BIBLIOGRAPHIC DATA SHEET

1. CONTROL NUMBER: PN-AAJ-939

2. SUBJECT CLASSIFICATION (695)

3. TITLE AND SUBTITLE (240) Moisture conservation and utilization in low winter rainfall areas of LDC's; review report no. 2

4. PERSONAL AUTHORS (100)

5. CORPORATE AUTHORS (101)

Or. State Univ. Dept. of Int. Ogr.

6. DOCUMENT DATE (110) 1977

7. NUMBER OF PAGES (120) 107p.

8. ARC NUMBER (170)

9. REFERENCE ORGANIZATION (130) Or. State

10. SUPPLEMENTARY NOTES (500)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

rainfall
semiarid land
moisture
moisture content
dry farming
agricultural production
conservation
information systems
research

13. PROJECT NUMBER (150)

14. CONTRACT NO.(140) AID/ta-G-1221

15. CONTRACT TYPE (140) 211(d)

16. TYPE OF DOCUMENT (160)

AID 590-7 (10-79)

PN-AAJ-939

Review Report #2

U.S. Agency for
International Development

Oregon State
University

211(d)

MOISTURE CONSERVATION AND UTILIZATION IN LOW WINTER RAINFALL AREAS OF LDCs

AID/ta-G-1221

September 1977

CONTENTS

2 PROGRAM PROFILE

3 CONDENSED SUMMARY

4 NARRATIVE REPORT

4 General background and description of the problem

4 Purpose of the grant

4 Objectives of the grant

5 Accomplishments

13 Other resources for grant-related activities

13 Utilization of institutional response capabilities in development programs

13 Next year's plan of work

15 Involvement of minority personnel and women

16 FINANCIAL REPORT

20 APPENDIXES

21 I - Work Plan

27 II - Requests for Assistance and Action Taken

31 III - Short-term Visitors

34 IV - Foreign Graduate Students in the OSU School of Agriculture

38 V - Grant Personnel

39 VI - Techcom Trip Reports

Report prepared by: Office of International Agriculture
Oregon State University
Corvallis, Oregon 97331 / USA

Program profile

grant title
MOISTURE CONSERVATION AND UTILIZATION IN LOW WINTER RAINFALL AREAS OF LDCs

grant number
AID/ta-G-1221

grantee
OREGON STATE UNIVERSITY

grant program director
DR. S.F. MILLER

AID liaison officer and office
DR. DILLARD GATES, TAB/AGR

period of grant
JULY 1, 1975 TO JULY 1, 1980

period covered by this report
JULY 1, 1976 THROUGH JUNE 30, 1977

amount of grant
$1,000,000

expenditures for report period
$214,420.52

CONDENSED SUMMARY

In July 1975 Oregon State University received a grant of $1,000,000 to broaden its expertise in dryland areas of the world where the limited rainfall occurs during the winter months and to create a center of assistance and information to aid less developed countries dealing with dryland production and marketing problems. This report covers the period July 1976 to June 1977, the second year of the five year grant.

Five major outputs are anticipated from the grant: information systems, education and training, research capability and knowledge base, advisory service, and international linkages. Approximately 10 man years were employed and $214,420 were spent during the reporting period in pursuit of these outputs.

During the year a 3,000 entry DRYLAND BIBLIOGRAPHY was prepared, and computerized access to the bibliography was programmed. A document delivery system was put into action as a companion effort.

A joint symposium on dryland agriculture with University of California/ Riverside was held in April 1977. Seventeen countries were represented. OSU staff members presented six papers at the symposium and chaired three of its sections.

Five graduate students were enrolled in the OSU dryland program. A special curriculum in dryland agriculture has been devised and is now offered by the University. The Sherman Branch Station at Moro continued to be improved and now is operational as the OSU dryland training and research station.

Members of the grant Techcom (technical committee) traveled to Australia to obtain first hand knowledge of the Australian dryland system and to establish contact with dryland researchers. One member continued on to India, Tunisia, and Turkey to explore socio-economic aspects of dryland utilization.

Over 40 foreign nationals visited OSU to discuss dryland problems as well as view the methods used in Oregon to produce dryland cereals and livestock. Additionally, Techcom members participated in 10 symposia, conferences, and workshops concerned with dryland production.

Preparation of the major publication of the state of the technical arts in dryland production continues by Techcom members. Completion of the SOTA paper is anticipated for January 1977.

Narrative Report

GENERAL BACKGROUND AND DESCRIPTION OF THE PROBLEM

Despite the phrase, "in Oregon you don't tan, you rust," the state's immense eastern region receives low amounts of rainfall concentrated during a few months of the winter season. Agriculture in this area, aside from that under irrigation, depends on winter season rainfall and is, in the full sense of the term, dryland agriculture devoted to small grains and animal forage.

Oregon State University and the state's agricultural experiment station have devoted major effort over the years to developing technology and practices to improve agricultural production in the dryland areas. One of the primary thrusts involved has been conservation and beneficial utilization of available moisture. Numerous disciplines have participated in the ongoing effort resulting in the establishment of a significant body of information and experience with dryland agricultural production dependent on winter rainfall.

OSU previously had experience with international programs in Turkey and Jordan oriented toward increasing cereal production and expanding cereal production research and extension. The existence of these programs, plus the interest and experience of OSU in dryland agricultural development, led to discussions with the U.S. Agency for International Development and ultimately resulted in AID awarding a 5-year grant to OSU to marshall and expand its expertise and to develop a center of excellence in dryland agriculture that could be harnessed for application to less developed countries. The grant, entitled Moisture Conservation and Utilization in Low Winter Rainfall Areas of LDCs, was subsequently launched in mid-1975.

PURPOSE OF THE GRANT

The specific purpose of the grant, as stated in the accepted proposal, is to mobilize and expand institutional response capability at Oregon State University to focus on moisture conservation and utilization in relation to food production with emphasis on small farms in low winter rainfall (Mediterranean climate) areas of the LDCs.

The grant allows OSU to develop broader response capability in: 1) situations involving grain-livestock interaction as a major dryland activity; 2) improved moisture conservation and utilization related to the grain-animal-forage production complex; 3) more efficient use of farm power and equipment within LDC social and economic constraints.

OBJECTIVES OF THE GRANT

In broad perspective, the grant's objectives encompass the establishment and development of a center of competence with the ability and willingness to respond to needs of LDCs in low winter rainfall areas throughout the world to improve dryland farming systems and, by extension, the quality of life.

Five major objectives/outputs were defined for the grant:

Output #1 - Establish and operate a centralized information system.

Output #2 - Develop and provide an education training program specifically addressed to problems of LDCs.

Output #3 - Expand, improve, and marshal an institutional research capability and knowledge base.

Output #4 - Develop and provide increased advisory capacity.

Output #5 - Promote and strengthen domestic and international linkages.

The objectives/outputs are detailed in the grant work plan (as revised), a copy of which is attached (Appendix I).

The 211(d) program at Oregon State University has been in force for two years, a fact that has precluded extended attention to, or activity on, all of the five program objectives.

ACCOMPLISHMENTS

Each of the five objectives/outputs established for the grant are discussed in this section relative to the activity that has occurred within that particular sector. The objectives/outputs are condensed to just the words underlined in the foregoing section, Objectives of the Grant.

At the outset of the grant, an organizational structure was created within Oregon State University with the key body being the AID/OSU dryland grant technical committee (Techcom). Membership of the Techcom for 1976-77 was:

Dr. F.E. Bolton, Department of Crop Science
Dr. D.E. Booster, Department of Agricultural Engineering
Dr. J.B. Fitch, Department of Agricultural and Resource Economics
Dr. T.L. Jackson, Department of Soils (Fertilizer)
Dr. R.F. Miller, Department of Rangeland Resources
Dr. A.H. Winward, Department of Rangeland Resources

Dr. S.F. Miller heads the Techcom as grant director and information/library support is represented by S.K. Riehl working through the Agricultural Librarian of the William Jasper Kerr Library at OSU, M.P. Kinch. H. Horvath replaced Ms. Riehl on a temporary basis until A.E. Wolff was hired, effective August 1, 1977. Responsibility for coordinating the grant lies with the Office of International Agriculture within the School of Agriculture.

A. CENTRALIZED INFORMATION SYSTEM

REVISED BIBLIOGRAPHY--A second edition of the DRYLAND BIBLIOGRAPHY was researched, compiled, and entered in an automated data handling system in preparation for printing and distribution later in calendar 1977. The revision contains more than 3,000 entries compared to 1,200 in the original.

The BIBLIOGRAPHY covers all disciplines related to dryland agriculture, but devotes special attention to agricultural engineering (including equipment), agricultural economics, soils, agronomy, and range management. Journals, books, serials, papers, bulletins, and previously uncataloged reports from the United States and the North African-Mediterranean region are included.

The BIBLIOGRAPHY may be searched by use of a computer through a key words system and remote teletype stations. Individual citations contain publication title, author's name, source, descriptive key words, and access number, but do not provide an abstract.

The first edition was issued in August 1976 and the total 200 copy printing was nearly exhausted by late May 1977. The bibliographic system has grown faster than anticipated.

Collected literature is housed in the Kerr Library in either the main library collection or in a special collection room assigned to the dryland agriculture program. The materials are indexed, coded, filed, and readily available to research personnel both inside and outside the University through library check-out procedures.

DOCUMENT DELIVERY--The OSU Library staff working with the dryland project developed a plan for a document delivery service directed toward LDC researchers. The service offers to photocopy and mail free up to 200 pages of noncopyrighted material.

An expanded document delivery service, bringing requested dryland agriculture materials to researchers and others in LDCs, was implemented during the year. A system was developed for billing recipients when requests for photocopying exceeded the 200 pages offered free.

OTHER ACTIVITIES--Representatives from the library developed a suggested unified bibliographic format for Techcom members to use in preparing State of the Arts (SOTA) efforts.

The list of dryland agricultural workers maintained by the library has steadily increased with 52 names added in the last four months of the report year.

The program continues to cooperate with the Consortium for International Development Network (CIDNET).

The accomplishments of 1976-77 are consistent with, and inclusive of, the scheduled events and targets specified in the work plan. A total of 18.7 man months of professional time plus 862 hours of student help was spent in the pursuit of the objectives at a cost of $28,946.77 from the grant. An additional 2 man months of non-grant effort at a cost of $2,000 were utilized in the pursuit of the objectives. They arose primarily in the form of support provided by the library and administrative and logistic support of the University.

B. EDUCATION AND TRAINING PROGRAM SPECIFICALLY ADDRESSED TO PROBLEMS OF LDCs

JOINT SYMPOSIUM--The two institutions holding 211(d) grants for rainfed

agriculture--University of California Riverside and Oregon State University--held a joint one-week event April 17-22, 1977, entitled: An International Symposium on Rainfed Agriculture in Semi-Arid Regions.

The meeting, at Riverside, attracted more than 100 attendees and participants representing 17 nations. In addition to 18 major papers, a series of shorter presentations took place as well as panel sessions. A two-day field trip through major agricultural regions of Southern California followed.

Members of the OSU contingent, and the titles of their presentation, were:

Dr. Larry Boersma, Soil Science:
Moisture Conservation Relationships

Dr. A.H. Winward, Rangeland Resources:
Place of the Ruminant in Integrated Resource Management

Dr. James B. Fitch, Agricultural and Resource Economics:
Agricultural Decision-Making in Dryland Environments

Dr. T.L. Jackson, Soil Science:
Need for Fertilizer and Predicting Response in the Mediterranean Area

Dr. Floyd E. Bolton, Crop Science, and
Prof. Dean E. Booster, Agricultural Engineering:
Tillage, Moisture Conservation and Water Use Efficiency for Dryland Cereal Production in Winter Rainfall Regions

Dr. Homer M. Hepworth, Crop Science:
Plant Protection--Weed Control and Range Management

In addition to presentations by OSU staff, several key speakers were brought to the symposium to share their expertise. Those supported by the OSU dryland program were:

Dr. Bill C. Wright, Wheat Research and Training Center, Ankara, Turkey:
Dryland Agricultural Cropping Systems in Low Winter Rainfall Regions

Mr. John Doolette, Ford Foundation, Tunis, Tunisia (ICARDA, Aleppo, Syria):
Legume-Cereal Rotation in the Mediterranean Area

Dr. William O. Jones, Food Research Institute, Stanford University:
Marketing, Distribution and Policy of Agricultural Products in Semi-Arid Agriculture

Dr. N. Keith Roberts, Consortium for International Development, Tehran, Iran:
Panel discussant

Dr. Stanley F. Miller, OSU dryland program director, and Dr. R. Miller each served as chairman for one of the major sessions. Several other members of the OSU staff concerned with the dryland program attended the symposium.

GRADUATE STUDENTS--Several graduate students were assigned to Techcom members. The students, in addition to working toward an advanced degree, are engaged in research related to the dryland program. The students are:

name	country	degree	subject	advisor(s)
M. Bahrami	Iran	M.S.	Soil Science	Jackson
Abdelatif Belmehdi	Morocco	Ag.M.	Crop Science	Bolton
Catherine Mee	U.S.	M.S.	Range Resources	Winward, R. Miller
Thomas Nordbloom	U.S.	M.S.	Agric. Economics	S. Miller
M.P. Russelle	U.S.	M.S.	Crop Science	Bolton

Ongoing wheat-barley research to establish levels of nutrient uptake and to diagnose deficiencies will involve Mr. Bahrami. Planned work will expand the evaluation of phosphorus uptake by various wheat varieties with results projected to have significance for wheat variety breeding programs.

Mr. Belmehdi completed courses in crop science, soil science, and agricultural economics in satisfaction of the Master of Agriculture degree with emphasis on dryland farming (described below). He began field research training in June 1977 at the Moro and Pendleton experiment stations preparatory to writing a paper comparing the relationship between temperature and rainfall for various cropping systems, i.e., fallow-grain, grain-peas, grain-sorghum, and annual grain crops rotations. He has been designated by the Government of Morocco to take the lead in developing a dryland cereal production program following his return.

The problem of ascertaining the nutritive value of wheat and barley aftermath for grazing by domestic animals has been assigned to Ms. Mee. She has begun research--taking and analyzing samples--in an attempt to determine the effects of crop variety, environmental conditions, season of use, and parts of the crop plant on the nutritive quality of aftermath. The study has a dual objective of evaluating livestock operations on marginal range-crop lands.

Mr. Nordbloom has worked closely with Dr. Fitch in reviewing simulation modeling of plant and animal growth and farm management under dryland conditions, and in preparing a proposal for economics study of dryland farms in North Africa. He also led a discussion with a visiting three-man team from Tunisia centering on risk and uncertainty in farming and livestock raising under dryland conditions. His studies and thesis efforts will reflect these topics.

Mr. Russelle is working under Dr. Bolton to determine soil moisture-temperature relationships prior to seeding (and) under four fallow tillage treatments. Water losses occurring under different depths and types of mulch were measured with the goal of developing information suggesting production techniques that help stabilize grain production in low rainfall zones.

MASTER OF AGRICULTURE--The Techcom undertook to devise a specialized curriculum in dryland agriculture to be offered within parameters of the existing master of agriculture degree at OSU. This is a highly flexible, practically oriented program with specialization in dryland agriculture that does not require a thesis.

Forty-five class hours are required with a minimum of nine hours in each of at least three fields and with not more than 21 hours in any one field. Participants are required to prepare a paper--demanding three to five hours of Reading and Conference in the department of major interest--in lieu of a thesis.

During the summer between the first and second year of the two year program each participant undertakes a supervised project (involving actual field work) consistent with his/her major area of emphasis and the position for which he/she is preparing himself.

Disciplines in which majors have been developed for dryland agriculture include:

Agricultural and Resource Economics Soils Crop Science Rangeland Resources Agricultural Engineering Technology

Candidates are encouraged to include a variety of class offerings in their programs including at least one extension methods class.

A leaflet describing the Master of Agriculture in Dryland Agriculture, and containing detailed suggested courses within various majors and other information for potential participants, is in press and expected to be available for worldwide distribution in late September 1977.

NEW COURSES--Preparing programs for a masters of agriculture degree in dryland agriculture, plus increasing interest in dryland agriculture generally, has prompted several new class offerings including conservation cropping, a course designed to fill a curriculum gap in production systems, particularly for graduate students from LDCs. The official course description for conservation cropping is: crops and cropping systems which make efficient use of moisture, protect against soil losses due to wind and water erosion, and maintain soil structure and organic matter under rainfed climatic conditions. Emphasis on dryland agricultural production systems.

WORKSHOP SCHEDULED--The OSU dryland program has tentatively scheduled a month long dryland agriculture workshop aimed at LDC researchers and scientists currently pursuing educational degrees at other institutions in the U.S. The workshop will be held in Oregon during late June-early July, 1978 and will include a mix of traditional class offerings, on-site field work, and field trips. The dryland research and training center at Moro, Oregon, will be utilized for the field segment of the workshop.

PROGRAM REVIEW--An AID review team of Dr. Dillard Gates, grant manager, Soil and Water Management Division of the TAB Office of Agriculture, Thomas Wilson, Near East Bureau, Technical Agriculture Section, and Ralph Hansen, consultant, carried out an 18-month review of the OSU 211(d) dryland program during March 15, 16, and 17, 1977, at Corvallis.

Dr. S. Miller and members of the Techcom presented overviews of the program's various sector activities, proposed research projects, and anticipated future involvements. The budget and work plan also were reviewed. The review team offered feedback and suggested changes in the workplan. The changes were made and a revised work plan submitted to AID/W the week following the review visit.

CONTINUED IMPROVEMENT AT MORO--The dryland training center located at the Sherman Branch Station (Moro, OR) is now operational with a number of research programs and trials in place related to both LDC and Oregon dryland cereal production.

Further improvements in facilities and equipment continue to be achieved. Addition of Metler balances now allows soil moisture samples to be analyzed promptly on site rather than transported back to Corvallis with the risk of moisture loss in transit.

The University is contributing substantial support to the realization of this objective by providing the Sherman Branch Station as the dryland training center. In total, approximately 25 man-months and $44,813.89 of time and project funding were expended in the pursuit of this objective.

C. INSTITUTIONAL RESEARCH CAPABILITY AND KNOWLEDGE BASE

STATE OF THE ARTS (SOTA)--Major priority during the report year was attached to review of material for incorporation in the SOTA document. A draft outline was prepared, modified, and adopted. Techcom members presented brief progress reports.

A first draft copy of the various sections of the SOTA document were called for by the first of October 1977. They will be circulated internally within the committee. Final drafts should be completed by January 1978.

TECHCOM TRAVELS--Techcom members Drs. Bolton, Fitch, Jackson, and Winward visited a number of research institutions and organizations in Australia during October 1976. The visit's objective was to observe the "Australian" dryland system first-hand, establish contact with researchers in the same field, and expand dryland information sources.

Dr. Fitch continued on to India, Turkey, Tunisia, and Italy to explore the socio-economic dimension of dryland agriculture.

Following the Riverside symposium, Prof. Booster, Dr. Jackson, Dr. R. Miller, and Dr. Winward visited the University of California Hopland Field Station to observe rangeland improvement research.

Prof. Booster attended a minimum tillage conference November 10-11, 1976 at Portland, OR. Minimum tillage authorities representing both industry and research from Illinois, Nebraska, Washington, and Wisconsin took part in the conference program.

RESEARCH PROPOSALS PRESENTED AT THE 18-MONTH REVIEW--The review of literature associated with preparing the State of the Arts paper has exposed gaps in information, areas that need data in order to more accurately assess the various trade-offs that might be available for dryland farming in LDCs. The Techcom began to identify these areas and subsequently prepared several proposals for research directed toward these questions. Among the topics were:

Winter Annual Legume-Livestock-Cereal Crop Management Systems

Study of the Economics of Livestock and Forage Production on Cereal-Livestock Farms in North Africa

Minimum Equipment Requirements and Effectiveness of Small-Sized Implements for Dryland Cereal Production

These items were brought to the attention of the AID review team. They were withdrawn, however, after a decision was made that OSU develop a unified program for AID/W consideration.

EXISTING MINI-GRANT RESEARCH--The 211(d) program currently has three research efforts operating on mini-grants allotted through grant funds.

Drs. R. Miller and Winward are attempting to assess the value of wheat and barley aftermath (material left following harvest) as a grazing source for domestic animals. Tradition in many dryland LDCs includes pasturing animals on pre-harvested grain fields. Questions arise as to the value of this practice versus more timely fallowing or possibly beginning operations for the next crop.

Also to be determined are the effects of variety, varying environmental conditions, season of use, and the selectivity toward various parts of the plant on the overall nutritive quality of aftermath. To date:

- a thorough study plan has been completed specifying in detail the methods to be used in the study;
- sampling locations have been established in the dryland regions of eastern Oregon;
- a literature search has been conducted to ascertain existing data on the topic;
- a graduate student has joined the effort to assist with research operations;
- and the first set of samples has been collected for analysis.

The study will continue through the winter of 1979.

At the Moro training and research center, Dr. Bolton is conducting research on two aspects of dryland cereal farming. In one, he--and two graduate students--are attempting to isolate the relationship of how soil temperature under mulch and fallow treatments affects winter crop emergence. Information developed could conceivably lead to techniques that would help to improve grain production in dryland regions.

A second program in crop science involves experimentation with strip tillage as a summer fallow for dryland cereal production.

Management of winter annual legumes and winter wheat cropping systems, a research program under the leadership of Dr. Jackson, has the objectives of:

- defining optimum levels of P, K, and S that should be maintained in sub-clover plants;
- describing effects of maturity on changes in nutrient concentrations in plants;
  (Both are essential steps in establishing critical nutrient levels in plant samples that can be used in diagnosing soil fertility problems).

- evaluating effects of P, S, K, Mo, and lime on the amount of N fixed by sub-clover pastures.

Preliminary data were obtained in 1977; experiments will be continued in 1977-78.

Over 60 man months of effort and approximately $111,713.09 were expended to achieve this objective.

D. INCREASED ADVISORY CAPACITY

PREPARATION OF PROPOSALS--The Techcom responded to requests from AID to prepare proposals for a dryland program in Morocco and a seed production project, also in Morocco. Both proposals were rejected with the midwest consortium of universities being named to carry out the dryland program and Washington State University the seed production project. The OSU dryland program responded in both cases.

Prof. Booster, in response to a request from Tunisia, provided information on hay swathers.

CONSULTATION--Dr. Bolton, at the request of the Office of Technical Support-Agriculture, Bureau for Near East, travelled to Washington in January and presented a one day seminar on problems associated with adopting improved dryland agricultural technology in LDCs. More than 20 members of the NE Bureau and TAB attended. The deputy director of the host office wrote a letter commending Dr. Bolton for "an excellent job...the discussion covered a number of topics and he covered them well."

AID requested Dr. Jackson to accept membership on a team being established to carry out an extensive review of the barrani project in Pakistan in September 1977. The request was accepted and Dr. Jackson began background familiarization prior to departure.

FRENCH LANGUAGE LESSONS--French is becoming an increasingly important language as AID moves more aggressively in Africa. In order to better fulfill the OSU grant objective, an intensive 10-week conversational class in French was presented to the Techcom and project support personnel by members of the OSU Foreign Language Department during January-April 1977.

Seven point eight man months of professional time and $17,796.90 were used to improve the dryland advisory capability of the University.

E. DOMESTIC AND INTERNATIONAL LINKAGES

VISITORS--Groups and individuals concerned with dryland agriculture in LDCs visited OSU during the year and participated in discussions with various Techcom members and others at OSU. A listing of 40 short term visitors, and their affiliation, is attached as Appendix III.

OTHER--Dr. Fitch has been granted a leave of absence from OSU to join the Ford Foundation office in Cairo. He will be involved in a variety of socio-economic studies related to dryland farming throughout North Africa, Sudan, and the Fertile Crescent.

Dr. Bolton has been scheduled to travel to Turkey in spring 1978 to participate in a review of the AID-Rockefeller wheat improvement program.

The Techcom presented a one-day seminar for the entire OSU School of Agriculture staff to make known the objectives, activities, and progress of the dryland program.

OSU also provided $10,000 to the CID administrative office to further the liaison capabilities of the consortium. An additional $10,000 will be given each year of the remaining life of the grant. The consortium provides an ideal unit for close cooperation and effort on international projects. The associated universities can pool talent and collectively provide better service to the developing world.

Eleven thousand one hundred and forty nine dollars and 4.9 man months of project effort were used in creating and strengthening linkages.

OTHER RESOURCES FOR GRANT-RELATED ACTIVITIES

Oregon State University is making a major contribution to the objectives of the grant through the free use of University facilities and administrative staffs. While this contribution was understood at the time of awarding the grant, its importance to the success of the grant should not be overlooked. The library provided support through the efforts of the William Jasper Kerr agricultural librarian.

UTILIZATION OF INSTITUTIONAL RESPONSE CAPABILITIES IN DEVELOPMENT PROGRAMS

Tables in the attached Appendix provide information concerning requests for assistance received by the grant as well as a log of visitors. The Techcom also responded to two AID requests for submitting project proposals, as mentioned earlier.

NEXT YEAR'S PLAN OF WORK

Activities for the coming year are described by major objective/output.

1. CENTRALIZED INFORMATION SYSTEM

Continued effort will be directed toward collecting, evaluating, and--as practicable--disseminating dryland information obtained worldwide. The computerized dryland bibliographic work will be carried forth. In particular, additional emphasis will be placed on enlarging the scope of the BIBLIOGRAPHY in the areas of range management and plant-animal interaction.

The expanded and revised BIBLIOGRAPHY will be made available, including a separate duplicate number index to facilitate use of the listings in the document.

With the main bibliography as a base, a service will be developed to provide a current awareness program which will alert Techcom members to new information as soon as it is published.

The library group will continue to keep in touch with other members of the CIDNET team, especially the effort at the University of California, Riverside, and the machine-searchable data base at UCR.

Other possible areas that will receive attention during the year involve interlibrary loan activity, services to graduate students, and searches of the LIRS on-line data bases.

2. EDUCATION AND TRAINING PROGRAM SPECIFICALLY ADDRESSED TO PROBLEMS OF LDCs

A month long dryland workshop will be held in Oregon during late June and early July to provide training and research experience for LDC representatives currently attending U.S. institutions in connection with other programs.

The tentative schedule calls for an initial week of classes covering the basics of dryland practices, followed by travel to the Moro training and research center for a period of field work, equipment familiarization, and exposure to research activity. A field tour of dryland range-cereal production areas will follow, winding up with return to western Oregon for a tour of winter annual legume research plots and conclusion of the workshop. Up to 20 participants are expected, according to early indications.

A continuing effort will be made to involve graduate students in various disciplines and phases of the dryland work. In particular, the master of agriculture degree with emphasis in dryland agriculture will be accorded special attention. The detailed leaflet describing the program will become available and will be distributed widely.

3. INSTITUTIONAL RESEARCH CAPABILITY AND KNOWLEDGE BASE

A first draft of the complete STATE OF THE ARTS document will be prepared and circulated for review, comment, and possible revision. The first draft is scheduled for completion January 1, 1978. Approximately six months will be necessary for publication.

An omnibus research proposal is under consideration for developing into a formalized proposal with a goal of implementation in FY 1979. A meeting is scheduled for late fall 1978 to develop the proposal for AID funding. Representatives from AID will participate in the meeting.

Research supported by mini-grants under the parent grant will continue with some preliminary data expected to be developed in the year ahead. The research has been designed to answer questions of importance in developing countries. Hopefully, through the omnibus proposal, funds will be provided to extend the research to a North African country for verification.

The Techcom will continue to review and evaluate opportunities for involvement that originate with CID as well as AID and, possibly, other organizations. A great number of opportunities are offered. Project personnel have spent, and will continue to spend, whatever time is necessary to properly evaluate opportunities as they arise.

4. INCREASED ADVISORY CAPACITY

Drs. Bolton and Jackson have been requested to join teams reviewing existing AID supported programs. In September, Dr. Jackson will travel to Pakistan

to assist with review of the barrani project. Dr. Bolton will join several other experts to visit Turkey for a review of the wheat production program.

OSU, through the Techcom and the Office of International Agriculture, will continue to readily accept requests for proposal submission and to provide careful scrutiny of such requests as well as a response. Also requests for direct technical support will be taken under advisement and responded to affirmatively as feasible.

5. DOMESTIC AND INTERNATIONAL LINKAGES

A close tie with the Rockefeller Foundation regional office in Cairo will result from Dr. Fitch's association with that effort.

Members of the Techcom plan to visit institutions in Sudan, Jordan, Tunisia, and Syria, including ICARDA (International Center for Agricultural Research in Dry Areas) during the coming year. John Doolette, research agronomist at ICARDA and one of the world's authorities on medics (winter annual legumes), will visit OSU in November 1977 to exchange information and forge closer links between various programs. Leaders of ICARDA also are expected to be in Turkey at the same time as Dr. Bolton leading to the possibility of further information exchange.

Washington State University (WSU) applied for CID membership and was accepted in 1976. Dr. S. Miller met with WSU international program personnel--including the Moroccan seed project--and established linkage with that program. He also offered OSU's support wherever possible.

The wheat breeding program at OSU lead by Dr. Kronstad will continue to cooperate with the Techcom in areas of mutual interest. A joint spirit of cooperation exists within the two projects and will continue to be encouraged.

INVOLVEMENT OF MINORITY PERSONNEL AND WOMEN

All techcom members are regular employees of Oregon State University and its various departments. No new technical positions were created because of the grant; however, new hirings were necessary for the position of project secretary and the new professional position of project librarian. In addition student help was required in the library.

All classified and non-classified positions at Oregon State University are recruited through established procedure, utilizing and following the statement of the Office of Affirmative Action and Equal Employment. The positions of project secretary and librarian were both filled by women.

During the year four students worked as library assistants; all four were women.

Opportunities are being created for graduate training through the grant. Prospective students will be evaluated without regard to race, creed, religion, age, national origin, handicap, marital status, or sex. All academic departments and the OSU registrar are careful to abide by this standard.

Financial Report

Table F-1 Financial Summary

Categories	Total 5-Year Budget	1st Year Expenditures 7/1/75-6/30/76	2nd Year Expenditures 7/1/76-6/30/77	Cumulative Expenditures to July 1, 1976	Balance as of July 1, 1977
Academic Staff	$ 470,817	$ 67,340.00	$ 97,825.00	$165,165.00	$305,652.00
Classified Staff and Students	78,183	3,234.00	16,048.05	19,282.05	58,900.95
Total Salaries and Wages	549,000	70,574.00	113,873.05	184,447.05	364,552.95
Other Payroll Expenditures	82,822	10,147.84	16,504.45	26,652.29	56,169.71
Materials and Services	83,678	1,569.91	5,102.99	6,672.90	77,005.10
Computer Costs	17,000	676.62	2,355.14	3,031.76	13,968.24
Publication Costs	20,000	0	334.57	334.57	19,665.43
Travel	127,500	13,869.24	34,145.99	48,015.23	79,484.77
Contribution to CID	50,000	10,000.00	10,000.00	20,000.00	30,000.00
Equipment	70,000	5,143.50	32,104.33	37,247.83	32,752.17
TOTALS	$1,000,000	$111,981.11	$214,420.52	$326,401.63	$673,598.37

Table F-2 Expenditure Report for July 1, 1976 to June 30, 1977

I.	A. Salaries			
	Academic			$92,126
	B. Other			
	Library		$5,699.00	
	Clerical		7,925.75	
	Other Non-Professional		8,122.30	
				21,747.05
	TOTAL SALARIES AND WAGES			113,873.05
	C. Fringe Benefits			16,504.45
II.	Student Support			-
III.	A. Consultants			-
	B. Guest Lecturers, Visitors, etc.			6,035.28
IV.	TRAVEL	TOTAL NO. OF TRIPS	TOTAL AMOUNT	
	A. Domestic	64	$9,726.72	
	B. Foreign	4	18,633.99*	
				28,360.71
V.	Equipment			
	One crawler tractor	19,190.58		
	One subsoiler	1,177.00		
	One chisel-sweep plow	1,073.10		
	One offset disk	2,274.50		
	One sprayer	789.65		
	One used Husky tractor	400.00		
			24,904.83	
	Other		7,199.50	
	TOTAL EQUIPMENT			32,104.33
VI.	Library Acquisitions			794.00
VII.	Publications			334.57
VIII.	Other			16,414.13
	TOTAL			$214,420.52

Table F-3 Expenditure Report, Actual and Projected Summary

	Expenditures to Date		Projected Expenditures			Total
	Reporting Period	Cumulative Total	YEAR 3	YEAR 4	YEAR 5	
Academic Staff	$97,825.00	$165,165.00	$109,366	$116,862	$80,231	$471,624
Classified Staff & Students	16,048.05	19,282.05	12,032	16,366	17,703	65,383
Total Salaries & Wages	113,873.05	184,447.05	121,398	133,228	97,934	537,007
Other Payroll Expenditures	16,504.45	26,652.29	20,638	22,649	16,650	86,589
Materials & Services	5,102.99	6,672.90	23,500	23,000	21,031	74,203
Computer Costs	2,355.14	3,031.76	4,500	4,500	4,500	16,532
Publication Costs	334.57	334.57	7,000	4,000	4,000	15,335
Travel	34,145.99	48,015.23	38,000	29,000	19,218	134,233
Contribution to CID	10,000.00	20,000.00	10,000	10,000	10,000	50,000
Equipment	32,104.33	37,247.83	20,000	18,853	10,000	86,101
TOTALS	$214,420.52	$326,401.63	$245,036	$245,230	$183,333	$1,000,000

Table F-4. Distribution of 211(d) Grant Funds and Contributions from Other Sources of Funding, Reporting Period July 1, 1976 to June 30, 1977

Grant Objectives/Output	211(d) Expenditures				Non 211(d) Funding Amount
	Period under Review	Cumulative Total	Projected Next Year	Projected to End of Grant	
Centralized Information System	$28,946.77	$48,185.95	$24,504	$ 42,856	$2,000 library
Education and Training	44,813.89	65,919.88	61,259	107,141	--
Research Capability & Knowledge Base Information	111,713.09	160,261.97	122,518	214,282	4,500
Advisory Capability	17,796.90	23,814.89	24,504	42,856	--
Domestic & International Linkage	11,149.87	28,214.94	12,251	21,428	--

APPENDIXES

Appendix I - Work Plan (Revised)

Appendix II - Requests for Assistance and Action Taken

Appendix III - Short Term Visitors

Appendix IV - Foreign Graduate Students in the School of Agriculture (OSU), 1977

Appendix V - Grant Personnel

Appendix VI - Techcom Trip Reports

Oregon State University

MOISTURE CONSERVATION AND UTILIZATION
IN LOW WINTER RAINFALL AREAS OF LDCs

211(d) Program

AID/ta-G-1221

WORK PLAN (Revised 3/77)

OUTPUT: #1 Centralized Information System

ACTIVITY	STAFF	START/FINISH DATES	SCHEDULED EVENTS/TARGETS	EXPECTED RESULTS
A) Collect, evaluate, inventory and disseminate information covering current LDC, U.S. and other developed countries' dryland agricultural production systems.	All	Sept. 1975-Sept. 1977	CID Information Workshop Sept. 22-26, 1975.	Published information summary and computer listing of available reference materials at OSU and other CID institutions.
1) Assessment of availability of current information already assembled at UCR, other CID Universities, and other institutions and/or agencies (USDA, FAO, etc.).	All		Visit UC/R Oct. 1975.	
2) OSU library linked to UCR and CID library information systems.	Lib.			
3) Assist in developing integrated information system in cooperation with CID Universities.	Lib., Dir.			
4) Develop an information dissemination system consistent with available resources.	Lib.	Jan. 1977	Active functioning program.	Dryland information more readily available to LDC scientists.
B) Integrate information from the State-of-the-Art survey of LDC's in low rainfall areas into the information system.	Lib.	Cont. through Jan. 1978		
C) Inventory sources of individual and institutional talent within LDC's and developed countries.	All	Cont. through July 1978	Questionnaire sent to all OSU Faculty - Jan. 1976; incorporation of talent into general CID pool.	Improved response capability.
D) Disseminate new knowledge from the State-of-the-Art survey through textbooks, newsletter, technical bulletins and extension-type publications.	All	Cont. through July 1978	Determination of appropriate method of dissemination July 1978.	Improved scientific awareness of the State-of-the-Art.
E) Design and develop an information retrieval system for acquisitions and dissemination of materials from the information bank, in cooperation with CID.	Lib., Dir.	Sept. 1975 - Jan. 1976	CID Information Workshop Sept. 22-26, 1975; initiate information retrieval systems Nov. 1975.	A computerized, searchable retrieval system available to scientists conducting research in dryland areas.

Oregon State University

MOISTURE CONSERVATION AND UTILIZATION
IN LOW WINTER RAINFALL AREAS OF LDCs

211(d) Program

AID/ta-G-1221

WORK PLAN (Revised 3/77)

OUTPUT: #2 Education and training program specifically addressed to problems of LDC's

ACTIVITY	STAFF	START/FINISH DATES	SCHEDULED EVENTS/TARGETS	EXPECTED RESULTS
A) Identify LDCs' educational needs in dryland agriculture as part of the State-of-the-Art survey.	All	March 1976 - Oct. 1976	On-site visits to Med. region March-May 1976; Sept.-Oct. 1976.	Identified education needs and priorities for both formal and informal training.
B) Establish an interdisciplinary curriculum committee to evaluate existing course offerings and to identify areas of need.	All	Jan. 1976 - March 1976	First draft of suggested curriculum changes, Feb. 1976.	Improved curriculum for formal training in dryland production and utilization.
C) Develop capacity to handle an increased number of LDC and U.S. graduate students in disciplines associated with dryland agriculture.	All		First student arrivals, Sept. 1976.	6 Ph.D. and 15 M.S. in progress by Fall, 1978.
D) Develop resources to conduct pilot basis short courses on specific topics involving dryland agriculture for: a) senior policy decision makers; b) junior technical personnel, either at OSU or at selected sites.	All		Course in integrated livestock-cereal production systems to be offered in late Spring, 1978.	
E) Develop special courses, workshops and conferences as needed for AID and CID personnel.	All	April 1977	Symposium on dryland agriculture in cooperation with the UC/R.	Topics: Tillage and moisture conservation; Farm implements and machinery; Crop & livestock interrelationships; Cereals & Forage production; Grazing systems; Dryland agricultural systems.
F) Establish an education, training, and research base in dryland crop production at the Sherman Branch Station near Moro, Oregon.	All	Nov. 1975 - Termination of project	Equipment needs to be specified Fall, 1975; equipment to be purchased Fall, 1975 - Spring, 1976; first applied field trials to be started Fall, 1976.	Completed training and research center for applied research and extension training.

Oregon State University

MOISTURE CONSERVATION AND UTILIZATION
IN LOW WINTER RAINFALL AREAS OF LDCs

211(d) Program

AID/ta-G-1221

WORK PLAN (Revised 3/77)

OUTPUT: #3 Research Capability and Knowledge Base will be Improved.

ACTIVITY	STAFF	START/FINISH DATES	SCHEDULED EVENTS/TARGETS	EXPECTED RESULTS
Carry out preliminary steps for on-site visit to Mediterranean.	All	Oct. 1975-Mar. 1976	Selection of team members; initial review of literature; determination of meaningful data to be collected; identification of countries and persons to be visited; schedule meeting with AID, CID and UC/R to coordinate mutual activities and share accumulated knowledge.	Written on-site visitation plan and schedule; awareness of the program of UC/R.
Prepare State-of-the-Art paper on dryland technology; sections to be included are:				
Cereal-production technology;	F.B.	Oct. 1975-Sept. 1977	Completed bibliographic review and identification of relevant literature; circulate rough drafts of various sections.	Completed State-of-the-Art paper.
Cereal-forage technology;	F.B., A.W.			
Cereal-equipment;	F.B., D.B.			
Forage-livestock;	A.W.			
Forage-livestock equipment;	A.W., D.B.			
Production economics;	J.F.			
livestock				
cereal				
Market and institutions;	J.F.			
livestock				
cereal				
Soil-moisture relations;	L.B.			
livestock				
cereal				

NOTE
Output #3 continued on next sheet.

Oregon State University

MOISTURE CONSERVATION AND UTILIZATION
IN LOW WINTER RAINFALL AREAS OF LDCs

211(d) Program

AID/ta-G-1221

WORK PLAN (Revised 3/77)

OUTPUT: #3 Research Capability and Knowledge Base will be Improved. (continued)

ACTIVITY	STAFF	START/FINISH DATES	SCHEDULED EVENTS/TARGETS	EXPECTED RESULTS
Carry out an on-site visit to the Mediterranean/ Near East region to compare existing conditions with State-of-the-Art.	All	March - May 1976	Evaluation of existing technology in the North African/Mediterranean area; countries to be visited include Morocco, Tunisia, Turkey, Iran and Pakistan.	Comparison report of existing conditions vs. State-of-the-Art.
Carry out an on-site visit to dryland areas of Australia	A.W., T.J., J.F., F.B.	Sept.-Oct. 1976	Familiarization and evaluation of Australian forage-cereal production system.	Useful contribution to knowledge of State-of-the-Art.
Develop research proposals on knowledge gap as identified by SOTA.	All	Jan.-July 1977	Develop a long term research proposal oriented toward further understanding the interrelationship between livestock and cereal production; submit proposal to AID/W by June 1977.	Completed research in one of the most important problems in dryland agriculture. The research will be multidisciplinary and fully integrated.
Serve as repository and principal institution for dissemination of knowledge with regard to dryland farming in low winter rainfall zones.	Lib.	Aug. 1975-July 1978	Determine system of collection and cataloging; obtain necessary materials through appropriate means including purchase when necessary; establish a literature search service.	Complete collection of published works; ability to send relevant materials to requesting agencies.

Oregon State University

MOISTURE CONSERVATION AND UTILIZATION
IN LOW WINTER RAINFALL AREAS OF LDCs

211(d) Program

AID/ta-G-1221

WORK PLAN (Revised 3/77)

OUTPUT: #4 Increased Advisory Capacity

ACTIVITY	STAFF	START/FINISH DATES	SCHEDULED EVENTS/TARGETS	EXPECTED RESULTS
Develop efficient advisory service to provide short-term and long-term consultants in dryland-related topics.	All	Jan. 1975 - June 1980	Initial capabilities to provide consultants to start by Jan. 1976 in dryland agronomy, soil management, agricultural economics, and weed control.	Increase competency in problem identification, analysis and design.
		July 1977	It should be noted that the agricultural economics component of the grant phases out July 1977 unless additional funding is provided.	Increase capability to assist in project operations dealing with education, research or extension.
		July 1977 - June 1980	Provide advisory and consultant service (in addition to the above) in livestock-grazing management systems and agricultural power and machinery specialties.	Increase capability to evaluate proposed and on-going programs and projects. Complete consultant and advisory service in: cereal production soil management/moisture conservation range management pest management including weed control farm management farm power and machinery management
Accept opportunities for staff to participate in special training programs, consistent with grant objectives, that are available through AID, CID and other groups.	All	July 1975 - June 1980		Improved staff response capability.
Provide for faculty exchange with other institutions or agencies.	Selected			Enlarge talent selection in pool.
Bring outside faculty to OSU to conduct seminars, workshops and conferences for staff improvement.	All	July 1975 - June 1980	Bill Wright (Rockefeller Foundation, Turkey) to discuss existing cereal forage production problems (Sept. 1975). Dr. R. J. French (Australian Dept of Agriculture) to discuss dryland research in Australia.	Staff education.

Oregon State University

MOISTURE CONSERVATION AND UTILIZATION
IN LOW WINTER RAINFALL AREAS OF LDCs

211(d) Program

AID/ta-G-1221

WORK PLAN (Revised 3/77)

OUTPUT: #5 Domestic and International Linkages

ACTIVITY	STAFF	START/FINISH DATES	SCHEDULED EVENTS/TARGETS	EXPECTED RESULTS
Prior to on-site visits, a close association between CID and OSU will be established to ascertain areas where interinstitutional approaches are desirable or where existing information can be exchanged. Special emphasis will be placed on the programs at U. of A. and UC/R where complementary activities and interties can be developed.	All	Continued	Preliminary meeting with UC/R to exchange information and solicit cooperation (Oct. 1975).	Close working relationship with CID universities, especially UC/R.
Professional partnerships will be established with USAID, CID, ICARDA, CIMMYT and FAO for the purpose of: initiating personnel exchange; developing contacts in LDC's and facilitating travel; fostering faculty-student exchanges; exchanging information; planning and conducting cooperative research programs or joint advisory services; and developing common training programs both in the US and LDC's. These latter inputs will be a continuing activity conducted throughout the program.	All: (Director to have special responsibility).	Continued	Contact with many of the institutions will be made in conjunction with on-site visits.	Close working relationship with international agencies and centers.
A strong linkage with Rockefeller Foundation, Ford Foundation, USAID and ICARDA will be developed to aid in identifying and financing individuals to participate in training programs at M.S. and Ph.D. levels. FAO can provide resources and identify people to participate in short courses and training programs of longer duration.	All	Continued	Contact will be made with the institutions during on-site visits. In addition, present personal and project linkages will be strengthened.	Facilitated flow of students to OSU to participate in training programs.
Linkages also will be forged with scientists in selected LDC's where cooperative research and training can be conducted. M.S. and Ph.D. students, on returning to their respective LDC's, will remain closely associated with the total program thus establishing permanent linkages.	All	Continued	A list of LDC scientists working in dryland areas will be developed. The possibility of providing information and scientific results through a periodic newsletter or other device will be explored. Cooperative research to be initiated with local scientists through new AID/OSU contracts (July 1978).	Closely knit group, if scientists aware of the state of the art and aware of work being conducted in similar ecological zones. Active research effort in adapting existing technology and developing needed new technology.

APPENDIX II - Requests for Assistance and Action Taken

Description of Request	Received from: Organization	Received from: Contact	Action Taken
Expression of interest in involvement in training programs in Iran	CID	Dr. Bruce Anderson	Expressed Interest
Associate Director of CID	CID	Dr. Bruce Anderson	No interest
Team Leader for Kenya Marginal Land Studies	CID Utah State	Byron Palmer	No interest
Senegal - Livestock Advisor, Range Management Specialist, Ag. Engineer	CID	John Fischer	No interest
Nomination for U.S. representative on Dryland Agriculture Work Group in the Sahel	CID	John Fischer	Circulated information; Sent 2 resumes
Expansion of Bolivia team - Ag. Economist, Soil and Watershed Management Specialist, Agronomist	CID	Keith Allred	Sent 4 resumes of those interested; OSU staff member considered for Ag. Economist position, but lacked Spanish
AID RFP 60014 - Morocco Dryland Farming Applied Research Team	CID	Dr. Bruce Anderson	Submitted proposal; unsuccessful, awarded to University of Nebraska
AID RFP 60015 - Morocco technical services in support of dryland farming and range rehabilitation plus determination of feasibility of establishing a domestic forage seed production capability	CID	James Wood	Submitted proposal; unsuccessful, awarded to Washington State Univ.
Expression of Interest in Integrated wheat development in Afghanistan	CID	Dr. Bruce Anderson	No interest
Dryland Agriculture Bibliography	AID/TAB/Wash	Delbert Myrern	Sent

Description of Request	Received from: Organization	Received from: Contact	Action Taken
Participation by Dr. Floyd Bolton in an AID/Near East Bureau Seminar on problems associated with adapting improved dryland agriculture technology in developing countries	Aid/Near East Bureau	Robert B. Morrow	Dr. Bolton attended and participated in the seminar
Nominations for short-term assignments in Ecuador - Agriculturalist, Agronomist, Ag. Engineer	CID	Dr. Bruce Anderson	No interest
Dr. James Fitch to speak on "Finding an Appropriate Technology for Farming in the Developing Countries"	Central Lane County League of Women Voters		Dr. Fitch spoke to the group
Dr. S.F. Miller to speak on international agriculture to OSU/Ag. Engineering Seminar	OSU/Dept. of Ag. Engr.	J.R. Miner	Dr. Miller spoke at seminar
Nominations and comments for Egypt team	CID	Dr. Bruce Anderson	Submitted names and vitae; Dr. Royal Brooks of OSU will be going on two-year assignment
List of retrained Peace Corps volunteers and their bio-data for possible AID/W African Bureau openings	CID	Irene Palmer	Circulated information for follow-up by dept. heads
FAO Divisional Directors	CID	Dr. Bruce Anderson	Unable to identify interested parties
Dr. S.F. Miller to speak to Home Economics Administrative Committee	OSU/Dept. of Home Economics	Dean Betty Hawthorne	Dr. Miller spoke to the committee
Dr. S.F. Miller to speak to Plant Pathology students regarding international agriculture	OSU/Dept. of Botany Plant Path.	Anne Anderson	Dr. Miller spoke to the students
Information regarding applying for work on the Egypt project	Harvard Law School	Grace Goodell	Sent her resume to Dr. Richardson, team leader at Colorado State University
Reaction to proposal by Bechtel Corp. that CID be a subcontractor with them on a major contract in Algeria	CID	Dr. Bruce Anderson	Solicited opinions and responded in the negative

Description of Request	Received from: Organization	Received from: Contact	Action Taken
Information on 211(d) project at OSU	Academy for Educational Development, Inc. Wash.	Peter Boynton	Sent annual report
Biodata on those interested in Indefinite Quanitty Contracts (IQC) in fields of Agriculture and Engineering	CID	Dr. Bruce Anderson	Circulated, collected, and sent approximately 35 contractor Biographical data Sheets on interested OSU staff
Dr. S.F. Miller to speak on international agriculture to Faculty Women's Club	OSU/Faculty Women's Club	Mary J. Lewis	Spoke to Faculty Women's Club
Training for Syrian food technology administrator in conversion of onion dehydration equipment to other vegetable dehydration	USDA	Judith Evans	No facilities at or near OSU, also off-season; suggested UC/Davis
Dr. S.F. Miller to serve as member of 2-week CID/ Bolivia Review Team	CID	Keith Allred	Dr. Miller went to Bolivia as team member May 11-26
Dryland Agriculture Bibliography	USAID/Pakistan	Richard Newberg	Sent
Expression of interest in AID RFP for Lesotho	Washington State Univ.	Martin Waananen	Discussions in progress
OSU Team to go to Indonesia to prepare a study on the feasibility of growing wheat grain in Indonesia	P.T. Bogasari Flour Mills, Jakarta	S.G. Yap	Expressed interest pending more information
Expression of interest and possible financial assistance for trip to U.S. to assist in construction of the annual forage legume crop rotation system in eastern Oregon	CIMMYT (ICARDA) Tunis	John Doolette	Pending; expressed interest; will pay expenses if necessary, Nov. '77 desired date of visit
3-month seed training program for Tunisian agronomist	USDA	E.A. Bolling	Denied due to lack of lead time and the need for more than 1 student to make efficient use of staff time

Description of Request	Received from: Organization	Received from: Contact	Action Taken
Expression of interest in Honduras project and nominations for short-term assignments	CID	Dr. Bruce Anderson	Circulated, nominated 2 people
Nominees for INRAN/Applied Economic Research and and Statistics Project in Niger and input for decision as to submittal and implementation of project	CID	John Fischer	Sent bio-data on more than 10 OSU ag. economists and statisticians as well as statement of non-interest in lead university status
Expression of interest in lead university status and nominees for potential team members on the Upper Volta Village Livestock Development Project	CID	John Fischer	No interest
Review of Phase I of State of the Art Paper on Water Harvesting	CID (U. of Ariz.)	D.B. Thorud	Reviewed by Dr. John Wolfe

APPENDIX III - Short-term Visitors

Name	Country	Dates	OSU Contact(s)	Arranged by (Name)	(Organization)
Mrs. Sarada Ojha (FAO Fellow)	Nepal	6/76-3/77	Danielson	E.A. Bolling	USDA
Solomon Bellete (FAO Fellow)	Ethiopia	9/75-9/78	Stevenson	Freeman Daniels	USDA
Prof. B. Ristevski	Yugoslavia	7/6-7/76	Lagerstedt Thompson	F.E. White	USDA
Edilberto Possamai	Brazil	7/21-22/76	Danielson J. Park Grabe	H. Dean Bunch	Miss. S. Univ.
Luciano Gomes	Brazil	7/30/76	Danielson Grabe Park	H. Dean Bunch	Miss. S. Univ.
Benedito de Souza Gloria Fernandez	Brazil Brasil	8/16-17/76	Koepsell Cain Mansour Grabe Park	H. Dean Bunch	Miss. S. Univ.
Christopher Norris Lindsay Ward Maxwell Middleton Allan Elwood	Australia	8/26-27/76	Ramig	Virginia Lemmich	USDA
Kamel Belkhodja Moncef Ben Said Ali Ben Zaid Salmi	Tunisia	9/1-3/76	Bolton Davis Stevenson Foote Martin Hilderbrand Eisgruber Fitch Conklin Young Nelson Purvis Joliff	Werner Kiene	Ford Foundation

Name	Country	Dates	OSU Contact(s)	Arranged by (Name)	(Organization)
Yilmaz Akar	Turkey	11/8-12/76	Bolton Jackson Kronstad Anderson Winward Booster		CIMMYT
Charles Poulton	FAO	11/26/77	S.F. Miller	Himself	FAO
Michael Mapunda Raynald Mrope	Tanzania	12/15/76	Wadsworth Sidor	Juraj J. Slavik	Visitor Program Service, Meridian House Internation
Peng Yew Tan (FAO Fellow)	Malaysia	1/3-2/28/77	Chaplin	E.B. Terwilliger	USDA
Kutlu Somel	Turkey	4/11/77	Fitch	Fitch	Mid-East Tech. Ur
Mr. & Mrs. Ramiro Andrade Mr. & Mrs. Adimir Henning	Brazil	1/4-5/77	Grabe Park	H. Dean Bunch	Miss. St. Univer.
Jans Nannerup	Denmark	1/13-17/77	Oldfield Hardin	V. Lemmich	USDA
Zenon Muszynsky	Poland	3/28/77	Currier	J.O. Butcher	USDA
Mehmet BulBul	Turkey	4/25-27/77	Jim Fitch	Himself	Univ. of Ankara
Mohamed StaM'Rad	Tunisia	4/28-30/77	Bolton Appleby Hepworth Kronstad Cooney Davis Wadsworth Lund Allmaras	Richard Affleck	USDA

Name	Country	Dates	OSU Contact(s)	Arranged by (Name)	(Organization)
Elizabeth Nettey Sanaa El Sayed Fleur de Lys O. Torres Fatima Hussien Al-Hamdani Aina Hussien Al-Fadly	Ghana Egypt Philippines Yemen Yemen	6/6-10/77	Hawthorne Bussard Litchfield Wadsworth Tucker Trow Staton Spears-Gray Straatman Johnson Lewis Raab Burridge Yearick S. Miller	Fleming Heegaard	USDA
M. Sefik Yesilsoy	Turkey	4/25-26/77	Fitch Bolton	OSU	Adana University
Jamal Fuad	Libya	7/1/77	Bolton		UNDP
Ahmed Moussa El Ali Faik Bahhadi	Syria	7/5/77	Bolton		Dir. of Ag, Aleppo Dir. of Livestock Prod. Aleppo Prov.
David Ariel	Israel	7/6-8/77	Goetze S. Miller Bolton		Cereal Crops Div. M.D.A.
Norman Borlaug Glenn Anderson	Mexico	7/10-11/77	Kronstad Bolton		CIMMYT
Paul Marko	Mexico	6/30-7/1/77	Burrill Deutsch Bolton		CIMMYT
R.B.L. Bhardwaj	India		Bolton Deutsch		Agronomy, IAR
M.L. Parkipuny	Tanzania		R. Miller		Masai Range & Livestock Develop. Proj.

APPENDIX IV

FOREIGN GRADUATE STUDENTS
in the School of Agriculture (OSU), 1977

Name	Country	Specialization
Gideon Abraham	Ethiopia	Agricultural Economics
Adeshina Aderibigbe	Nigeria	Animal Science
Abdulilah M. Al-Ani	Iraq	Horticulture
Khosrow Amiri	Iran	Agricultural Economics
Marcos V. Assuncao	Brazil	Crop Science
Yaw Atuahene	Ghana	Agricultural Economics
Solomon Bellete	Ethiopia	Agricultural Economics
Abdellatif Belmehdi	Morocco	Crop Science
Abraham Benitez	Mexico	Food Science
Pedro Brajcich	Mexico	Food Science
Robert Bromley	Canada	Wildlife Science
Carlos Camargo	Brazil	Crop Science
Vanderlei Canhos	Brazil	Food Science
Yih Chang	China, Rep. of	Food Science
Rong-Yue Chao	China, Rep. of	Food Science
Kee Chai Chong	Malaysia	Agricultural Economics
Lorenzo de Rosenzweig	Mexico	Food Science
Marta L. Dondero	Chile	Food Science
Francisco Dubbern de Souza	Brazil	Crop Science
Mawuena Dzogbefia	Ghana	Crop Science
Elgasim Elgasim	Sudan	Animal Science
Yousef El-Shrek	Libya	Food Science
Asghar Eskandanian	Iran	Range Resources
Ching-Hua David Feng	China, Rep. of	Food Science

Name	Country	Specialization
Tarciso Filgueiras	Brazil	Crop Science
Ahmet E. Firat	Turkey	Crop Science
Yosef Geddeda	Libya	Horticulture
Edison Geromel	Brazil	Food Science
Manuel Gutierrez	Chile	Food Science
Jose Hennigen	Brazil	Crop Science
Ahmed Hussen	Ethiopia	Agricultural Economics
Abu El Hassan Ibrahim	Sudan	Crop Science
Kwang Hi Im	Korea	Agricultural Economics
Toshiaki Itami	Japan	Fisheries and Wildlife
Thomas Johnson	Canada	Agricultural Economics
Yuh-Mei Jong	China, Rep. of	Food Science
Ahmad S. Khan	Pakistan	Agricultural Economics
James Kollmorgen	Australia	Botany
Michel Kulbicki	France	Fisheries Science
Jae Sung Lee	Korea	Food Science
Julio C. Lhamby	Brazil	Crop Science
Hardi Kian-Hong Liauw	Indonesia	Veterinary Medicine
Claudio Lovato	Brazil	Crop Science
Huey-Sheng Chao Ma	China, Rep. of	Food Science
Carlos Madero	Mexico	Food Science
Felix Mathenge	Kenya	Crop Science
Marlene Matos	Brazil	Crop Science
Mei-chen Miaw	China, Rep. of	Food Science
Byung Min	Korea	Veterinary Medicine
Raul Moreno	Chile	Crop Science
Marut Muangkoe	Thailand	Agricultural Economics

Name	Country	Specialization
Firoozeh Naaseh-Shahri	Iran	Food Science
Pierre Ngaba	Cameroon	Food Science
Joe Eric Ngam	Cameroon	Animal Science
Dennis T. O'Brien	Australia	Agricultural Economics
John B. Okoro	Nigeria	Animal Science
Eligio Ortega-Rivas	Mexico	Animal Science
Engin Ozdilek	Turkey	Crop Science
Maria Lucia Paez	Brazil	Agricultural Economics
Paulo Paez	Brazil	Agricultural Economics
Vichien Petpisit	Thailand	Crop Science
Aimee Rabakoarihanta	Madagascar	Horticulture
Lekkala Reddy	India	Crop Science
Enrique Rico	Mexico	Horticulture
Philip Rolston	New Zealand	Crop Science
Benigno Rotta	Brazil	Crop Science
Kenneth Russell	Canada	Agricultural Economics
Rubens Sader	Brazil	Crop Science
Harash B. Saluja	India	Agricultural Engineering
Ariel Santos	Mexico	Animal Science
Promode K. Shah	India	Crop Science
Chin Aik Soh	Malaysia	Horticulture
Colin Sorhus	Canada	Resource Recreation
Gody Spycher	Switzerland	Soil Science
Tumi Tomasson	Iceland	Fisheries Science
Glafiro Torres-Hernandez	Mexico	Animal Science
Jacobo Totesautt	Venezuela	Range Resources
Jose Valencia-Villarreal	Mexico	Crop Science

Name	Country	Specialization
Mei-Hwa Wang	China, Rep. of	Horticulture
Wei Wang	China, Rep. of	Crop Science
Benny Wanjala	Uganda	Fisheries Science
Yueh-Kei Kristein Wong	China, Rep. of	Horticulture
Yun-Fu Yin	China, Rep. of	Horticulture
Suntaree Yingjajaval	Thailand	Soil Science
David Yodkovik	Israel	Fisheries Science
Dale Zobell	Canada	Animal Science

APPENDIX V - GRANT PERSONNEL

Floyd E. Bolton - Agronomist, 1.00 FTE, July 1, 1976 to June 30, 1977.

Dean E. Booster - Agricultural Engineer, .25 FTE, July 1, 1976 to June 30, 1977.

Patty Brown - Secretary, 1.00 FTE, August 16, 1976 to June 30, 1977.

James B. Fitch - Agricultural Economist, .50 FTE, July 1, 1976 to June 30, 1977.

Thomas L. Jackson - Soil Scientist, .50 FTE, July 1, 1976 to June 30, 1977.

Richard S. Miller - Rangeland Specialist, .25 FTE, January 1, 1977 to June 30, 1977.

Stanley F. Miller - Director and Agricultural Economist, .50 FTE, July 1, 1976 to June 30, 1977.

A.H. Winward - Rangeland Specialist, .50 FTE, July 1, 1976 to June 30, 1977.

Assisted by A.E. Deutsch and G.S. Knapp, staff members of the Oregon State University Office of International Agriculture.

AUSTRALIA TRIP REPORT
October 3-22, 1976
T.L. JACKSON & A.H. WINWARD
211(d) AID Dry Land Project
List of Individuals Contacted

Sydney

Dr. F.C. Butler, Sr. Deputy Director N.S.W. Dept. of Agr.
Dr. Ken Hutton, Chief Div. Res. Serv.
John Dillon, Administrative Assist.
Bob Kommoll, Liaison with Wheat Industry Res.
Bob Johnson, Extension Agronomist
John Ballard, Soil Agronomist

Wagga Wagga N.S.W. Area of Research

Dr. Al Smith, Regional Director of Res. N.S.W. Dept. of Agr.
Mr. T.B. Spence, Soil Fertility
Mr. E.J. Corbin, Oil Seed, Grain Legumes New Crops, Cropping Systems
Mr. A.A. McNeill, Minimum Tillage, Crop Residue Mgt.
Mr. G.O. Batten, Soil Testing, Soil Chemistry
G.H. Osborne, Sub Clover Research - (Lime x P x Mn)
Roger Southwood, Pasture and Animal Mgt.
Mike Curll, Pasture and Animal Mgt.
R.D. Fitzgerald, Pasture and Animal Mgt.
Ted Wolfe, Pasture-cropping systems, Sub Clover var., Temora-substation

Rutherglen Research Station, Victoria Dept. of Research

Dr. Arthur Mann, Director
Tim Reeves, Agronomy Ldr.
Tony Ellington, Soil Fertility Research
David Hamilton, Livestock Mgt. (Cattle-Sheep) Research
John Reeve, Livestock Mgt. (Cattle-Sheep) Research
E.G. Baker and Sons, Farmers

Bendigo-Victoria

Ian Smith, Ext. Dist. Agronomist N.W. Dist. Ext. Office
Bryan Carnow, Pasture Mgt. Extension Specialist
Allan Broadbent, Farmer

Horsham-Victoria Wheat Research Inst.-Victoria

Frank McClelland, Dist. Agronomist and Agronomic Research
Dr. Graham Bath, Officer in Charge-Victoria Dept. of Agr.
Jim Kollmorgen, Plant Pathologist
Dr. Graeme Ford, Soil Scientist

Walpeup-Malee Research Station-Victoria

Dr. John Griffiths, Mgr. and Officer in Charge
Mr. Dave Coventry, Legume Mgt. and Research Coordinator
Dr. Ivan Mock, Barley & Lupins Research
Mr. Don Wolsgot, Wheat Variety Testing

South Australia

Mr. Tim Prance, Dist. Agronomist, Bordertown
Mr. Neville Franks, Farmer on Loamy Clay Soil

Adelaide Area-S.A. Dept. of Agr.

Mr. Arthur Tideman, Chief Agronomist, S.A. Dept. of Agriculture
Mr. Reg. French, Agronomy Officer
Mr. Gill Williams, Act. Sr. Agronomist
Mr. Don Russell, Livestock Officer
Mr. Brian Rodda, Farmer-Medic, Wheat Systems-York Peninsula
Mr. Rex Krause, Principal Research Office, Northfield Research Station
Mr. Ted Higgs, Sr. Research Officer, Northfield Research Station
Mr. Doug Reuter, Soil Fertility Specialist
Mr. Eric Crawford, Parafield Research Station, Officer in Charge
Mr. Harold Nourse, Turrett Field Research Station
Mr. E.D. Carter, Agronomy Sr. Lecturer, Waite Res. Inst.
Dr. I.P. Quirk, Dean and Director, Waite, Res. Inst.
Dr. Allden, Act. Head Agronomy, Waite Res. Inst.
Dr. Don Puckridge, Agronomist, Waite Res. Inst.
Dr. G.D. Lewis, Soil Scientist, Waite Res. Inst.
Dr. A.R. Egan, Agronomist, Waite Res. Inst.
Dr. Bryan Cartwright, Soil Scientist, CSRIO
Mr. Brian Jefferies, Principal Livestock Officer, S.A. Dept. of Agr.
Mr. Tom Bond, Grazier, and Farmer
Mr. Bob Hannam, Micronutrient Res.-Northfield Res. Station
Dr. Bob Kuchel-CSRIO

Broken Hill-New South Wales

Mr. Roger Stanley, SCS-Broken Hill
Mr. John Lawrie, SCS-Broken Hill
Peter and Mary Beven, Grazier Sturts Meadow Station
Fowlers Gap Research Center

Sidney-N.S.W.

Dr. Jim Vincent, Soil Microbiologist-Sydney Univeristy
Dr. Ross Barlow, Agronomist-Macquarie University
Prof. F. Milthrope, Head Biology Dept.-Macquarie University
Dr. Peter Hughes, Plant Physiologist-Macquarie University
Dr. Mark Westoby, Range and Pasture, Biology Dept.-Macquarie University

We had six major impressions concerning our trip to Australia. These were: (1) the widespread belief in the "Australian System" of legume-livestock-wheat farming, (2) the interdependence of the livestock production systems in different rainfall areas, (3) the minimal use of hired labor, (4) the very adverse soil conditions found in cultivated fields, (5) the extreme variability in the rainfall, and (6) the very hospitable reception we received from all Australian agricultural workers and farmers that we visited. Each of these points will be discussed in some detail.

The Australian System

The Australian system of legume pastures-livestock-wheat production programs is almost a national policy among agriculturists we visited in New South Wales, Victoria and South Australia. Wheat production on a per acre basis was on the decline from about 1870 to 1900. With implementation of a fallow system in the early 1900's production climbed to the 1870 levels (about .5 tons/ha). However with the introduction of legumes into the rotation in the 1950's production has more than doubled. The essential components of this system are (1) optimum sulfur, phosphorus, and micronutrient fertilization for the legumes to provide maximum nitrogen fixation, (2) the use of livestock to harvest the legume pasture crop with major emphasis on maximum use of forage in a way that American producers might consider at the expense of livestock, and (3) production of a cereal crop to harvest the nitrogen fixed by the legume and returned by the livestock.

Essentially all research and demonstration programs are designed to study the effect of a variable or change in practice on the total system. In the subclover - crop producing areas that we visited in New South Wales, and

Victoria, the subclover pasture is generally maintained for three or four years followed by three or four years of a cereal crop. In the areas that produce annual medics, which are generally areas with less rainfall and non-acidic soils, the crop production systems usually have one year of legume followed by one year of a cereal crop. The livestock numbers on an individual farmer's operation tend to fluctuate with the feed supply. Wool producing wethers provide a balance since they can be sold from the farm or increased in numbers fairly readily. They also provide a class of livestock that can survive the frequent wide fluctuations in seasonal availability of feed with large losses in body weight.

Wheat production with the summer fallow system started during the latter part of the eighteenth century. This system of farming resulted in maximum oxidation of soil organic matter to provide nitrogen and phosphorus for the wheat crop. Serious soil erosion and loss of soil organic matter occurred. The legume system of farming was developed in the late nineteen forties and early fifties. Prices were higher for meat and wool products so that emphasis was placed on use of phosphorus and sulfur fertilization of legumes to give maximum nitrogen fixation from the forage crop. The wheat and other cereal crops were grown to harvest the nitrogen that had been fixed by the legume with the land being returned to a legume pasture crop as soon as the availability of nitrogen reduced the normal yields of the grain crop.

Major emphasis has been placed on the use of legumes and grasses to increase soil organic matter to reduce erosion, improve soil physical condition, and to increase the availability of nitrogen for the grain crop that follows. Wheat stubble is generally pastured and then burned, even on the experiment stations, to reduce any possible nitrogen immobilization from incorporation of crop residue.

In this system of farming, anything other than a "short fallow" will result in excess release of N from decomposition of legume residues, especially the first year following pasture. This extra availability of nitrogen frequently results in "haying off" whenever soil moisture is less than optimum. When the wheat stubble is burned, the second wheat crop frequently has optimum nitrogen. The third crop, which is often barley, will have reduced yields from lack of nitrogen and the subclover pastures are reseeded into the barley stubble. A shorter rotation is used in many of the medic producing areas, with medic being produced one year and wheat or barley the next.

As the price of livestock products have decreased and the relative price of wheat has increased, emphasis has been placed on optimum fertilization of the wheat crop with phosphorus to maximize wheat yields with the assumption that residual phosphorus from the wheat crop will carry the legume crop.

Livestock and Livestock Systems

The sheep industry is the most important rural industry in Australia accounting for almost one-third the gross value of all rural production. Wool and fat lambs are a major source of foreign exchange. Sheep numbers have declined from a record of 180 million head in 1970 to approximately 130 million today. The decrease is related primarily to reduced wool and meat prices. Cattle, on the other hand, have increased from 22 million head to 29 million head during this same period. However, current suppressed beef prices and the new U.S. meat import quotas are having an effect on cattle numbers during 1976. Cattle are generally Herefords or Hereford X Short Horn crosses, and most meat is sold as grass-fat beef.

The production of sheep in the different rainfall areas are interrelated. The Merino wool breed is produced in the drier, desert areas of central

Australia. In these operations, a pure bred line of merinos are maintained for replacements for the home flock or a portion of the Merino ewes are bred to Border Leister rams to provide ewe replacement for the fat lamb farms in the higher rainfall areas where legume pastures are rotated with cereal crops. On the fat lamb farms, the cross bred ewes are bred to a Dorset or Schropshire ram, to produce the lambs that are marketed as fat lambs from Australia. Thus, a mark interdependence between the different livestock areas is essential to maximize returns from the systems of farming used.

Labor

It is a generally held tradition in Australia that land owners do all or most of their own work. It seemed to us that the Australian people pride themselves in the amount of land and animals each individual can manage. It is apparently not uncommon that one farmer manages several thousand head of livestock with either no outside help or only minimal help during high labor demand periods, e.g. shearing. A major reason cited for this philosophy was the price of labor. However, it appeared that on some operations the cost of labor could be offset by the reduced animal losses, increased lambing rates and the increased crop and pasture production that could be had with more intensive management.

The Soils

Land resources are extensive and relatively cheap. Labor, machinery, fertilizer, and other inputs have been relatively expensive. Most of the soils have quite high clay content, are often shallow, are difficult to cultivate, and by our standards, would be considered very poor crop producing soils. Under these conditions, the emphasis has been placed on fertilizing a

system, or a rotation, for maximum return from fertilizer rather than for maximum crop yields. There has been very little buildup of residual phosphorus fertilizer. Since nitrogen comes from the decomposition of legume residues and soil organic matter during the growing season, there is seldom a significant buildup of nitrate nitrogen during a fallow season as we know it in the Pacific Northwest. Under these conditions, testing soils for phosphorus and nitrate nitrogen does not have the potential for improving management decisions as it does in the Pacific Northwest where much heavier rates of fertilizer have been used and where fertilizer is relatively cheaper in comparison to returns from crops.

Variability in Weather Conditions

The continent of Australia has one major mountain range along the east coast that reaches a height of four to five thousand feet. Other "mountain ranges" reach an elevation of two to three thousand feet with a few 5000 ft. peaks. This means that there is no snow pack to maintain flow of water in the rivers and there are very few river systems with a significant flow of water. The rainfall appears to be extremely variable from year to year as well as for different seasons of the year. This causes a much greater fluctuation in yield potential than we normally encounter in the Pacific Northwest. Also, the large areas with relatively shallow soils and soils with very poor physical conditions do not have the potential to store moisture which could act as a balance to even out crop production as does many of our windblown soils in the Pacific Northwest.

The Hospitality of Australian Agricultural Worker

We certainly received a very hospitable welcome from all research and extension workers that we visited; individuals were very willing to provide

time to show us different agricultural production problems, and to provide us with publications, visits with farmers, and transportation to make our trip as efficient as possible.

The following is a series of comments of information and impressions obtained from individuals throughout the Australian trip.

Orientation Meetings in Sydney, October 5

We met with representatives from Dr. F. Butler's Office. Butler is senior deputy director of research for New South Wales.

Emphasis was placed on explaining the Australian system (the livestock-N Fixation by legumes-wheat production systems) that is followed throughout most of Australia. The following points were emphasized: Subterranean clover is the major legume grown in the areas with higher annual rainfall, droughty summers (We think because of the low percentage of hard seeds), and moderately acid to acid soils. However, it was pointed out that in some areas, with higher rainfall and dry summers, subclover was grown on soils with a pH above 7. Annual medics are the dominate legume grown on areas with lower rainfall and which normally have higher soil pH. Medics also are grown on some areas with moderate amounts of summer rainfall. Important perennial grasses seeded with subclover included tall fescue, orchard grass, perennial ryegrass and reed canary grass.

A major research effort is being directed toward identification of alternate legumes such as sweet lupins (with low alkaloid content), Australian winter peas, and faba beans that can be grown in combination with cereal crops to increase the percentage of years that are in a grain or cash crop enterprise. Various oil seed crops are also being investigated, but emphasis is being placed on new crops that will contribute to nitrogen fixation in the

system. Researchers emphasized that in some areas a greater dependency upon cash crop would make it easier for the growers to cope with the large fluctuations in annual feed production and the subsequent livestock carrying capacity. Considerable enthusiasm was expressed for the production of sweet lupins that have no alkaloids present and produce a grain crop ranging from 30 to 40% protein. The problems of scorch disease on subclover, a bacterial disease, was discussed. This is apparently one of the serious diseases appearing on subclover.

Points emphasized by individuals during our visit to the Wagga Wagga Research Center.

Mr. Spence and Mr. McNeil have been concerned with soil fertility and crop residue research work. They emphasized that nitrogen fertilization can result in reductions in yield on dry years while the response from phosphorus fertilizer will not be as great on dry years as on years with better moisture supply. There is almost never a reduction in yield from application of phosphorus or from applying two or three times the optimum rate of phosphorus.

In discussions with Smith, Batten, and Osborne, the problems of soil testing and predicting fertilizer response were reviewed. It was pointed out that emphasis had been placed on trying to identify the minimum level of phosphorus fertilization that would produce near optimum growth for a specific rotation and that this approach toward fertilization seldom resulted in a buildup of residual phosphorus where a soil test would identify fields with high levels of phosphorus that would not require fertilization for optimum yields. Continued use of phosphate over 30 to 40 years has resulted in some acidifying effect and they are beginning to investigate the possible effects of liming acid soils for production of subclover and nitrogen fixation by subclover.

Outstanding points noted and reviewed with Ted Wolfe and Roger Southwood on Pasture and Animal Management Research were: (1) The combination of alfalfa and subterranean clover as legumes in a pasture management system with emphasis being placed on determining the optimum stand density for alfalfa in this system. Alfalfa and subclover complement each other as forage sources since peak periods of production are at different seasons of the year. (2) The very heavy grazing or complete utilization of forage by livestock in their pasture management experiments. (3) The very wide range of subclover varieties that are being developed and tested at the Temora Sub Station, and (4) the potential that the subclover varieties have for producing forage that is low in estrogen content, mature at different seasons of the year and varieties that will persist under flooding conditions.

Important Points Emphasized During Our Visit to the Rutherglen Research Station

Director Arthur Mann and Agronomists Reeves and Ellington emphasized many of the points concerning the Australian system of legume, livestock cereal crop production that were emphasized at other stations. The most interesting aspect of the visit to the Rutherglen Research Station was the excellent production being obtained from sweet lupins and the apparent very high nitrogen fixation from lupins that resulted in increased yield of the wheat crop following the lupin crop. They reported that under optimum conditions yields of 5,000 pounds of grain per acre had been recorded in research plots and that protein content on research stations as well as on farmers fields has varied from 30 to 40 percent for the lupin grain. It seemed evident that in a subclover-wheat-wheat, lupin-wheat rotation that the production of wheat following the lupin crop appeared about equal to the first crop of wheat following the subclover pasture. The yield of wheat following lupins appeared to be approximately double the third cereal crop in a subclover wheat-wheat-wheat

rotation. Again emphasis was placed on the use of super phosphate fertilizers to maximize nitrogen fixation by the legume and to evaluate whether the greatest profit would be returned by fertilizing the wheat crop with high enough rates of phosphorus to carry over for the legume crop or whether phosphorus fertilizers should be applied to both the wheat crop and the legume crop. They emphasized that when land was summer fallowed during a summer season (four months preceding sowing the fall wheat crop in May) that nitrate nitrogen produced by incubation during this period is frequently lost by leaching or denitrification during periods of heavy winter rains. Apparently, even in areas with 15 to 20 inches of total rainfall, there will be periods during the winter where denitrification conditions exist on many of their soils with relatively heavy clay B horizons that restrict drainage. This is another explanation for the relative inefficiency of the summer fallow system in much of Australia as compared to the Pacific Northwest.

Two farm visits were made in Victoria. The E.G. Baker and Sons farm near Rutherglen and Allen Broadbent near Bendigo. The management on both of these farms is obviously influenced by their very close association with individuals on the experiment stations and district agronomists. In both cases, farms have been used for demonstration and field research plots. Individuals were very aware, or at least had made a serious attempt to evaluate the effect of any individual management practice on the total net profit for their unit and the possible interrelationships of farming practices on both cash crop and livestock feed production. The problems of summer fallowing and tillage associated with the hard setting red brown earth was emphasized by both farmers with the possible implications this could have for a summer fallow program as practiced in the Pacific Northwest.

Impressions at the Horsham and Wolpeup Areas of Northwestern Victoria.

Horsham and Wolpeup are in areas of lower rainfall with extensive areas or relatively sandy soil. This was the first area where the possible benefits of summer fallowing were discussed in more detail and where more emphasis is probably being placed on maximizing returns from cash crops rather than from livestock. The lower rainfall combined with the sandier soils results in greater fluctuation in the potential average amount of feed available for livestock and introduces more risk in the livestock portion of the farming operation.

Greater emphasis was placed on potential use of phosphorus soil test to predict needs for phosphorus in the crop rotation and the possible use of total nitrogen as a criteria for nitrogen fertilizer use in specific rotations. The deeper sandier soils offer greater potential for subsoil moisture storage. This can help even out the yields of cash crops following summer fallow. Some emphasis was being placed on shallow rooted spring planted crops that would control wind erosion and not use subsoil moisture.

Impressions Obtained During South Australian Visit October 12-18.

The farm visits in South Australia covered a wider range of soil and climatic conditions than the visits in New South Wales and Victoria. The farm visits in the Border Town area and the York Peninsula emphasized tillage practices that could be followed on the black clay soils that crack and dry out during the summer months and on the shallow red soils over limestone cobbles. In both cases, the farmers felt that they were learning more about the management of their soils and that they had not reached their ultimate yield potentials in terms of production from either the grain crop or the

livestock portions of the farming operation. Fluctuations in the date of the fall rains and its influence on seedbed preparation was probably more of a critical factor in altering the yield potential for winter wheat where the heavy black clay soils dominated most of the land. We were shown a farm which had been completely abandoned during the 1930's because of low farm prices and wide fluctuations in yield. The combination of phosphorus fertilizer, legume production with the nitrogen fixed by the legumes, utilization of the forage by sheep, and harvesting the nitrogen from the system by the cash crop was certainly an essential part of maximizing farm returns on these heavy clay soils. It was important to maintain a relatively high percentage of the land in a perennial pasture on the heavier clay soils which do not need tillage every year. This was in contrast to the Brian Rodda operation where medics and wheat were grown on alternate year rotation on the York Peninsula. In the two year medic-wheat rotation on Rodda's operation much of the entire farm area was cultivated each year.

The visit to the Tom Bond fat lamb farm, about 80 miles south of Adelaide, presented one different aspect of Australian agriculture. The farmers throughout this area obtained almost all of their income from livestock operations with some dairy units being mixed with the fat-lamb farms. This area had been brought into production during the last 30 years with the discovery of combined copper, zinc and phosphorus deficiency that had very markedly limited the production of forage as well as the health of livestock in the area. Tom Bond maintained subclover-perennial rye grass pastures for 8 to 10 years and only plowed them out as it was necessary to reduce the component of weedy, unproductive grasses in the pasture mixture. Emphasis was placed on obtaining much higher lambing percentages than in the drier areas of the state and a larger percentage of the farm income came from fat lambs rather than

wethers and wool production. This was an excellent example of where continued use of phosphorus fertilizer over a period of years has built up a residual level of phosphorus in the soil. Mr. Bond had not applied any fertilizer during the last two years and it was evident that he had very lush productive subterranean clover pastures. He stated that he would probably apply phosphorus fertilizer on a number of his fields this fall, certainly a phosphorus soil test would be an excellent tool to help him decide which fields needed the higher rates of phosphorus fertilizer.

During one day we traveled to the area north and east of Burra towards the northeast corner of South Australia. This was our first introduction to the true dryland, non-cropped pastoral areas. There was again wide fluctuations in the rainfall in this area, with an average of only 10 or 11 inches of rainfall, making crop production very risky. Emphasis was on maintaining the palatable shrub species as the major forage source. Some annual medics were produced throughout this area and medic burrs had been scattered by livestock throughout much of the rangeland that has never been seeded. This was our first introduction to the desert shrubs and to the concept that shrubs allow the storing of feed for twelve months in advance. With the wide fluctuations in annual rainfall, the seasonal production varied drastically, but range management practices and identification of degree of grazing made it possible to hold feed in reserve and have some ability to predict feed supplies for a year in advance.

Research workers at the South Australian Department of Agriculture and the Waite Agricultural Research Institute emphasized work that had been done to identify optimum stocking levels to maximize returns from crops produced. The wide range of annual medic varieties (over 5000 genotypes being tested in Australia) plus the varietal work being done with grain legumes was very

impressive. The coordination of research work between the universities and the State Department of Agriculture workers was evident with excellent research being done in the area of micronutrient research for both forage and livestock production. Emphasis has been placed on identifying components of management systems that maximize returns for the farmers with rotation systems being treated as a unit. It seemed that present research work is placing some emphasis on identifying and diagnosing specific deficiencies for individual crops or components of the rotation system. Greater use is being made of both soil and plant analyses to identify areas where the fertilizer program for a rotation system needs to be modified to maximize returns from fertilizer dollars spent.

Visit to Broken Hill and Sturt Meadows.

The return from Adelaide to Sydney included a stop at Broken Hill in the true range country with their extensive livestock operations. This is the area that is restricted to the production of Merino sheep with the major income coming from wool. As we traveled north from Broken Hill to the Peter Beven livestock station, the effects of grazing management and overgrazing on the different species present in the desert vegetation was very evident. A unique system exists here because of the large amount of forage produced by shrubs that do not drop their leaves annually. Grazing management practices are designed around the twelve month forage supply stored in these shrubs. These plants make it possible to maximize animal and wool returns under conditions of a fluctuating climate.

Land in this dry zone is owned by the state and leased to ranchers on a long term basis (21 or 42 years). All improvement, e.g. fences, building,

etc. are owned by the lessee and are sold if the lease changes hands. The average "station" in the Broken Hill area is between 40,000-50,000 acres. Stocking rates vary from 5-25 sheep per square kilometer (4-21 acres/AUM) which is not much different than our sagebrush-grassland ranges in eastern Oregon. Vegetation on areas with winter moisture and droughty summers is primarily shrubs and annual grasses. Further north where rainfall comes more during the summer the vegetation is shrubs with a perennial grass understory.

Since there are few periods of the year when streams flow, water must be collected and stored in dams, ponds or stock tanks. Location of these watering sources has a significant influence on animal distribution and forage utilization.

During the past three years the area has received from 2-3 times the normal rainfall. Some animals from the cereal-pasture zone have been shipped into these range areas to make use of the extra feed. The above average feed years are causing an increase in the numbers of kangaroos, emus and rabbits. Their high numbers already are causing concern to the ranchers and will undoubtedly become a severe problem during normal rainfall years.

Australian sheep producers have very little problem with predation. The wild dog (dingo) has been kept north of the major sheep producing areas by a 8000 km, dingo-proof fence.

The emphasis for improving livestock forage in Australia has been in the cereal-pastoral zone. Only recently have they begun to do intensive research in the drier areas. Dr. Westoby from Macquarie University stated that the return per unit input (man and non-renewable energy) is from 2-4 times greater on rangelands than in the cereal-pastoral zone. He felt that an increased effort will be put in rangeland research.

Visit to Macquarie University

On our return to Sydney, we visited Macquarie University where we met Dr. Milthorpe, the head of the Biology Department, Dr. Peter Hughes, an agronomist working on drought tolerance, Dr. Westoby in pasture and range research, and renewed acquaintences with Ross Barlow, who completed his Ph.D. at Oregon State University two years ago. Excellent research facilities were present in this university that has been established during the last 10 to 15 years. Major emphasis was being placed on laboratory growth chamber and greenhouse research that could be carried within the facilities of the university proper. Some cooperative work was attempted with individuals from the State Department of Agriculture, located on research stations in western New South Wales. The work on drought tolerance by Peter Hughes was of particular interest. He is re-examining the possibility of moisture stress during initial seedling germination on possible drought hardening of plants. This is an idea originally proposed by Russian scientists that probably needs re-examination. The ability of desert plants in central Australia to close their stomates at 9:30 to 10:00 in the morning and thus reduced transpiration and to utilize soil moisture at 40 to 50 atmospheres of tension is a very unique part of the Australian desert ecosystem.

We left Australia on Thursday evening, October 21, after a very informative and busy three-week schedule. Our trip could not have been organized more efficiently. The hospitality of the Australian agricultural workers throughout this time was excellent. It is difficult to see how we could have achieved a wider understanding of Australian agricultural production problems in this short period of time. A collection of approximately 60 lbs. of reprints and literature were brought back from Australia with us.

Australian Trip Report
October 12-30, 1976
211(d) Dryland Agricultural Project
F.E. Bolton
List of Individuals Contacted
October 13-17

Adelaide Area-S.A. Dept. of Agr.

Mr. Arthur Tideman, Chief Agronomist, S.A. Dept. of Agriculture
Mr. Reg. French, Agronomy Officer
Mr. Gill Williams, Act. Sr. Agronomist
Mr. Don Russell, Livestock Officer
Mr. Brian Rodda, Farmer-Medic, Wheat Systems-York Peninsula
Mr. Rex Krause, Principal Research Office, Northfield Research Station
Mr. Ted Higgs, Sr. Research Officer, Northfield Research Station
Mr. Doug Reuter, Soil Fertility Specialist
Mr. Eric Crawford, Parafield Research Station, Officer in Charge
Mr. Harold Nourse, Turrett Field Research Station
Mr. E.D. Carter, Agronomy Sr. Lecturer, Waite Res. Inst.
Dr. Allden, Act. Head Agronomy, Waite Res. Inst.
Dr. Don Puckridge, Agronomist, Waite Res. Inst.
Dr. G.D. Lewis, Soil Scientist, Waite Res. Inst.
Dr. A.R. Egan, Agronomist, Waite Res. Inst.
Dr. Bryan Cartwright, Soil Scientist, CSIRO
Mr. Brian Jefferies, Principal Livestock Officer, S.A. Dept. of Agr.
Mr. Tom Bond, Grazier, and Farmer
Mr. Bob Hannam, Micronutrient Res.-Northfield Res. Station
Dr. Bob Kuchel-CSIRO

Western Australia - Department of Agriculture and CSIRO, Perth
October 18-23

Mr. N.J. Halse, Chief, Plant Research Division
Mr. John Roberts, Agronomist (Recently returned from Libya Project)
Mr. Clive M. Francis, Pasture Livestock Specialist
Dr. J.W. Bowden, Soil Fertility Specialist
Mr. L.D. White, Chief, Agricultural Extension Division
Mr. David Tennant, Plant Physiologist (Soil, water, plant relations)
Dr. David Bennett - CSIRO, Resource Planning and Management
Mr. Peter Sewell - CSIRO, Resource Planning and Management

Queensland - Toowoomba and Dalby Area
October 24-30
Department of Primary Industries

Mr. Ross Murray - Cereal Production and Soil Conservation
Mr. Lindsay D. Ward - District Adviser (Extension) Cereals Production
Mr. C.P. Norris - Agricultural Engineer (Farm Machinery)

Queensland Wheat Research Institute - Toowoomba, Qld.

Dr. A.L. Clarke, Director
Dr. P.S. Brennan - Cereal Breeder
Dr. W.M. Strong - Senior Agronomist (Soil-Nitrogen-Water Relations)
Mr. D.R. Woodruff - Senior Plant Physiologist (Plant-Water Relations)
Mr. R.D. Berndt - Soil Conservationist (Soil-Plant-Water Relations)
Dr. E.T. Craswell - Senior Soils Technologist (Soil Fertility Research)
Dr. N.J. Grundon - Agronomist (Soil micronutrient research)
Mr. Max Middleton - Farmer (Cereal Grain and Cattle) Dalby Area

South Australia and Vicinity

My impressions from the Australian study tour coincide closely with those of T.L. Jackson and A.H. Winward. I, too feel that there was a lot of emphasis given to the legume-livestock-cereal farming regime throughout all the regions visited. One aspect of the "Australian System" that needs to be mentioned is the very important element of skilled management that is required to make the system work properly. The farm manager must know how to grow and manage the livestock element, the legume element and the cereal element in a coordinated package in order to reap the benefits of the total system. If one part of the system fails it usually has a large effect on the other parts and the whole system suffers.

If one thinks of introducing this system of farming into a developing country situation, then the level of managerial skill required to make the system work becomes a key element. It is envisioned that this aspect would make the direct transfer of the Australian system to a developing country most difficult, unless accompanied by a strong, long-term, training program for the local technician and farmer groups.

Even though the legume-cereal-livestock rotation is designed to be a long-term, self-regenerating, low cost system, it still requires careful attention to detail in the farming practices during each step. In many instances during farm visits, it appeared that each farmer had

"tailor-made" the system to fit his own particular situation. I was very impressed by farmers' knowledge and their application of this information in their operations. The technical aspects could be easily transferred to a developing country by a knowledgeable person, providing the environment was suitable. A good example is John Doolette's work in Tunisia. However, the primary purpose of transferring technology is to gain adoption by the resident farmers. If the resident farmers lack the proper skills and knowledge to apply the system then application of the system breaks down.

Australian agriculture is certainly impressive and has a lot of experience to offer both the developed and developing countries in dryland agricultural production. The somewhat unique climatic and environmental conditions of the areas of Australia visited may somewhat limit the application of these systems in other parts of the world.

Since my impressions of the South Australia portion of the trip are similar to those of Jackson and Winward, the remainder of this report will be devoted to the agricultural situation in the states of Western Australia and Queensland.

Western Australia - Perth and Vicinity

The dominant feature of Western Australian agriculture is the coarse sandy soils that prevail in most of the cereal zones. Severe plant nutrient deficiencies including phosphorous, manganese, zinc and copper are apparently characteristic of the virgin soils in this region. Once the nutrient problem is determined and corrected, the areas of adequate rainfall are quite productive. During my initial briefing by Dr. N.J. Halse, Chief of the Plant Research Division, it was pointed out that there were about 10,000 wheat farmers in W.A. with an average of 3000 acres per farm. In the cereal zone the typical farmer also had

3000 sheep, and this operation was maintained by 1½ persons average per property, plus some custom operations during the busy seasons of harvest and/or sheep shearing. He also pointed out that there was 37 million sheep in W.A.

Western Australia - Libya Dryland Farming Project

One purpose for visiting in Western Australia was to familiarize ourselves with the Dryland Farm Project in Libya which is operated by the W.A. State Department of Agriculture. This project is completely financed by the Government of Libya under a contract with the W.A. State Department of Agriculture.

The main objective of the project is to provide the advisory capacity and farm equipment to develop a dryland farming system in an area of Libya that receives between 150 and 350 mm rainfall annually. The rainfall pattern is very similar to the Pacific Northwest of the U.S., i.e., the majority occurs between November and March. The average minimum temperature during this period is about 5°C. Apparently, there was little previous cultivation of the land for cereal production in this area, only a few scattered villages and nomadic bands with sheep (fat-tail) and goats.

One of the first Australian Agronomists assigned to this project, Mr. John Roberts, had just returned from Libya a few months ago and I was fortunate to be able to spend several hours with him discussing their program there. According to Mr. Roberts the project essentially involved a direct transfer of Australian cereal-legume-production technology to Libya. The Australian team consisted of an officer in charge, an agronomist, a technical field assistant and 9 farmers from W.A. All equipment, seeds, fertilizers, vehicles, etc. were imported from Australia. The only training of local nationals so far was for tractor and equipment operators.

The first year (1974-75 crop) 9000 hectares were seeded after land preparation. The average yield for this area was only about 200 kg per hectare. The Australian team using Gamenya wheat and Clipper barley (Australian varieties) along with 100-120 units of super phosphate and 40 units of urea were able to produce an average yield of between 500 to 600 kg per hectare. About 300 hectares of legume pastures (medics, subclover and cupclover) were seeded in the spring of 1975. The greatest problem in the pasture program to date is getting enough sheep (fat-tail) at the proper time to utilize the forage produced.

The second year (1975-76) the Australian team seeded 48,000 ha. of wheat and barley and 8,000 ha. of medics. Of the 8,000 ha. of medics, 3,000 ha. were lost due to wind erosion. The average yield on 48,000 ha. was about 500 kg per hectare of grain.

Mr. Roberts stated that due to the lack of any previous field research information, they encountered many problems in deciding which management practices to use. Even though the yield was increased by three-fold (from 200 to 600 kg/ha) the yield level is still below the economic threshold. The large scale development phase is to be held at the present level and a series of applied research field trials is being started. These trials include the following:

1. Rates of phosphorous on wheat and barley
2. Rates of nitrogen on wheat and barley
3. Interaction of phosphorous X nitrogen on wheat and barley
4. Minor elements copper, manganese, zinc, molybdenum, etc.
5. Wheat and barley variety trials
6. Rate of seeding (cereals)
7. Date of seeding (cereals)
8. Depth of seeding (cereals)

9. Medic species trial

10. Rates of superphosphate on medics

11. Pasture-legume innoculation trials.

12. Weed control trials (chemical and cultural)

Both Dr. Halse (project coordinator in W.A.) and Mr. Roberts felt that the production program would have been on more solid ground, had it been preceded by a sound applied research program by at least 2 to 3 years. They also expressed concern about the lack of a training component for Libyan agronomists.

The West Australian Department of Agriculture has collected and is maintaining a world-wide collection of subterranean clover and lupine species. Mr. Clive M. Francis showed me part of the collection, being maintained at the Medina Horticultural Research Station about 20 miles east of Perth. Dr. John Gladstone is in charge of the lupine collection but was not present in Perth during my visit. A duplicate collection of the Black Medic species collection in South Australia is also maintained in West Australia.

Mr. C.M. Francis made an extensive seed collection tour of Turkey in June and July of 1974 looking for new lines of subterranean clover and lupine. About 450 seed samples were collected and are presently being evaluated throughout Australia. The seed collection tour was undertaken in conjunction with his attendance at the XIII International Grasslands Congress in Moscow and was financed by the Australian State Wheat Research Council.

As a result of their interest and involvement in pasture legume research, the West Australian Department of Agriculture is providing most of the pasture legumes species and technical assistance for an international pasture-legume regional evaluation trial in Badajoz, Spain.

The project is sponsored and financed by the F.A.O., U.N.D.P. program. The project includes pasture, forage and edible legumes for the whole Mediterranean region. Mr. Francis is the Australian project leader in the program. It is anticipated that this program will lead to the development of an International Center for Pasture, Forage, and Edible Legumes with a world-wide scope of operations.

Cereal production in Western Australia is somewhat more extensive than in South Australia and more farms are devoted strictly to cereal production rather than integrated cereal-legume-livestock operations. A large portion of the research of CSIRO and the State Department of Agriculture is devoted to soil fertility studies, particularly with regard to available phosphates. More nitrogen fertilizers are used for cereal production than in South Australia, probably because the coarse sandy soils are so low in almost all plant nutrients. One afternoon was spent in the Resource Planning and Management Section of CSIRO with Dr. David Bennett and Mr. Peter Sewell, who are working on models for decision-making in different farm enterprises. They had just completed a model for determining the economic use of superphosphate for both cereal and pasture-legume production. They called the model "Decide" and used an extensive series of phosphate fertilizer trials conducted at many locations for several years as the basis for the model. The model includes the management elements of newly developed land versus old lands, soil type, plant species, method and time of application of superphosphate, time of seeding, cropping history, estimated yield levels, "on farm" cost of superphosphate, value of phosphate residual and current price levels to assist the individual farmer in making a decision on how much phosphate to use. They indicated that the farmers were adopting the model as a guide in determining their rates of application. This group is now working on a smiliar model for nitrogen fertilizers.

Some time was spent visiting with David Tennant, a plant physiologist, who is interested in soil-water-plant relationships in cereals. His main research area concerns root growth and development in wheat in relation to soil type and depth of rooting. He works closely with the cereal breeder (not present during my visit) attempting to determine selection criteria for wheat varieties better adapted to dryland conditions. His work with plant nutrient deficiencies (N-P-K) has shown that the lack of any one of the three major nutrients greatly reduces root growth and development. When one or more of the major plant nutrients were deficient, the nodal roots were affected to a greater degree than the seminal roots. Mr. Tennant's work has led to renewed interest in "starter" type fertilizers at low rates, placed near the seeds at planting, to aid in rapid root growth and development. It is believed that this practice will increase the capacity of the wheat plant to extract soil water to a greater depth during periods of drouth stress.

The remaining time of my visit in Western Australia involved a field-trip to the South Coast with Dr. J.W. Bowden. We travelled parallel to the West Coast on the way to Esperance through the higher rainfall zone which is similar to the cereal-pasture-livestock zone of South Australia. The area along the South Coast (Albany to Ravensthorpe to Esperance) is still being developed as new cropland. The soils in this region are loamy sand with a high amount of coarse sand (65%) in the upper profile layer. The other textural components are fine sand, 20%; silt, 5%; clay, 10%. The whole area is very low in plant nutrients, particularly phosphates. Manganese, copper and zinc deficiencies are also quite prevalent. Once these nutrient deficiences were determined and corrected, crop yields are adequate for economic development. Past research results are presently being used to promote development of

these lands by the Australian government. Several trials were observed during the trip in which the production of cereals or legumes was nil in check plots without added plant nutrients. These were the most striking plant nutrient deficiencies I had ever observed in a field situation.

The return trip to Perth was through the center of the cereal producing area southeast of Perth. A fallow-wheat rotation was commonly used in this region. Little research had been conducted on soil management for moisture conservation, but more interest in this aspect of cereal production was expressed by several of the research workers contacted. Burning of the stubble after harvest is still a common practice and poor weed control during the long fallow period is causing excessive soil profile moisture losses. The cereal-legume-pasture rotation was not used nearly as extensively as in South Australia. This system has been repeatedly tried in this region but the success was limited due to very erratic rainfall amounts and distribution. The fallow-crop rotation is apparently a much more stable farm enterprise for this region.

A brief stop was made at the Newdegate Research Station to observe copper deficiency trials on winter wheat. The differences were quite striking between no copper and the first increment of 2.5 pounds per acre. The trial had been in progress for about 7 years and apparently the 2.5 pounds per acre rate was adequate to correct the deficiency of copper over this period of time. The Newdegate Research Station is only about 8 years old and is still in the developmental stage in many research areas. It was designed to serve the entire South Coast Region and its research covers the whole range of crop and livestock problems. Western Australia seemed to be blessed with a large number of large, relatively well-equipped research stations scattered throughout the various agricultural zones.

Queensland - Toowoomba, Dalby and Vicinity

The visit in Queensland was very productive from my viewpoint in that several months previously I met 4 Australian agriculturalists while attending a tillage conference in Colorado. I was able to visit 3 of the 4 gentlemen while in the Queensland area. Ross Murray, Lindsay Ward and C.P. Morris of the Department of Primary Industries have the assignment of developing better cereal production systems, including erosion control methods, for the state of Queensland. Since Mr. Ward and Mr. Morris had just spent 6 weeks touring the Great Plains and the Pacific Northwest of the U.S. we were able to compare impressions quite easily.

The climate in Queensland differs considerably from that in South and West Australia in that the rainfall pattern shifts from the winter period to the late spring and summer. However, the cereals are still planted in the fall season as winter wheats. The rainfall pattern allows many farmers to use a wheat-short fallow (6 months)-sorghum rotation similar to those used in the central Great Plains of the U.S. Moisture conservation through improved soil tillage and management is becoming more and more important in the production system.

In the Darling Downs area (a large flat alluvial plain) the rainfall mean is about 25 inches per year and adequate for an annual cropping pattern. The crop period for wheat or barley is from June to December (fall to winter in Australia). After harvest in December and January the land is sometimes fallowed until June when wheat is planted again. Grain sorghum is grown during the spring-summer period (January to May) and is often planted immediately to cereals in June. If rainfall is below normal the land is then fallowed, sometimes 14-18 months until the next cereal period.

As you move further west from the Darling Downs area the rainfall drops rapidly in total amount and the cropping system becomes wheat-fallow again. Most of the soils in this area are very heavy clays, mostly montmorillonite type, which shrink and swell when drying or wetting. The clay content ranges from 70 to 80 percent. These soils are extremely difficult to cultivate. The continued burning of the stubble after harvest for many years has contributed to the lack of tilth in the soil surface. The research workers in the Department of Primary Industries and the Queensland Wheat Research Institute have been conducting trials on various stubble-mulching practices for the past several years. Some of the results on farmers fields have been quite good. Several farms visited reported better tilth on the soil surface, easier tillage operations and less cracking during dry periods. Various types of stubble-mulch equipment (sweep-chisel plow, rodweeders, deep-furrow drills, field cultivators, etc.) have been imported from the U.S. and are being tried in this region. In some cases the number of tillage operations has been reduced by one or two using the stubble-mulch system.

The cereal-legume-pasture-livestock system that is so prevalent in South and West Australia is not used very extensively in Queensland. Apparently the forage legumes don't grow and produce as well in this region. A second reason given is that until recently the fertility level of the soils was adequate to produce reasonable yield levels without additional nitrogen. In recent years there has been increased interest in nitrogen fertilizers and more is being used each season. A lot of emphasis is presently given to soil fertility research throughout the area. Introduction of the stubble-mulch system as opposed to burning of the crop residues has apparently caused part of the interest in nitrogen fertilization. Responses to added nitrogen on plots with stubble retained

on the soil surface have been greater than plots which were burned and then cultivated.

In Queensland, as in the other states of Australia visited during this trip, all of the extension activities and most of the applied field research and demonstration work is conducted by the State Departments of Agriculture. This agency is named the Department of Primary Industries in Queensland. Ross Murray, Cereal Production and Soil Conservation Supervisor, Lindsay Ward, District Adviser (extension) in Cereals Production and C.P. Norris, Agricultural Engineer in Farm Machinery have been formed into a team to conduct research and demonstration trials in dryland cereal production for their region. Most of their work is conducted on farmers' fields. This work is in the beginning stages with only a few trials in the field at present. The back-up research support is provided by the staff at the Queensland Wheat Research Institute. After reviewing the field work with Lindsay Wood in several areas, my remaining time was spent at the Wheat Research Institute discussing the various research areas covered by the staff there.

Queensland Wheat Research Institute

This institute located in Toowoomba, Qld., on the northern edge of the Darling Downs, has a technical staff of about 40 scientists and technical assistants. The research covers almost all aspects of cereal production including wheat breeding, plant pathology, crop agronomy, pasture agronomy, soil fertility and cereal chemistry. Most of the research is directed toward wheat production under sub-humid to semi-arid growing conditions. It was apparent during my visit that many of the research areas were related to similar problems in the Pacific Northwest of the U.S. This fact was rather surprising to me since the climatic and soil conditions differ considerably from our dryland region.

The Institute Director, Dr. Allan Clarke had previously visited the Oregon State University campus in 1974. he was generally familiar with cereal production in Oregon and was able to direct me to those of his staff who were working on research problems of common interest. Some of the staff with whom I visited and their area of research are as follows.

Ross Berndt - working on a model of water balance systems related to different cropping systems such as continuous wheat, fallow wheat, wheat-sorghum, wheat-fallow-sorghum, etc. He is trying to determine the factors involved in allowing the cereal producer to chose a system related to the present prevailing conditions. The highly variable climatic conditions from season to season, especially in rainfall distribution and amount, makes decision-making by the producers as to which cropping system would be most profitable a hit or miss type proposition. The model if perfected would allow producers to make more rational decisions for any given season, based on the immediate past and present conditions.

Dr. Noel Grundon - working on soil micro-nutrient research. He has found that zinc deficiencies occur more often after continuous cropping than after fallow-wheat cropping systems. These zinc deficiencies are more common when the pH is above 7.8. Copper deficiencies occur on slopes but hardly ever on the level sites.

Dr. Wayne Strong - is studying the movement of nitrogen in soils that develop large, deep cracks upon drying. He has found that a large amount of mineral nitrogen can be carried deep into the soil profile when heavy rains occur on soils with deep cracks.

Dr. David Woodruff - has taken results from a large number of trials conducted by the Wheat Research Institute, at many locations and years over all aspects of crop production, and developed a model for

wheat growers to use when making decisions at planting time. The model includes such items as:

1. Quantity of stored water in the soil available for use.
2. Rainfall characteristics of the region.
3. Soil texture.
4. Cultural history of the field (long fallow, short fallow, double cropped, previous crop, incidence of weeds, etc.)
5. Time of planting.
6. Yield history for the past 5 seasons.
7. Adjustments for fertilizer use.
8. Seeding rates and varieties.
9. Choices of cropping strategies.

This model might well be considered as a guide for developing similar models for Oregon cereal production as well as in some developing countries situations.

Potential for Increased Agricultural Land Development in Australia

During the various field trips in South Australia, Western Australia and Queensland, there seemed to be a feeling that under the proper circumstances vast areas of new lands could be developed. This aspect was not discussed in any detail, but from time to time newly developed lands were observed. It appears that the greatest potential for expansion of agriculture is the area of Queensland and the northern territory. Most of this land can only be considered for Dryland Farming, principally in cereal crops. In addition most of the new lands would require the alternate fallow-crop rotation because of the rainfall amount and distribution pattern. The extent of the potential new lands that could be developed in Northern Australia is covered in the attached report

entitled, "Field Crop Development in Tropical Australia." (See Appendix Report)

The most surprising aspect to me is that the total annual cultivated areas could potentially be increased from 2.82 million hectares to 11.1 million hectares (Table 1, Appendix). Of this total approximately one-half (4.65 million hectares) is classified as -subhumid/semi-arid, indicating that any expansion in Australian agriculture will involve considerable dryland farming areas. This report may explain in part the great interest in Australia at the present time in world-wide dryland production research programs.

I wish to concur with my colleagues Drs. Jackson, Winward and Fitch that the hospitality and interest of all Australian agricultural workers and farmers was excellent and greatly appreciated. It was this fact above all else that made this study tour extremely informative and pleasant.

APPENDIX

FIELD CROP DEVELOPMENT IN TROPICAL AUSTRALIA

J.K. Leslie, Queensland Department of Primary Industries

J.A. Doughton, Department of the Northern Territory

INTRODUCTION

Primary surveys undertaken in northern Australia (largely by C.S.I.R.O.) allow approximate land capability interpretations and estimates of agricultural potential in terms of scale and locations. The authors' estimates (believed to be conservative) yield a potential annual cultivated area in Queensland, the Northern Territory and northern Western Australia of 11 m hectares. The Current annual cultivated area in Australia approximates 16 m hectares of which 2.8 m occur in tropical and subtropical zones.

The zone may be dissected into five broad agro-ecological regions viz.

1. Wet Tropics.

Annual rainfall greater than 1 500 mm. Frost free coastal areas of Queensland - Mossman - Ingham, Proserpine - Sarina.

2. Monsoon Tropics

Annual rainfall 700 - 1 500 mm north of latitude 20°30'S (Proserpine, Q.). 12 - 30 week summer growing season. Frost free with exception of elevated areas on Great Dividing Range. Includes Kimberley region, W.A., Daly River Basin and Coastal Plains, N.T.; Cape York Peninsula and Burdekin River Basin, Q.

3. Subhumid/Semiarid Tropics.

Annual rainfall 600 - 700 mm between latitudes 20°30'S and approx. 26°S. Light to moderate frosts. Summer growing season extended by fallowing and variable winter rainfall (Nix 1975). Constitutes the majority of Fitzroy River Basin, Q.

4. Sub tropical - Humid/Sub humid

Rainfall greater than 700 mm south of latitude 22°S and extending into New South Wales. Rainfall is summer dominant with significant winter component. Nil to moderate frosts.

South east coastal and sub-coastal Queensland.

5. Sub tropical - Subhumid/Semiarid

Annual rainfall 500 - 700 mm extending south from latitude 26°S to a southern limit approximately the New South Wales - Queensland border. Rainfall summer dominant with reliable winter rainfall component, and growing season extended to 12 months by fallowing. Moderate to severe frosts. The Queensland portion of Upper Darling River Basin.

Estimates of potential cultivated areas are presented in Table 1.

TABLE 1

Potential Annual Cultivated Areas in Tropical Australia

(ha X 10^6)

Region	W.A.	N.T.	Qld	Total
1. Wet Tropics	-	-	$0.3^{(0.16)}$	0.3
2. Monsoon Tropics	$0.45^{(<0.01)}$	$0.5^{(<0.01)}$	$2.0^{(0.03)}$	1.95
3. Tropical - Sub humid/ Semiarid	-	-	$4.0^{(0.48)}$	4.0
4. Subtropical - Humid/ Sub humid	-	-	$4.2^{(1.64)}$	4.2
5. Subtropical - Sub humid/ Semiarid	-	-	$0.65^{(0.51)}$	0.65
Total	0.45	0.5	$10.15^{(2.82)}$	11.1

Figures in brackets are existing areas (1975) and include 0.22 m ha sugarcane and 0.9 m ha forage crops, fruit, vegetables, etc.

AGRICULTURAL OPTIONS

The Wet Tropics

Sugarcane occupies virtually all the existing cultivated areas which include the most suitable soils in terms of slope, fertility and drainage. Further development must be on lower fertility soils with erodible slopes or problems of seasonal inundation and waterlogging. Sugarcane and tropical pasture offer the most stable forms of land use.

The sugar economy is dominant and diversifications into other plant products must compete in the form of high income agro-industrial crops, or occupy subservient roles in land development or as transitional crops on pasture land and on non-assigned cane areas.

Grain crop production is faced with the normal problems of the humid tropics - grain weathering, harvesting difficulties and extreme variation in insect pest and disease occurrence. Soils are mostly too permeable for rice production, and existing production on less permeable soils is unlikely to develop substantially.

Soybeans have performed satisfactorily and further agronomic and genetic improvement is being sought. Development to any level will be dependent on larger production in the monsoon tropics with development of markets and handling facilities. Wet tropic production seems unlikely to exceed 10 000 ha.

Cassava offers substantial prospects. Root yields near Innisfail have been extremely high by world standards, and as a plantation crop it has practical affinities with the sugar industry. It does, however, have little soil stabilizing influence, and its mineral demands with complete utilization of top and root are very high. Research effort in growth physiology, production agronomy and plant breeding-particularly for root

types which would facilitate mechanical harvesting - is warranted. Mechanization of harvesting is a key issue and product uses along lines discussed by McCann and Saddler (1975) and DeBoer and Forno (1975) need both quantitative data and pilot process evaluation.

Intensive search for new commercial crops (including cassava) specifically for our wet tropics appears to be unwarranted, but efforts aimed at the monsoon tropics may well find applications in this region.

Monsoon Tropics

In relation to current agricultural development in the region the reviewer has to conclude that effort by scientist and farmer has developed a solid technological foundation which is adequate to sustain considerable agricultural progress. As a general comment is is believed that the existing technology lacks mainly the cohesiveness which a substantial agriculture would both demand and impart.

It is impossible to escape the overriding issue of remoteness, high input costs, and the lack of transport systems and service infrastructure which have thwarted the efforts of private individuals, companies and governments toward agricultural development in the past. Regional production or sorghum, maize and soybeans is scaled to local consumption and even the intensive pasture development of the Atherton Tableland is tied to the North Queensland milk market. The major exceptions in North Queensland are all high income crops - sugarcane, tobacco, peanuts, certified bean seed, pasture seeds and potatoes (the last aimed at a small seasonal market in Southern States). Sugar and peanuts offer solid opportunities for expansion into export markets. The Burdekin long grained rice industry, producing two crops annually on impermeable solodic soils is small but commercially viable. This industry coupled with experience on the coastal

plains of the N.T. and on the Ord River, Irrigation Area in W.A. constitute strong evidence of very extensive possibilities for rice growing if public and political moods and economics ever favor development of the rice industry. Major flood protection, drainage and irrigation works would be necessary on the N.T. coastal plains before large scale production would be feasible. Certainly, the water resources and to a large extent the technology for these developments exist. Fauna control is a particularly difficult obstacle.

Major agricultural development in the region has to pursue export markets and volume production. This demands internationally competitive costs of production and in turn, transport and infrastructure. What comes first? There are two alternatives. The first - the development package - is the simultaneous development of industry and infrastructure. The feasibility study into sugarcane on the Ord River may lead to this and the major industrial development of the Pilbara region would have a complementary influence. It is difficult to conceive agriculture catalysing other new developments of this type in the region. Mining developments could provide other focal points and any mining proposal should be the subject of concurrent assessment of the hinterland in agricultural terms with a view to associated agricultural development through Government participation. The second alternative is for stepwise intensification of existing rural industry with matching proliferation of transport and service facilities. In the case of the North one can envisage a sequence of beef roads, pasture development, fodder and grain cropping for animal supplementation, which may then lead to more intensive agricultural developments. This is the probable pathway - albeit an uncertain and long one.

An important feature is the susceptibility of many soils to severe soil erosion in the monsoon season. Crops like maize, sorghum, peanuts

and cassava and in-crop weed control lend little to soil stability. Contour structures offer only partial control and restrict the broad-acre farming techniques demanded by economies of scale. There is a need to research surface management techniques and stabilizing rotations on erodible situations in the region. The need exists for areas already developed but is seen as a pivotal issue in determining the scale of future land utilization for agriculture. Those presently investigating pastures for the region should recognize that pastures may have to contribute to arable rotations in the future. Adapted species not well suited to extensive management systems should be carefully documented with this in mind.

Land capability interpretations are heavily dependent on the weight given to erosion, and broad surveys can be very misleading in this respect. Capability surveys need to be repeated across the north at a much more intensive scale, while there is still little development pressure. The Department of the Northern Territory is undertaking this in the Northern Territory (e.g. Aldrick and Robinson 1972), but large areas of North Queensland are inadequately charted. With current technology the 1.95 m ha estimate of Table 1 is probably double the 'safe' agricultural area. With sound conservation systems the figure may be an underestimate.

In the remainder of this century it is difficult to envisage change beyond development of the Ord and extension of the Burdekin irrigation areas (both based on sugarcane) associated with some minor grain crop development, irrigated and dryland. Any significant dryland extensions are more likely to occur in North Queensland where infrastructure exists already, than in the Daly River - Tipperary area. Even in Queensland, transport costs are a major deterrent to agricultural proliferation.

The emphases for the next twenty years could be in:-

(a) Genetic improvement in existing crops - maize, sorghum, peanuts, soybeans and tobacco - for yield adaptation and disease resistance.

(b) Thorough exploration of potential new crops e.g. guar, cassava.

(c) Land capability studies to provide more accurate delineation of useable resources. This should be coupled with a survey for underground water resources in selected areas. e.g. western Cape York Peninsula.

(d) Research into management systems for erodible soils and slopes at two or three key locations.

(e) Agricultural, economic and engineering appraisal of the potential areas for major paddy rice developments on the coastal plains of the "Top End," Northern Territory.

(f) Investigation of the feasibility of small settlement schemes on some of the better agricultural lands adjacent to existing or new population centres.

Subhumid / Semiarid Tropics

The Fitzroy River Basin is undergoing steady agricultural development. The greatest lack is an intensive rail network, but growers are already trucking grain up to 150 km to rail terminals. Positive Government action could capitalize on coal mining developments to create a permanently useful rail system for joint use with agriculture. The primary development of brigalow lands has been for cattle production on sown grass pastures, with arterial beef roads providing the bridge to railheads. Agricultural development is accelerated by the need to cultivate for control of timber regrowth.

Crop production technology using dryland farming principles allows profitable grain farming - principally sorghum and wheat, but with safflower, sunflower and some barley also. There is no natural obstacle to attainment of the stated potential, but there is certainly room for crop improvement and land management changes.

Average commercial sorghum yields are disappointingly low. This is partly poor farming - moisture conservation, weed control and sorghum midge control lacking. It is also associated with lodging and lack of tropical adaptation in existing cultivars. Lodging is a complex problem genetically linked with high grain yield of hybrids, and involving the charcoal rot fungus - Macrophomina. Sorghum cultivars tend to lower yields with decreasing latitudes and this phenomenon is evident in their central Queensland performance. A number of physiological reasons have been advanced for this e.g. rapid phenological development precluding development of the vegetative framework for a high yield potential; high night temperatures with high respiration rates - but these are speculative. The potential for sorghum production in central Queensland justifies considerable effort to achieve tropical adaptation, and progress would be of value to the monsoon tropics also. This is a major international objective with such organizations as I.C.R.I.S.A.T. strongly committed. Sorghum midge resistance is another solid but elusive objective of breeding programmes.

Summer fallowing has given wheat considerable reliability in the south eastern part of the region (Dawson-Callide area) and in the unreliable western sector (central Highlands) commercial experience has been slightly more satisfactory with wheat than sorghum. The north eastern portion (Isaacs - Mackenzie) is probably better suited to summer crop production than to wheat. There is no evidence that specific adaptations of wheat cultivars to this region exist, but there is certainly a case to put selection pressure in that direction. Frost occurrences in the north are light and rare beyond July. This has led to the concept of using the end of the summer rains for wheat sowings - a move aimed at reliability of crop establishment. The concept is thought to require tailoring of wheat varieties if it is to be properly exploited.

Safflower seems destined to remain a Cinderella crop. Seed development is seriously affected by Alternaria infection on the flower bracts, and the crop will require resistance breeding if it is to continue in commercial use. Sunflowers are also subject to Alternaria infection, and rust has been a major hazard of late sowings for some years. Both diseases demand resistance breeding.

As in the monsoon tropics, soil erosion is a major factor. Of the existing 591 000 ha cultivated in central Queensland, 228 000 ha requires intensive conservation practices (contour banks) and 196 000 ha needs simple protection (contour working, grassed strips, residue retention). Only 32 000 ha are currently protected. There is an urgent need to develop and impose farming systems using surface retention of crop residues, and to research complementary use of rotation pastures. Unfortunately there are no well adapted pasture legumes for the major part of the region. Siratro and lucerne are suitable for the east and southeast portions respectively. The need for pasture legumes is a high priority need for this region and for the semiarid subtropics also. Central Queensland grain agriculture has not accepted pasture rotations as obligatory to stable land use of Class II, III and IV land and through conservation farming may yet prove to be sufficient. Property sizes are generally large enough to allow mixed farming and rotation practices to be introduced if they are found to be essential.

The Emerald Irrigation Area (13 000 ha)is moving towards cotton production. There has been a cotton industry in the Dawson-Callide for many years. There is no evidence in that district, or in the initial crops at Emerald, that the insect problems of central Queensland cotton are likely to be any worse than in southern Queensland or northern New South Wales.

Temperatures are higher and this leads to superior fibre strength and diameter - important quality criteria. The irrigation schemes are not tied to a cotton economy however. Wheat, sorghum and soybeans all offer economic diversification. A revitalized beef industry will also allow lucerne hay production.

Humid / Subhumid Subtropics

The sub-coastal portions of this region include agricultural areas of long standing producing a broad spectrum of crops, e.g. South Burnett, Lockyer and Fassifern districts. There are also significant vegetable areas and citrus, banana and pineapple plantations which demand continuing inputs from many scientific disciplines. The coastal region agriculture is predominantly sugarcane which has already utilized the best soils, and which will probably have first call on the better soils remaining.

Developmentally, the region is not endowed with fertile soils on 'broadacre' topographies. It does however have rainfall, and it has infrastructure. In the region as defined (22°S latitude to the Qld/N.S.W. border) there may be 300 000 ha which could be cultivated with careful management for erosion and some drainage works. It is probable also that tropical pastures will transform the fertility of many infertile soils to a point where agriculture can be contemplated.

The region has only recently attracted intensive resource surveys, and much of it remains unsurveyed in a land capability sense. It is a region of high cattle populations, and any change towards agricultural use must involve mixed farming or subdivision of grazing lands. In addition, the future of the coastal lands including the wallum, is a race between land speculators, hobby farmers etc. and more serious agricultural utilization.

A very subjective assessment is for further intensification of agricultural crops, principally peanuts, soybeans and maize on less than 100 000 ha of grazing land. It is difficult to determine whether this potential warrants the research inputs that such a complex region appears to need.

Subhumid / Semiarid Subtropics

Since the second World War, at which time agriculture was restricted to the eastern Darling Downs, there has been a substantial proliferation of farming, which has extended to the western margins of the region at approximately the 500 mm annual isohyet. In the last decade there has been a marked trend for specialized summer crop production (sorghum, soybean, sunflower, navybeans and even peanuts) to expand in the eastern, higher rainfall areas. Barley has also expanded there relative to wheat - primarily the result of declining soil fertility. Concurrently, the centre of gravity of the wheat industry has moved westwards.

The instability of exploitive farming systems is clearly evident on older areas of cultivation. The evolution of more stable systems is now being assisted by legislative erosion control enforcement. The problems, in principle, are similar to those discussed for more tropical latitudes and the research needs are also similar. Hopefully this region will pioneer the stabilizing approaches for the tropics as it has pioneered the existing systems.

The challenges to agricultural science in this region are perhaps more sophisticated than those of the frontier regions. In particular the emphasis of crop technology moves from some production to marginal increases in production, and land use options are so numerous that systems analysis is being involved to clarify the principles of integrating these options.

Nevertheless there are major opportunities for genetic improvement in all crops and for improving commercial crop nutrition. There are associated needs in disease resistance research, field physiology and fertilizer technology. It is possibly more efficient to undertake in-depth work first in this region, than to develop it concurrently in the northern regions. However, it is believed that similar work should be developing now in central Queensland. Unless research resources are expanded this is unlikely to occur. It is incumbent on us to undertake more of our work to enable extensions and applications to other environments. This emphasizes the identification of operative principles and supports the role of simulation as a generalizing technique.

The region does not possess a ley farming system. In the lower rainfall sectors there is a dearth of adapted legumes to which reference has already been made. In the higher eastern rainfall areas (greater than 625 mm) Medicago spp are well adapted and sown pastures are equally as productive as their southern Australian equivalents. Lack of acceptance of sown pastures in the east is partly due to loss of production in the transition phase between crop and pasture. It is due more, however, to the fact that the pasture acre does not produce the net income of the crop acre. Farm sizes tend to be too small as living areas, for mixed farming to develop more property amalgamation. There are important lessons for the more tropical regions in these problems.

It might be though that a region already producing nineteen crop species would not need new species. Yet there is a real niche for grain legumes, particularly for winte grain legumes and for the drier sector. Crops such as lupins and gram (Cicer arietinum) are receiving some attention and deserve more. A major grain legume could play a very significant role in the evolution of a stable, but wholly arable, farming system on most topographies of the region.

McCann, D.J., and Saddler, H.D.W. (1975) - A cassava-based agro-industrial complex - a new industry for Australia?

Part 1 - Financial considerations
PACE 28: 23-27.

McCann, D.J., and Saddler, H.D.W. (1975) - A cassava-based agro-industrial complex - a new industry for Australia?

Part 2 - Technological considerations
PACE 28: 37-40.

DeBoer, A.J., and Forno, D.A. (1975) - Cassava: A potential agro-industrial crop for tropical Australia. J. Aust. Inst. Agric. Sc. 41: 241-252.

Aldrick, J.M, and Robinson, C.S. (1972) - Report on the land units of the Katherine - Douglas Area, N.T., 1970. Northern Territory Administration, Land Conservation Series No. 1.

Nix, H.A. (1975) - The Australian climate and its effects on grain, yield and quality.
In "Australian Field Crops. I. Wheat and Other Temperate Cereals." Edited by A. Lazenby and E.M. Matheson. (Angus and Robertson: Sydney): 183-226.

TRIP REPORT

James B. Fitch

Australia

Dates of Visit: October 12-19, 1976

Persons and Places Visited:

Adelaide, South Australia and vicinity (October 12-16):

E.D. Carter, Dept. of Agronomy, Waite Agricultural Research Institute
A.F. Tideman, Chief Agronomist, SA Dept. of Agriculture
Gil Williams, Economist, SA Dept. of Agriculture
Don Russell, Animal Scientist, SA Dept. of Agriculture
Reginald French, Chief Soil Scientist, SA Dept. of Agriculture
Brian Rodda, York Penninsula Farmer
Phillip Cooks, Pasture Specialist, Northfield Research Labs, SADA
Ted Higgs, Pasture Specialist, Northfield Research Labs
Rex Krause, Director, Northfield Research Labs
Barry Marshall, Cereals Specialist, Northfield Research Labs
Terry Heard, Cereals Specialist, Northfield Research Labs
Eric Crawford, Para Field Plant Introduction Center, SADA
Lloyd Blasing, Para Field Plant Introduction Center, SADA
David Harvey, Economist, SADA
James P. Quirck, Director, Waite Agricultural Research Institute
W.G. Allden, Acting Chairman, Agronomy, WARI

Perth, West Australia (October 17-19)

John Roberts, Agronomist, West Australia Department of Agriculture (formerly assigned to WA program in Libya)
Norman J. Halse, Chief, Plant Research, WA Department of Agriculture
Clive Francis, Senior Research Officer, Pastures, WADA
Jack Ripley, Economist, WADA
John Stoates, Economist, WADA
David Bennett, Division of Land Resources Management, WA Office, Commonwealth Scientific and Industrial Research Organization
John Thomas, Division of Land Resources Management, CSIRO

India

Dates of Visit: October 20-23, 1976

Persons and Places Visited:

Hyderabad, International Crops Research Institute for the Semi-Arid Tropics, (October 20-22):

Ha s P. Binswanger, Economist, ICRISAT and Agricultural Development Council
B.B. Singh, Visitors Services Offices, ICRISAT
B.A. Krantz, Director of Farming Systems, ICRISAT
N.S.P. Rao, Economist, ICRISAT
James Ryan, Chief Economist, ICRISAT
N.K. Sanghi, Plant Breeder, All-India Coordinated Research Program on Dryland Agriculture

New Delhi, Ford Foundation:

Michelle Pettit

Turkey

Dates of Visit: October 24-27, 1976

Persons and Places Visited in Ankara and Vicinity:

C.K. Mann, Economist, Rockefeller Wheat Research and Training Center
Hasan Cemil Akin, Director of Extension, Ankara Province
Mansour Bilgeg, National Extension Wheat Specialist, Ministry of Agriculture
Mike Prescott, Plant Pathologist, CIMMYT and Rockefeller Center
Unal Sarigedik, Economist in Charge of Economic Research and Programming, Ministry of Agriculture
Recat Aktan, Professor of Political Economy, University of Ankara
Bill Wright, Director, Rockefeller Wheat Research and Training Center
Basri Derecioglu, Director, Wheat Research and Training Center, Ankara Region
Turan Giines, Dean, Faculty of Agriculture, University of Ankara
A. Fethi Acil, Chairman, Agricultural Economics, University of Ankara
Atkan Gunay, Economist, Central Anatolia Region Agricultural Research Institute

Tunisia

Dates of Visit: October 28-November 5, 1976

Persons and Places Visited:

Werner Kiene, Director, Ford Foundation Office
Georger Novikoff, Director, SMithsonian Project on Desert Ecosystems
Abraham Hirsch, Rural Development Officer, USAID Tunisia
Mohamed S. Hajej, Director, Institute for Arid Zones Research, Tunisia Min. of Ag., Medenine
Christian Floret, Ecologist, FAO Project, Gabes
Coleman Crocker-Bedford, Tunisian Pre-Saharan Project, Gabes
Mr. Jaritz, German Pasture Improvement Project at Tunisian Agricultural Research Institute (INRAT)
Dalton Comeaux, Pasture-Livestock Extension Specialist, USAID Tunisia
John Doolette, CIMMYT Forage Specialist, Ford Foundation, Tunis
Aberrazak Daaloul, Cereals Research Institute (Institut de Grandes Cultures), El Kef
Hedi El Hamari, Regional Commisar for Agricultural Development, El Kef
David Nygaard, U. of Minnesota Grad. Student in Agricultural Economics, at Tunisian National Ag., Institute, Tunis
Carl Ferguson, Agricultural Programs Officer, USAID, Tunis
John Blackton, Rural Development Specialist, USAID
Ali Ben Zaid Salmi, Economist, Tunisian National Ag. Institute
Moncef Ben Said, Economist, Tunisian National Agricultural Institute

Italy

Dates of Visit: November 6-9, 1976

Persons Visited at U.N. Food and Agriculture Organization, Rome:

Wuu-Long Lin, Econometrician, Economic and Social Policy Department
A. Tongul, Livestock Economics Specialist
Apostolos Condos, Econometrician, Economic and Social Policy Department
R.A. Russell, Agricultural Operations
Karl Friedrich, Economist, Farm Management
Mr. Risopolos, Livestock and Forage Specialist
I.T. El Zabry, Senior Economist, Middle East Group, Economic and Social Policy Department

Trip Report
James B. Fitch
October 10 - November 10, 1976
211(d) AID Dryland Project
Trip Narrative

Introduction

Five countries were visited in the course of this trip. These were, Australia, India, Turkey, Tunisia, and Italy, all selected because of their connection to dryland agriculture. The areas in Australia which were visited included South Australia and west Australia. The area visited in India was primarily in and around the City of Hyderabad, which lies in the south central part of the Deccan plateau. Next the Annatolian plateau of Turkey was visited, with attention focused on the area in and around the city of Ankara. In Tunisia, a wide variety of dryland areas were visited. The trip was concluded with a visit to the UN Food and Agriculture Organization in Rome, where FAO experts were consulted on the problems of dryland farming areas.

Australia and Tunisia, share marked similarities in climate and agricultural systems. The agricultural environment in Turkey resembles that of the Pacific Northwest east of the Cascade mountains far more than it resembles Australia or Tunisia. India was a unique stop on this trip in that the area visited is tropical and also a summer rainfall area, and thus is not directly applicable to the topics of interest in the OSU 211(d) program. Nevertheless, the region is predominately one of dryland farming. Furthermore, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is located at Hyderabad and is carrying out some areas of study which focus on problems similar to those encountered in the regions of more direct interest to the OSU 211(d) project. Throughout this report emphasis

will be placed on the areas where both cereal and livestock are grown although some observations will be made on bordering pastoral zones which are too dry for cereal production. These areas invariably have strong interactions with the livestock cereal areas.

Most of this report will be devoted to seven major topics, 1) the integration and interdependence of cereal, forage and livestock production, 2) observations about the wheat legume rotation and "weedy fallow" practices, 3) government policies, especially those relating to the prices of crops and production inputs, 4) marketing systems, especially those relating to livestock, 5) institutions for the control and management of resources, 6) mechanization in the use of machinery, and 7) risk management. The final section of the report will list, in serial fashion, a number of comments and observations based on conversations with various people visited throughout the trip.

Integration and Interdependence of Cereal, Forage, and Livestock Production

The one striking feature about the farming systems in all of the countries visited is the high degree of integration and interdependence between livestock and cereal crop production. Those who are interested in improving cereal production frequently see livestock production as interfering with the production of cereals. In a certain sense this is true, i.e. livestock production competes for the resources required for cereal production.[1/] Nevertheless, it is also true that livestock and cereal production can be highly complementary. This is the case with the Australian cereal legume rotations, where livestock are grazed on either medics or subterranean clovers which also serve to fix nitrogen and consequently boost cereal production.

[1/] For example in Turkey and Tunisia "weedy fallow" systems are employed, wherein the stubble is grazed after wheat is harvested. Rather than being fallowed after the stubble is grazed off, land is allowed to return to weeds for further grazing.

Farmers probably do not see themselves as just cereal producers or livestock producers but rather as producing both items, each of which provides or contributes something toward the farmer's overall living needs. Producing both cereals and forage for livestock has many advantages. It allows the producer a degree of flexibility with which to cope with unforeseen changes in weather. It also provides some flexibility in coping with fluctuations on the market. In other words, in having two products rather than one product a farmer is diversifying his operation and thus equipping himself to deal with the events in an uncertain world.

From an economic point of view, what one wants to determine is the point of economic equilibrium between crop and livestock production. In oother words, does the value in cereal production which is sacrificed as a result of increased livestock production exceed the value of the increased livestock production? If the answer to the latter is yes, then the farmer's operation is not in economic balance. Unfortunately, little if any economic information which would shed light on or answer these questions was encountered throughout the trip, from Australia to Tunisia and Rome.

Crop livestock integration takes on its most extreme or most advanced form in the case of Australia. The Brian Rodda Farm in the state of South Australia is a case in point. This 1700 acre unit is devoted approximately one-half to the production of cereals in any given year and one-half to the production of improved pasture (in this case of the medicago variety). The medic pastures permit Rodda to raise 1700 head of adult sheep and thus to enjoy the income from a considerable amount of wool and cull animals, in addition to his crop income. On some Australian cereal livestock farms, sheep carrying capacity can go as high as 3 sheep per overall farm acre. Of course, the sheep carrying capacity and crop

yields depend on rainfall and soil conditions. Areas where rainfall is less than approximately 250 mm per year are devoted strictly to range sheep production in South Australia, and by regulation there is no cropping in this zone. On the other hand, areas where rainfall ranges above 500 mm per year are devoted predominantly to pasture livestock operations, with cereals playing only a minor role. Nevertheless, all three of the Australian climatic zones are interdependent, with the range sheep area providing stock for the cereal-sheep production area and for the pasture livestock production area, and with sheep being moved among all three areas as seasonal and annual changes in weather provide surpluses of forage in some regions and deficits in others.

Cereal-livestock production in Turkey provides a number of contrasts to the Australian system. In Turkey, sheep, which are raised primarily for meat rather than wool, are typically managed in a village herd. Each farmer in a village assigns his animals to the village herdsman for care. They are returned to the farmer's own house or living area each night. The herd is grazed on lands which are owned in common by the village. When crop lands are not actually in crop, (i.e., cereals), they automatically become temporary parts of the village commons and are subject to grazing by the village herd. A farmer, who has his own sheep in the village herd has no right to deny access by the herd to his cereal lands when they are in fallow.

In Tunisia the system is somewhat different still. Here some farms are integrated units where livestock are managed by the owner himself and are retained on the owner's own individually held lands. In other cases, however, there is a continued reliance on nomadic herdsmen who perform a variety of functions. For a certain fee a farmer or livestock owner may assign his sheep to a nomadic herdsman who then takes the responsibility for moving the sheep

from area to area with the herd that he manages, in order to seek out sufficient forage. Such herdsmen rely on grazing their herds on public lands when forage is available there, but they also pay farmers for grazing rights on pastures, wheat stubble, and "weedy fallow" lands. Thus, even when sheep are assigned to nomadic herds they compete with cereal production in the sense that fallowed cereal lands can earn a return for the owner in exchange for permitting them to be grazed by sheep. Thus there is an incentive to leave land in stubble and let it go to weeds for grazing, rather than cleaning it up for maximum moisture conservation and weed control for the next cereal crop.

There is undoubtedly a strong incentive to increase livestock production in both Turkey and Tunisia due to a livestock-cereal price ratio which is evidently much higher than in either the United States or Australia. Cereal prices in all four countries are roughly comparable. The price of live sheep in both Turkey and Tunisia is in the range of $1.00 or more per pound live weight, which is considerably higher than such animals would bring in either Australia or the United States. For example, a live mature adult sheep in North Africa frequently brings about $50 a head. A cull live sheep in Australia, while possibly of lower quality, is worth only from $3 to $5 per head. On the other hand, it was the high price of wool in the early 50's which greatly contributed to the growing importance of sheep in the Australian cereal-livestock rotation.

Some kinds of forage and grazing rights are sold in Tunisia, unlike other countries. Nomadic herdsmen do pay for the right to graze weedy fallow lands, as well as improved and natural pastures, which is not true of other countries visited on this trip. The market for hay and straw may also be more active and well organized in Tunisia than in other countries. This means that Tunisia

provides an opportunity for economic research into the value of fodder and forage which is not available in other countries.

Observations About the Wheat-Legume Rotation and "Weedy Fallow"

There are many questions raised by the weedy fallow systems which are employed in North Africa and Turkey. In economic terms, it boils down to this: Is there economic justification for the weedy fallow system or does this system just represent "bad practice?" Many questions related to this issue have to be answered. There appears to be a dirth of economic information in the countries visited with which to answer these questions. It is known that weedy fallow has some economic value. This is demonstrated by the fact that in Tunisia herdsman pay farmers money for the right to graze their herds on what is essentially weedy fallow land. Nevertheless, the question still remains as to whether weedy fallow is the highest economic use of cereals lands during the period which they are not actually growing a cereals crop. In North Africa, one must ask whether greater economic benefits cannot be derived from improved legume pastures of either the medicago or the subclover varieties. In Turkey, the question probably is one of determining whether the increased wheat yields from leaving lands fallow and increasing moisture retention and reducing weeds are not greater than the value of grazing forgone on weedy fallow.

Much is being made of the Australian system of legume pastures in rotation with cereals. Undoubtedly this system makes a great deal of sense, both from ecological and soil management points of view as well as in strict terms of economic returns. Nevertheless, the author believes on the basis of his trip to Australia that there is still considerable land which should be called "weedy fallow." Not all of the pasture lands or the pastures which are used in rotation with cereals crops in Australia are of the improved legume varieties.

Not all cereals land goes through a maintained, improved pasture cycle. It is often just allowed to "rest" for a year or two between cereals crops, and during this period anything that grows up is permitted to be grazed. In the state of West Australia during the 1971-72 crop year, for example, out of a total of 14,700 hectares of land cleared, 6,845 were in improved pasture 3,766 were in crop and the balance would be unimproved pasture and would have included many lands which could only be termed weedy fallow. Thus, even in Australia where improved legume pastures are landed, weedy fallows still exist. This brings one to ask whether or not weedy fallow does not in some cases represent the highest economic use for cereal fallow lands in Australia, under certain conditions, as well as in countries around the Mediterranean. This is a question of economics which is subject to investigation.

Government Policies

A variety of government policies are typically adopted to guide and support agricultural production. Foremost among these, perhaps, are price policies aimed at affecting or controlling the prices of agricultural products as well as the prices of inputs used in agricultural production. Properly designed policies can stimulate both agricultural production and development. Nevertheless agricultural policies frequently are also aimed at protecting or benefitting the consumer or some interest group other than the farmer. At times these two goals or uses of policies can come into conflict. This was evident in some of the countries visited on the trip.

Price policies in Australia have attempted to protect the producer from unduly wide fluctuations in the market. Wheat prices, for example, have long been subject to government controls designed to protect the producer and simultaneously stimulate production. In the late 1960's these policies served to build agricultural surpluses in Australia which resulted in the government

abandoning its existing price support program in favor of a land quota system for wheat. The quota system, in turn, was abandoned during the international wheat shortages of the early 1970's. Currently the government does have a support program for wheat prices which revolves around a pooling system. A guaranteed price[2/] is set but the guarantee is not absolute. If the market price drops below the guaranteed price the government is liable to pay farmers the difference only up to a specified amount. The current government commitment is $80 million. When the government makes such payments, and if prices go above certain limits in subsequent years, then farmers are obliged to use some of the excess in prices received to repay the government pool. Thus there is a tendency for low prices to be raised and high prices to be reduced, thus stabilizing price fluctuations. Cereals other than wheat are not supported, nor is meat a price supported item. Wool, which is perhaps a more important product than meat in the Australian case, is supported by a national wool board, however, which handles all wool sales and exports. Thus, two very important items in the Australian farmers list of products, wheat and wool, are subject to some form of government price guarantee.

The Turkish government sets agricultural prices for 10 or 12 major crops including wheat. This has been a standing practice for many years. The farm lobby in Turkey is reported to have a strong influence in the administered price setting. Local observers claim that prices for wheat have generally been favorable to the farmer. Administered prices usually take the form of a guarantee, and sale to government agencies is not compulsory.

[2/] Under systems previously in existence, the guaranteed price for wheat was based on cost of production. Currently, however, price guarantees are based on "reasonable expectations" for future wheat prices. It is not known how the reasonable expectations are calculated.

In Tunisia the influence of the ideals of socialism undoubtedly has a strong influence on the government's setting of agricultural prices. There is a strong emphasis on insuring that the consumer is able to buy wheat and meat at a price that he can afford. It was the general feeling among those interviewed that this leads to setting prices which frequently are not highly favorable to the farmer. In the case of meat, there is evidence that administered prices may be well below competitive market prices. For example, in some small towns north of the capital there is a flourishing black market in lamb and mutton.

Tunisia has been a net importer of meat and grains in recent years whereas Turkey has beeen exporting grains. Australia, of course, is a long standing and powerful international exporter of grains, based on its production which is in surplus of domestic needs.

During the crop season starting with fall planting this year, Turkey has embarked on a wide scale program of credit provision with the objective of improving the supply of inputs for the production of cereals. The program commenced with the provision of high quality seed, as a trial run. The idea is that government agencies provide farmers with seed at planting time and the farmers are obliged to return the seed in kind, with no interest charged, at the time of harvest. If the program works, the plan is to be extended to the provision of fertilizer and herbicide in coming years.

Indications are that reception by Turkish farmers is quite high this year. In Ankara province, for example, 120,000 hectares were planted under the program, more than the 98,000 hectares which had been the objective. If the program is expanded to inputs in coming years, the idea is that repayment of the loan will still be in the form of wheat, i.e., the wheat equivalent of the value of the input provided, at no interest.

Administrative procedures for the program appear to be relatively complex. The Turkish extension service is the primary program administrator. Field extension offices have the responsibility of verifying that farmers have land commensurate with the amount of seed that they apply for under the program. The total amount of land which any farmer can plant under the program is limited. This apparently is aimed at not providing too great a benefit for the large farmer. Once the extension agent verifies that a farmer is eligible, and certifies the number of acres for which he is eligible, an order is sent to the state farm which provides the seed. The Turkish grain purchasing authority is responsible for collecting repayment on the seed. If other inputs come under the program in future years, these will be provided by separate government purchasing agencies. Thus a considerable amount of coordination between government agencies is required.

Due to the fact that title to much of the individually operated Turkish farm land is not clearly established (the government is about half way through a national cadestral survey) loan security is problematic. The procedures used to get around this problem in the current program is to provide credit and inputs only to farmers who are members of village cooperative organizations, formed specifically for program participation. Thus membership in the participating group becomes the loan security, rather than land title. If a farmer defaults from repayment of the loan, then the administrative agency can deny future participation in the program to the entire group. This presumably will be a strong incentive for the individual to comply with repayment, since not to repay would cause him considerable social difficulty and perhaps ostracization in his own village.

Marketing

Marketing facilities and systems can be especially crucial in the case of dryland agricultural production. Nowhere was this more evident than in the case of Australia. As noted earlier, livestock production in the three climatic zones in south and west Australia is highly interdependent with shipment from some areas being required at certain periods to make up deficits in other areas. Typically, each Australian farmer or livestock producer operates in only one of the three areas. It is not common for a farmer in the cereal livestock zone, for example, to own or lease land in the range area. When livestock are transfered from the range area to the livestock zone a change in ownership almost always takes place. Sales are arranged through brokers in a very efficient and well-organized marketing system.

Little is known about the livestock marketing systems in Turkey and Tunisia. However, one wonders whether improved mobilization of animals from one area of these countries to another might not lead to more effective forage utilization. The semi-arid range lands of southern Tunisia are currently heavily overstocked. Forage supplies in the northern parts of the country are relatively more abundant. Mightn't a more effective livestock marketing system serve to alleviate this situation? Little published information is available about Tunisia's livestock marketing system.

Institutions for the Control and Management of the Resources

Institutions for the control of the basic resources used in livestock and cereal production were different in each of the countries visited. Australia's cultivated lands are individually owned whereas rangelands and grazing lands in the dry zone are publicly owned. Cultivation is prohibited by law in the dry zone, which begins at approximately the 250 mm line.

Stocking rates for livestock (sheep) are set by the state governments. Livestock producers operate range units on long term leases from the state; these leases tend to be passed on within a family and thus come to resemble private ownership rights. Nevertheless, the fact that the government can set fairly restrictive limits on the use intensity of land probably differentiates it from private land.

In Turkey, with the exception of a few large state farms which specialize in producing wheat seed, private land ownership predominates. As noted earlier, however, village grazing lands are held in common, and when cereal lands are not actually under crop they can be commonly used by the village herd. This probably results in excessively large (in an economic sense) herd size and overgrazing. The village herdsman is the one who sets the stocking rates. The individual farmer has every incentive to try to get the herdsman to take as many additional head of livestock as possible. If this description is accurate, then from a general or regional economic viewpoint the Turkish situation may well be one where "too much" livestock is produced and "too little" cereal is produced.

In both Turkey and Tunisia one notices many cases where a failure to plow with the contour contributes to water-borne soil erosion. In Turkey this situation was attributed to the system of land inheritance. As farms are divided among each subsequent generation, there is a reluctance to favor one son by giving him all of the good land. Thus, there is a tendency to subdivide large fields into successively smaller and smaller strips running up and down the hillsides, so that each heir receives some of the good land at the bottom of the hill and some of the poor land at the top. It does not take much subdivision of this nature before plots become too narrow for contour plowing. Thus the inheritance system or inheritance

customs lead to a situation in which land cannot be effectively managed for long term conservation.

In southern Tunisia the system for the management of rangelands is particularly perplexing. While some lands in this area are held by individual producers, it is reportedly more common for range units to be owned by extended families which are the modern day remnants of former nomadic tribes. It is possible that some of these families are large enough for the lands which they control to take on the attributes of a common. Whatever the reasons, it is evident that many of these lands are terribly overgrazed. In some cases, protective vegetation is being permanently destroyed, and the bare or denuded sandy soils are being blown into dunes by the wind. This gives rise to what is known as "desert encroachment." Periodic cultivation of these lands for cereal production contributes further to wind erosion and desert encroachment problems. Apparently, population pressures are also contributing to this situation. Population may well exceed what the land resource can support given the traditional technology and agricultural practices of the zone. Thus, it may well be that the inhabitants are living so close to the "ragged edge" of existence that they cannot afford to undertake the conservation practices which would preserve the resource for continued production and support of life in the future. For whatever reason, the "natural capital" in the form of desert vegetation is quite rapidly being destroyed.

One means of dealing with this situation would be for the government to establish stocking rates which would limit the number of livestock to be grazed in a given area and perhaps also to proscribe cultivation in the more arid areas, such as has been done in Australia. When these measures were undertaken initially in Australia, however, that country still had

sufficient resources to provide a variety of other opportunities for the persons who were thereby displaced from the range areas. This may not be the case in Tunisia at the present time, and enacting such procedures might serve to work extreme hardships on many of those people who currently rely on desert area crop and livestock production.

Another approach to the Tunisian problem would be to develop management practices or technologies which permit the more effective utilization of the semi-arid areas. Some hope along these lines is provided by the Smithsonian-sponsored Tunisian Pre-Saharan Project, located between Medenine and Gabes. Management procedures being explored here are to divide a given range unit up into separate pastures for each of the four seasons of the year. Even without reducing livestock numbers, this system is apparently producing a regeneration of the desert cover by permitting each plot to rest for nine months of each year. On the surface at least it appears that these management practices would not be difficult to adopt. Even if they were successfully implemented, however, they in themselves contain no incentive or device to prevent the subsequent buildup of population to levels which would exceed even the carrying capacity under the newly adopted system.

While the overall management system and institutional structure are somewhat different in the case of Tunisia from what one finds in Turkey, it seems quite probable that the overall effect is nevertheless the same. That is, failure to have institutions which will adequately control grazing in some areas undoubtedly leads to excessive livestock numbers which in turn puts excessive pressures on cereal-producing lands to contribute fodder to support livestock production.

Ownership and control of lands in the primary crop production areas of Tunisia again stands out in contrast to patterns of other countries visited on this trip. Ownership is divided approximately evenly between the state or government and individuals. Government lands are either in state farms or in state managed cooperatives. Such a large government sector in agriculture adds a distinct flavor to the Tunisian system. Farms under government ownership typically will be from 500 to 1,000 or more hectares in size. The objectives of the management of these farms obviously have not been strictly oriented toward profit maximization or efficient allocation of resources. In particular, the employment of labor is an important side objective. At the same time, mechanization has also been pushed. These two factors when combined often lead to poor performance in terms of profitability.

One 600 hectare livestock and forage farm which was visited near Jendouba in northwestern Tunisia was staffed by some 50 farm workers, plus 15 supervisors and technicians. Each worker is paid about the equivalent of $75 per month. In addition to this hefty labor component the farm boasted 7 tractors in addition to combines and other ancillary equipment. This would compare to an Australian farm of similar size visited earlier in the trip where two full-time workers (supplemented by extra labor only at shearing time) and two tractors, plus a combine and ancillary equipment, were all that was required.

Mechanization and the Use of Machinery

Both Tunisia and Turkey are undergoing quite rapid tractor mechanization. In Turkey, for example, the tractor population in 1974 was reported to be 200,000, with some 40,000 units having been added to the inventory in 1973 alone. This was equal to what the entire tractor population of the

country had been in the early 1950's. In the case of both countries, mechanization has obviously been stimualted by the individual savings of workers who have migrated to Europe for a number of years. Such workers frequently come back and buy a tractor to improve their own home farm, or they send funds back to relatives who use them for the same purpose. Crop production specialists emphasize the importance of timely cultural practices, which can be facilitated by the tractor. Also, there is frequently the contention that tractors, due to superior motive power, provide soil preparation which is superior to that which can be achieved with animal draft equipment. Similar comments apply to grain harvesting combines which have also grown rapidly in number in these countries.

While tractors, combines and similar capital intensive equipment have undeniable advantages in many cases, excessive rates of adoption of this type of technology has its pitfalls. Observations were made previously about the excessive mechanization of government farms in Tunisia. To be sure, there is encouragement in the Turkish systems which have evolved for private contracting of combine and tractor services to small scale operators. But labor displacement is always a danger. The fact that tractors and combines are not always easily adaptable to the small farm plots which exist in these countries is also evident. Unless special systems and institutions are developed which permit small farm owners to enjoy the services of large scale machinery, the tendency will be for small operators to lose in competitive advantage and for small farm units to be displaced or eliminated and integrated into larger units, with former owners joining the mass of displaced rural workers.

The ICRISAT center in India has adopted a farming systems program which relies entirely on small scale, animal draft equipment. ICRISAT has

managed to assemble an impressive array of some 10 to 15 different types of animal drawn implements. ICRISAT engineers have developed an improved tool bar for animal draft which also becomes the basis for an efficient cart. Such equipment offers considerable hope for permitting small farmers to participate in agricultural modernization. It also promises to provide considerable foreign exchange savings for countries which would otherwise have to import the oil to run tractors.

Risk Management

Farming is by nature a risky business, but the very by-word of dryland farming is uncertainty. The dryland farmer depends entirely on the weather to provide moisture, and the rainfall upon which he relies is extremely variable both in quantity and in time of occurrence. Many of the traditional practices which have evolved in dryland regions undoubtedly represent means of coping with uncertainty in the environment. Yet events in the real world are seldom caused by a single phenomenon. It is difficult to know which practices represent attempts to cope with risk and uncertainty, and which practices are a result of other causes. The joint production of livestock and cereals obviously offers certain advantages from the point of view of risk management. But there is also certain complementarity in joint cereal livestock production from a static, non-risk oriented production viewpoint. The present state of knowledge about the drylands simply does not permit us to untangle the riddle as to which practices have been adopted primarily to cope with risk, which depend upon other causes, and which simply represent poor management.

In Turkey, Tunisia, and Australia, there was evidently much use of livestock in association with cereal production as a means of coping with uncertainty in the environment. In practice, it appears that the rotation

of cereals one year,with fallow, weedy fallow or improved pasture the next year is never strictly adhered to. Rather, farmers make the decision as to which of the two sides of the rotation will be planted, depending on weather conditions, perceived or expected forage needs, and undoubtedly even based on the current prices of livestock and cereal.

In the semi-arid tropics, as at ICRISAT, it is evident that many of the traditional practices which farmers employ are means of coping with uncertainty in the environment. This is especially true of intercropping and relay cropping, where if one crop fails the other may still survive to provide the cultivator some return and some means of surviving what would otherwise be a disastrous season. Relay cropping, intercropping, and cereal livestock rotations to some degree are all means of diversification, a well known strategy for coping with uncertain environments.

Miscellaneous Observation

John Roberts of the West Australia Department of Agriculture, who was previously assigned to West Australia's program in Libya, pointed out the importance of good marketing/mobilization systems for livestock in establishing the new cereal legume rotation. In Libya the West Australian team found that once medic pastures had been established there were simply not enough livestock (sheep) available in the production area to provide adequate grazing for these pastures. There were simply no systems in existence for getting livestock from the backlands, where forage is deficient, to the new areas.

David Bennett and John Thomas, of the Land Management Division, Commonwealth Scientific and Industrial Research Organization (CSIRO), in Perth, have developed a number of computer games which are designed to help understand individual and group decision making problems in dryland production

areas. These games include Decide, designed to demonstrate the results of alternative fertilization decision to farmers, the Pastoralist Game, designed to show individual range operators the long run results of various stocking decisions, the Dam Game, a group decision making game designed to demonstrate the effects of establishing new water catchments in dryland areas, a Network Analysis game to demonstrate the effects of various means of ryegrass control, and also other games.

Dr. Hans Binswanger and other social scientists at ICRISAT in Hyderabad, India, are conducting an extensive village survey, which covers four villages in Maharastra State and two villages in Andra Pradesh. There are forty respondents in each village giving a total of 240 in the ICRISAT sample. Initially base data on resources, wealth, farming equipment, etc. is gathered from each respondent. Then periodic input and output data is gathered from each respondent every 21 days. Special schedules designed to get at such topics as decisions related to uncertainty, are worked in on top of the regular periodic schedule. This survey should provide valuable information about the determinants of behavior of producers wider uncertainty in a dryland area, and it may well apply to the winter rainfall area of interest to the OSU project.

According to Chip Mann of the Rockefeller Wheat Research and Training Center in Ankara, Turkey, a survey of 20 villages (240 farmers) was conducted in Turkey last summer. This survey is designed to reveal certain production relationships and attitudes among the farmers about new production. It is currently being analyzed by Kutlu Somel, a graduate student at the Food Research Institute in Stanford.

According to Drs. Selmi and Ben Said of the National Agricultural Institute (INAT) in Tunisia, the value of forage in Tunisia has been rising much faster than the value of cereals. In a recent survey these

researchers found that some farmers are actually allowing land to return to natural pasture rather than plant it to cereals, and they are able to rent such land out for grazing for a 3 to 6 month period for as much as the equivalent of $115 per hectare. It is felt that this rate rivals the returns which can be gained from cereal production.

N.K. Sanghi, a plant breeder with the All India Coordinated Research Project on Dryland Agriculture, Hyderabad, provided an interesting list of reasons and rationales for the intercropping and relay cropping which is so common in tropical, summer rainfall drylands. These included the following: 1) intercropping provides a means of more efficiently using total available moisture. Each crop makes use of moisture at different times and uses moisture which in many cases would otherwise just evaporate, 2) legumes in the intercropping system provide nitrogen to non-leguminous crops, 3) since different pests attack each crop, a row of one type of crop provides a pest barrier (and perhaps also a disease barrier) for the crops in adjoining rows, 4) intercropping evens out the labor peaks and spreads out the labor requirements, thus leading to more efficient labor use, 5) intercropping provides a means of risk distribution or diversification against risk.