers. The relative humidity of the chambers was regulated by adding glycerine to the chamber solutions with stirring. Tests for the degree of anhydrobiosis were % coiling and survival after exposures to P_2O_5 . Nematodes tested were Aphelenchus avenae, Helicotylenchus dihystrera, Scutellonema brachyurum, and Acrobeloides sp. The optimum dehydration schedule for inducement of anhydrobiosis and survival of A. avenae, H. dihystrera, and S. brachyurum was two days at 100%, two days at $\pm 99\%$, two days at $\pm 98\%$ and two days at 97.7%. The optimum schedule for Acrobeloides was four days at each humidity. Dehydrated nematodes were exposed to P_2O_5 for up to 24 h. The dehydration of all four nematodes induced 91 to 98% to coiling. Survival to 0% relative humidity was not correlated to coiling but rather to duration of dehydration. Coiling appeared to be a short-term physical response to dehydration while anhydrobiosis was a longer term physiological response to slow dehydration.

3. The effect of the nematicide, methyl bromide, on anhydrobiotic Aphelenchus avenae.

Experiments were designed to test the hypothesis of Van Gundy (1965) that anhydrobiotic nematodes were resistant to chemicals. In cooperation with Dr. Munnecke's lab, anhydrobiotic and active Aphelenchus avenae were placed in dry and moist conditions (in soil and on Millipore filters) and subjected to 3000 ppm methyl bromide for up to 82 h. Results of this experiment showed that 60% of the anhydrobiotic nematodes survived, whereas 100% of the active nematodes were dead following the treatment.

To correlate these laboratory results to actual field conditions, we intend to place anhydrobiotic nematodes in a dry agriculture field and determine their resistance to methyl bromide.

4. The importance of the energetic reserves in the survival of Scutellonema cavenessi and Helicotylenchus dihystra to the desiccation.

Helicotylenchus dihystra from California, USA, and Scutellonema cavenessi from Senegal, Africa were extracted from field soil using wet sieving techniques. Adult females of each species were selected on the basis of transparency of the digestive tract. Opaque nematodes were selected to represent nematodes with large quantities of stored food reserves, principally carbohydrates and lipids, while transparent nematodes were selected for their lack of food reserves. Quantitative tests of S. cavenessi showed that opaque nematodes contained an average of 44.4, 96.9 and 117 ng and that transparent nematodes contained 44.4, 0 and 24 ng of nitrogen, lipid and carbohydrate, respectively. The nematodes were dehydrated in Simon's wet chambers using glycerine solutions to maintain a relative humidity. The transparent H. dihystra and S. cavenessi females did not survive to desiccation. These results suggest that the quantity of stored food reserves in the form of carbohydrates and lipids may be important factors in the survival of nematodes during periods of desiccation.

"State of the Art: Acacia albida as a complementary
permanent intercrop with annual crops"

Prepared under contract for United States
Agency for International Development

Peter Felker
Moisture Utilization in Semi-Arid Tropics:
Summer Rainfall Agriculture
AID 211(d) Grant

Department of Soil and Environmental Sciences
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"Condensed Summary of Agriculturally Related Acacia albida Literature"

INTRODUCTION

At present the available literature does not allow a completely accurate objective analysis of Acacia albida capabilities and potential capabilities. Nevertheless this reviewer having closely followed the literature on leguminous trees for 5 years and having worked with the leguminous tree Prosopis in native stands, in the greenhouse, and in University of California, Riverside field station studies, believes the following condensed Acacia albida summary to be a fair, conservative, and defensible representation of Acacia albida's agro-sylvo-pastoral capabilities.

CONDENSED SUMMARY

Directly under Acacia albida foliage cover yields of millet and peanuts increased on infertile soils from 500 ± 200 kg/ha to 900 ± 200 kg/ha. Approximately 45 large trees per hectare were required to achieve complete soil cover.

In addition to yield increases under A. albida, a 50 to 100% increase in soil organic matter and nitrogen content, a marked increase in soil microbiological activity, and an increase in water holding capacity beneath the trees has been found.

Acacia albida has been demonstrated to nodulate and fix nitrogen in pot studies. How, when, and where A. albida fixes nitrogen in the field was unclear, but an analysis of the nitrogen cycle suggested that A. albida nitrogen fixation was probably the cause for increased soil fertility beneath A. albida canopies.

Average annual A. albida height growth for 8 trees was 92 cm, with a range of 50 to 160 cm. Annual diameter growth ranged from 0.6 to 2.9 cm, and this 4.8-fold diameter growth range represents a 23-fold range in volume growth, because volume is proportional to diameter squared.

A. albida flowered at seven years of age and produced first pods at about eight years of age, but did not bear well until about thirty years of age. A. albida tree pod yield has been reported to range from 6 kg/tree to 135 kg/tree which has been extrapolated to yields ranging from 105 kg/ha to 5400 kg/ha.

The pods were a much used source of livestock feed in West Africa. The protein content of the pods was 10-15%, the seed protein content was 26-28%, and the carbohydrate content was about 50%. Feeding trials on A. albida pods have not been carried out.

It has been suggested, through not proven, that A. albida has increased the land carrying capacity from about 10-20 persons/km² to 25-40 persons/km² and that A. albida has made it unnecessary to clear and fallow land permitting sedentary, permanent agricultural settlements. A. albida has been an important part of West African culture and in some areas sacrifices of millet and chickens have been made to A. albida.

Acacia albida has substantially increased the well-being of small farmers in Sahelian regions by increasing soil fertility and crop yield and by providing pods for animal food. While this is indeed remarkable, there is much room for improvement. Acacia albida has never been the subject of genetic or horticultural studies designed to improve its beneficial characteristics. Acacia albida strains in Senegal are land races and might be compared in productivity to maize and wheat in the U.S.A. in the 1800's. There is little doubt that cultural, selection, and propagation techniques, plant pathology studies, pruning and spacing studies, and development of devices for protection from animals could profoundly improve A. albida's beneficial qualities and the quality of life for Sahelian farmers.

TRIP REPORT

for

S. D. VAN GUNDY
Department of Nematology
University of California
Riverside, California

to attend

Regional Planning Conference on Root-knot
Nematode Research in the Near East

held at the University of Cairo, Egypt

January 29 - February 2, 1978

Sponsored by: Nematology Research Center
University of Cairo
North Carolina State University
USAID Contract No. AID/tamc-1234

The Regional Planning Conference on root-knot nematode research in the Near East was held at the Nematology Research Center at the University of Cairo. This unit is the largest nematology research and training center in the Near East and in all of Africa. There are 10 Ph.D.'s on the research and teaching staff and currently six graduate students enrolled for higher degrees. Their physical facilities include a separate relatively new building for housing the Nematology Research Center, two plastic houses and about 200 outdoor cement-lined micro plots for maintaining nematode collections. They are participating in two PL-40 projects; one on plant parasitic nematodes and the other on nematode parasites of insects. They also maintain a close liaison with two nematologists in the Ministry of Agriculture, with four nematologists in the National Research Center and with the nematologists at the University of Alexandria. There are now a total of 17 professional nematologists in Egypt.

Nematodes are one of the major pests limiting agricultural production in the fertile Nile Valley and more recently in their desert reclamation projects. Approximately one million acres of desert have been or are in the process of being brought into agricultural production. The introduction of nematodes into this pest-free land is a major problem. Contamination comes through the irrigation water from the Nile River, planting stock grown on infested land in the old agricultural areas and moved to the new land and the transportation of soil and organic matter from the old riverbed to the desert soils. Their pest problems are very similar to pest problems encountered in the Sahel of Africa.

Their research should have a wide application and should be given strong consideration for improving crop production in Africa. There appears to be a major obstacle in the transfer of this information through the lack of publication of research results in international journals and in their inability

to have access to international literature. Their library subscriptions to scientific journals have been discontinued since the war in 1973. Many student theses remain unpublished in the library. This seems to be an important area where USAID and PL-40 could make a major contribution to distribution of scientific knowledge in this region.

The conference was attended by 26 participants representing 14 nations (see attached list of participants). The first two days of the conference were devoted to presentation and discussion of nematology research by each of the participants (typed summaries are available for review in my office). Two days were devoted to discussions on the USAID root-knot project, establishment of research priorities in the region and the specific participation of the various individuals in the USAID root-knot project. I presented an hour guest lecture on the nematology program at Riverside and a general review of the ecology of root-knot in semi-arid agriculture.

Two field trips were conducted to see agricultural production in Egypt. One day was spent touring the Tahreer and Janaklies Farms in the desert reclamation program. One project was a government-owned farm of about 20,000 acres devoted primarily to seed production of vegetable and field crops. Nematodes were considered one of their most important pests limiting production and full utilization of their reclaimed land. The other project was a government-run farm for the production of wine. This farm produces about 8 million dollars worth of wine and distilled spirits each year. Nematodes are a major problem in the maintenance of long-range vigor of the vines. Since all of these soils are extremely sandy and the crops grown on them are marginally irrigated, the plant stress caused by nematodes is much more severe than in the fertile fine-textured soils of the Nile Valley and delta.

Another weekend trip was taken to Luxor to view agricultural production along the Nile River. Crop production consisted of mixed vegetables, citrus

and animal forage, with sugar cane as the major cash crop. Both trips were very informative about agricultural production of Egypt and about their nematode pest problems.

I also received an invitation to attend the Fourth Conference of Pest Control to be held in Cairo September 30 to October 3, 1978. This conference is organized by the Academy of Scientific Research and Technology and the National Research Center. If anyone is interested in attending, I would be glad to supply the application forms.

The final three days of my trip were spent consulting with Dr. M. Luc and other scientists and officials of ORSTOM in Paris. One afternoon was spent with Mr. Michel Gleizes, Secretary General of ORSTOM, discussing our nematology exchange program between ORSTOM-Dakar and Riverside. He seemed anxious to continue our exchange program and he and Michel proposed another candidate, J. C. Prot, from Dakar for the fall of 1978. The proposal is on the same basis as Y. Demeure who is currently in Riverside. A major concern of Mr. Gleizes was the one-sidedness of our exchange and he strongly encouraged us to send someone for a study leave in Dakar. Some attention should be given to this aspect in our USAID program. Discussions were also held on the possibility of planning a joint "Pest Management Symposium" in Dakar during the Spring of 1979. His response was positive but he could not make any commitments until a formal proposal was submitted for review. Michel Luc and I have drafted a general proposal. When it is finalized, I will forward it as an addenda to this report. In general I felt Riverside's relationship with ORSTOM was extremely good, and that we should make every effort to continue it and improve on its balance in the coming year.

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Travel Report October 15-28, 1977

Glen H. Cannell

This report will briefly cover my trip to Senegal, Upper Volta and France in October of 1977. The trip objectives were: 1) to lay the groundwork for Dr. Peter Felker's visit to Senegal and Paris, France to develop materials for the State of the Art: Acacia albida, and 2) to visit with Mr. Robert Ford, Project Leader for the indigenous study on farming systems and methods in northern Upper Volta.

Contacts for the Acacia albida study in Senegal were made with the FAO Forestry Representative/Dakar, Director of Centre National de Recherches Forestiere (CNRF). The complete archives on Acacia albida for the Sahel region are located at CNRF. Visits were made with the Director of the Society de Developement et de Vulgarisation Agricole (SODEVA), and with their country offices at Thies. Other visits were made at CNRA, Bambey, the ORSTOM laboratories at Dakar and the USAID Mission. Excellent cooperation was pledged by all groups to assist Dr. Felker in his visits, and this later proved to be the case. Dr. Felker visited with farmers (a trip arranged by SODEVA), all libraries for each organization were accessible, and a trip into the northern Senegal regions related to the project was made possible by cooperation with CNRA, Bambey.

The visit to Upper Volta proved to be very beneficial. Mr. Ford has made a remarkable study of three villages, and the rapport with the villagers, farmers and village leaders was excellent. Several farmers were cooperating in each village and they farmed 300-400 fields of various sizes, growing millet, sorghum, cowpeas, peanuts and other crops. All fields were being measured and yield data obtained on each field. An immense amount of data is being collected and it will require some time to process; however the data should be valuable for future projects in Upper Volta from several standpoints. Ford has received good cooperation from the AID Mission in Upper Volta and had the opportunity to present material from his project to the Mission staff in a seminar.

The visit to Paris, France was to locate materials for Dr. Felker and to further establish contact with ORSTOM. The program has partially supported a contact person in Paris to work with our program people and to translate certain research articles. This has proved to be an effective means of working with libraries and other organizations that have information on the West African region that was not available in Senegal.

Travel Report: May 30 - June 6, 1978

Glen H. Cannell

This trip was part of a UCR team effort to plan and participate in drafting a proposal with the Institute de Senegalese Recherche Agronomique (ISRA) at Dakar, Senegal concerning a cowpea research program to be implemented in Senegal. Plans for this meeting were made in cooperation with IITA, Cornell University, Boyce Thompson Institute (BTI), ISRA and UCR. Drs. Weathers, Hall and Cannell represented UCR, Dr. Staples represented BTI, Dr. Staponkus represented Cornell, Dr. Goldsworthy represented IITA, Director Sauger represented ISRA, Dr. Beye represented CNRA/Bambey and others from the Bambey Research Station.

The following is a brief summary of the resulting draft proposal:

OBJECTIVES:

As part of an overall program of improvement of cowpeas in West Africa, and recognizing that water availability is one of the major limitations to production in the Sahel region, the project is concerned with (1) ecological factors that determine availability and use of water in semi-arid environments of West Africa where cowpeas are grown in order to devise ways to minimize the limitations imposed on crop production; and (2) plant characteristics that allow cowpea to evade, avoid, or tolerate drought with the objective of incorporating these characters, either singly or in combination, to develop improved cultivars for specific environments where the risk of drought is high.

Specifically, the following aspects will be considered:

1. Hydrological balance and climatic analysis of cowpea production systems in semi-arid regions of West Africa;
2. Characterization of plant response to drought with respect to phenological, morphological and physiological characters;
3. Development of screening techniques for use in breeding programs for improving drought resistance of cowpeas;
4. Varietal evaluation;
5. Crop management practices which maximize water utilization.

While drought resistance is identified as a primary constraint, the project recognizes the need to integrate the above studies with work to overcome other constraints as part of an overall program of cowpea improvement for semi-arid regions.

RESEARCH:

The program would be conducted at Bambey and Louga (or some other selected research center in the drier region). Special research would be conducted at the various cooperative institutions related to the overall project.

TRAINING:

Graduate students would be selected from the Sahel countries and would be trained at UCR. Training would also occur at IITA and at Bambey with short courses for Senegalese and others of the Sahel region. Senegalese would also be trained as co-workers with project scientists.

EXTENSION AND DISSEMINATION OF INFORMATION:

The results of management studies in Senegal will be extended to other locations in the semi-arid regions through the SAFGRAD organization of field trials and farmers' demonstrations that presently extend to 18 countries.