LAT
333 913
U29b
PD-AAG-391
931-489
PD-AAG-391
931-489

FIELD REVIEW AND ASSESSMENT

OF

WATER MANAGEMENT RESEARCH

BY

UTAH STATE UNIVERSITY

in DIS

Utah State University: Latin Americ
ontracts AID/csd-2167 and AID/ta-c-1]

March 1976

Report Prepared by

Ernest Smerdon, Agricultural Engineer
Howard Haise, Agricultural Engineer-Agronomist
Douglas Caton, Agricultural Economist

Smerdon, Ernest; Howard Haise; and Douglas Caton

Field Review and Assessment of Water Management Research by Utah State University

March 1976

72 pages

6 appendices and 4 tables

AID Contract Number: 931-17-120-489

AID Project Number:

Source: DIS

ARC Catalog No. LAT 333.913 U89 f

Work under the present contract should be continued as programmed. Subsequent to the completion of the project major effort should be planned dealing with programs to assist small farmers in on-farm water management in Centra America and in South America. In addition, the socio-political studies underway should be continued, but re-structured along socio-economic and impact assessment lines. It appears that work on evapotranspiration should not have such high priority in the future. Early work had a larger component in field demonstration of irrigation methods and practices. However, the project has drifted from the goal of improving on-farm water management. More emphasis on adaptive research and development and "how to" demonstrations seems to be desired. Each individual project should relate to others to ensure a focus of all component projects on the objective of immediately improving food production through better on-farm water management. Recommendations include: (1) strengthen internal communication to reduce confusion and problems for the contractors; (2) strengthen AID's ability to better relate project substance to project purpose and objectives; and (3) define "research" so it has the same meaning for all parties involved in the project.

TABLE OF CONTENTS

Page

I. INTRODUCTION I-1

A. Purpose of the Field Review and Assessment I-1
B. Review Procedure I-5

II. THE FOOD AND AGRICULTURAL SITUATION IN LATIN AMERICA II-1

A. Agricultural and Food Production Trends II-1
B. Soil and Water Management as the Basic Ingredient of Improved Food Production Systems II-4
C. Socio-Economic Considerations in Water Management II-6

III. REVIEW AND ASSESSMENT OF USU FIELD AND ON-CAMPUS RESEARCH . . III-1

A. Historical Summary III-1
1. Introduction III-1
2. Field Program III-1
3. On-Campus Program III-3
4. USU Observations on the Contract III-4
a. Constraints III-4
b. Costs and Benefits III-4
5. Previous Project Reviews III-5
B. Review and Comment on Field Research III-6
1. Ecuador III-6
2. Peru III-8
a. Current Level of Input on Project III-8
b. Current Thrust of USU-Peru Effort III-9
c. Importance of USU Work to Peru III-11
3. Brazil III-11
a. Previous Research Programs in Brazil III-11
b. Current Research Programs in Brazil III-13
(1) Petrolina III-13
(2) Juazeiro III-15
(3) Barreiras III-17
(4) Brasilia III-18
4. El Salvador III-20
a. Introduction III-20
b. Coordination of the Research Program III-20
c. Country Support III-21
d. Research Activities III-23
e. Field Trip to Small Irrigation Project III-25
5. Guatemala III-26
a. Introduction III-26
b. Current Level of Input on Project III-27
c. Current Thrust and Importance of the USU Effort . III-28
6. Other USU Field Research Projects III-28
7. The On-Campus Research Program III-29

Page

8. Observations on Modeling III-31
a. The USU Model III-31
b. Modeling in General III-34

IV. DISCUSSION OF ISSUES AND OBSERVATIONS OF THE PROJECT REVIEW TEAM ON CONDUCT AND COORDINATION OF RESEARCH ON-CAMPUS AND IN THE FIELD IV-1

A. Introduction IV-1
B. Observations and Comment on the Issues IV-3
a. Issue 1: Lack of Research Strategy of Focus on a Problem IV-3
b. Issue 2: Training IV-4
c. Issue 3: The Value of the Consortium and/or Cooperative Approach to Water Management Research . . IV-5
d. Issue 4: Extension and Utilization of Results . . . IV-6
e. Issue 5: Research Sites IV-7
f. Issue 6: Specific Problems IV-8
g. Issue 7: End of Project Status IV-9
C. Notations and Observations IV-10
a. Drip Irrigation IV-10
b. Evapotranspiration IV-10
c. Small Farmer Irrigation IV-11
d. Field Effort Versus Campus Effort IV-11
e. Education and Training IV-11
f. A Comment on the Issues IV-12

V. CONCLUSIONS AND RECOMMENDATIONS V-1

A. Management Conclusions V-1
B. Technical Conclusions V-5
C. Recommendations V-7

Appendix 1. Summary of Chronology of Contracts
Appendix 2a. Personnel Inputs
Appendix 2b. Indigenous Country Support
Appendix 3a. TA/AGR Support
Appendix 3b. Fiscal On-Off Campus Analysis
Appendix 3c. Travel
Appendix Table 4. On-Farm Water Management Research - El Salvador
Appendix 5. AID Loan for Improved Water and Land Use in Sierra
Appendix 6. El Salvador Project Work Plan 1975-76

LIST OF TABLES

Table 1. Location of Programs by Objectives I-4
Table 2. Indices of Total Food Production, 1965-74, Latin America II-2
Table 3. Indices of total and per capita agricultural and food production by country and regions II-3
Table 4. Agricultural Exports and Imports by Principal Countries . II-5

FIELD REVIEW AND ASSESSMENT

OF

WATER MANAGEMENT RESEARCH

UTAH STATE UNIVERSITY
(AID Contracts CSD/2167 and AID/ta-c-1103)

I. INTRODUCTION

A. Purpose of the Field Review and Assessment

AID's Technical Assistance Bureau (TAB) initiated research in on-farm water management in 1968-69 using central AID funds at a level of about $1,000,000 per year initially, increasing to about $1,250,000 each year, with Utah State and Colorado State Universities. Institutional development grants were also made to these two universities in 1969 at a level of $750,000 each, and to the University of Arizona in the amount of $350,000, to cover a five year funding period.

A field review and project progress assessment was conducted on the Colorado State University contract, January-February 1976.[1/] The field review and project progress assessment of the Utah State University contract also had the same two-fold purpose as the CSU project review:

1. to evaluate the timeliness and usefulness of the on-farm water management information being yielded by the USU research, together with an assessment of gaps or deficiencies, and;

2. to provide an overall assessment of priority on-farm water management research needs relative to food production-water management relationships.

1/See Field Review and Assessment Report, Colorado State University, Haise, Phelan and Caton, February 1976.

The USU research statement has a general objective, "to increase food production in the arid and sub-humid lands of the less developed countries," and eight (8) specific objectives, covering "water conservation and utilization," Objective 1, to "institutional factors," Objective 8. The general and specific objectives, in full, are as follows:

General Objective

"The general objective of this research is to increase food production in the arid and sub-humid lands of the less developed countries through the improvement of water management practices and the integration of those with other good management and cultural procedures. The research under this contract is aimed at water management problems in the semi-arid lands of the Latin American region but should be applicable in principle to similar conditions in other regions. This improvement of water management practices is necessary to obtain maximum economic returns from limited water resources and such inputs as improved seeds, increased use of fertilizers and pesticides, and supporting institutional structure."

Specific Objectives

"The specific research studies will be selected to meet the high priority needs of the Latin American area. These studies will include but not be limited to:

1. The development of knowledge and data on how best to conserve and utilize water falling on the land as rain and the most efficient means of supplementing needed soil moisture by a limited amount of irrigation water.

2. The development of knowledge and data that can be used for the economic design and construction of water conveyance and delivery systems including structures for control and measurement of irrigation water especially on the farm.

3. The development of surface and sub-surface water removal systems to eliminate the hazards resulting from surface flooding and high water tables.

4. The identification of important factors to be considered in land preparation and leveling of the various soils in the major climatic zones and the relationship of these factors to water management, erosion, water infiltration, and good land use and cropping practices.

5. The development and adaptation of methods of water application, including time and amounts, which are suitable and efficient for different soils of varying physical properties (water-holding capacities, intake rates, etc.) with major crops.

6. The integration of these water-use factors into a productive cropping system consistent with farm size and available farming practices.

7. Where soil, water quality, salinity, and exchangeable sodium are problems, studies will include soil amendments, soil and water management procedures and use of salt-tolerant crops.

8. The identification of institutional factors (legal, social, economic, religious, manpower, credit, etc.) that influence the efficient distribution, management, and utilization of water at the farm level."

As stated on page 3 of the 1973 annual report:

"In the original contract there are eight specific objectives stated as indicated above. Since there was some overlapping of both objectives and research activities, these original objectives were consolidated into the four objectives listed below:

1. Development of farming practices including methods, timing, and amounts of water applied to the land which optimize the use of water from rain and irrigation within the constraints of climate, soils, markets, infrastructure and interaction with other agricultural practices.

2. Development and adaptation of efficient water control and delivery systems especially for on-farm use.

3. Development of strategies for minimizing the deleterious effects on crops of excess surface and subsurface water, poor water quality and excessive concentrations of soil salinity, exchangeable sodium and other toxic elements.

4. Identification of institutional and policy factors (legal, social, economic, manpower, credit, etc.) that influence the efficient distribution, management and utilization of water at the farm level and the development of strategies for replacing inhibiting factors with facilitating factors."

Since its inception in June, 1968, and counting the 211(d) grant, roughly 6.0 million dollars of AID funds will have been utilized by USU on "institution building" and on-farm water management research by March 31, 1977. This funding level is comparable to the funding level of Colorado State University over the same time period. The general and specific water management research objectives of both institutions are identical. Together these two projects represent a major effort on the

part of each University, and the funding represents a significant portion of AID's Central Research Program. The team is well aware of the magnitude of these projects and their costs, but is also aware of the significance of the impact that improved on-farm water management can make on food production, on farm income, and protection of capital structures and investments in less developed countries (see CSU review report cited above). Particularly, the impact is significant if the research: (1) relates food and on-farm soil and water management by means of priority criteria, and (2) is conducted in an integrated "cropping system" mode.

Table 1 summarizes the types of work and the countries where field work has occurred. This table was prepared by USU for the 1973 Park City, Utah, AID sponsored conference on water management research.

Table 1. Location of programs by objectives during initial contract period.

Location	Objective							
	1	2	3	4	5	6	7	8
Bolivia		X						X
Brazil	X	X			X			
Chile	X	X		X	X		X	X
Colombia		X	X	X	X	X	X	X
Ecuador		X						X
El Salvador		X	X		X		X	
Guatemala		X						
Honduras		X						
Peru								X
Venezuela	X	X						
Logan, UT			X			X		

In this table, the general objective directing primary emphasis on food production is apparently subsummed or given. Further subsummed is the critical value significance of treating on-farm water management as a complex of considerations involving the essentials of water management and their operational interrelationships, as follows:

1. delivery systems
2. land preparation
3. distribution and utilization
4. drainage
5. maintenance and conservation
6. socio-economic considerations.

Water management, then, involves management of water, crops, and the further consideration of labor, capital investments, land and water costs, maintenance, and costs and returns of cropping systems. Improved water management also involves consideration of alternative cropping systems and socio-economic constraints.

B. Review Procedure

The aim of the field review and project assessment team was, first, to obtain an idea of what the project was focused upon and why. Because documents covering project inception, its history, and results to date were provided only in annual reports, the team undertook to gather together other relevant documents.

The team also prepared: 1) a questionnaire to collect and organize the information on each project; 2) a work schedule; 3) a first order identification of sources of data, and 4) a preliminary outline of a report on the field review. These preliminary guidance documents were modified from time to time. A final outline of the report was prepared at the end of the review.

The itinerary of the review team was based upon a week in Peru, a week in Brazil, a week in El Salvador, and two days in Logan, Utah. The Ecuador field worker (Craig Anderson) on water law came to Peru from Ecuador, and the Guatemala worker (Bert Embry) came to San Salvador. The field research was reviewed from three points of view: 1) is the project achieving its objectives; 2) how do the projects rank considering alternative problems and alternative procedures; and 3) how the projects are interrelated, related to the model and how are they focused on the food objective.

The review trip began February 28 and ended March 22 at Logan. The time of the team was spent: 1) identifying country goals, gaining an understanding of country bio-physical, human, and socio-economic objectives; 2) gaining an understanding and appreciation of USAID country assistance objectives and programs; and 3) the research setup, research objectives, staffing, facilities, and budgets of country project and on-campus research.

These were done in meetings and consultation with researchers, research directors, USAID agriculture personnel, Mission Directors and Country Planning Directors. The team personally visited remote areas of small farmer and income concern, for example, the Tarma area of the Andes of Peru, the northeast interior of Brazil, the Brassiera area between Brasilia and Petrolina in Brazil, and the hill areas in El Salvador.

The team found at every turn, from farmers to directors, a concern with irrigation and with soil and water management, and a desire for high level assistance to move more rapidly toward technical and economic goals on the food front, coupled with training and upgrading of technical

personnel and farmers. An admitted deficiency in all countries is finding a good format for technical diffusion, socio-economic upgrading, and improved way of life for the rural human factor.

II. THE FOOD AND AGRICULTURAL SITUATION IN LATIN AMERICA

This section is included to set forth the team's reasoning why the food objective is so important, and why farms and cropping systems should be thought of, and therefore water management, in a total food system context. Food projection is barely keeping pace with population growth, and in many cases (countries) it has not been able to keep pace with the influence of population, and inflation combined. Food shortages are exerting an inflationary force of their own on prices.

A. Agricultural and Food Production Trends

Agricultural production and total food production has increased steadily over the past ten year period (1961-65 = 100), but the trend by country is mixed (Tables 2 and 3). Two problems of major impact on rates of agricultural production increases needed are population and inflationary measures. Population increases in Latin America are severely taxing agriculture's ability to keep up, averaging 2.6 percent 1973-74, for example. The indices of population-food production trends since 1965 in Latin America are listed in Table 2.

Inflation continues as a major problem in Latin America as compared to 1973. Consumer prices in 1974 rose 10-20 percent in Central America, 20-25 percent in the Caribbean, and 15-25 percent in most of South America. Exceptionally high rates included Bolivia's 35 percent, Costa Rica's 40 percent, Brazil's 25 percent, Argentina's 41 percent, Uruguay's 100 percent, and Chile's 376 percent. High unemployment, consequently, continues as a result reaching 15-20 percent in a number of Latin American countries.

Table 2.--Latin America[1/]

INDICES OF TOTAL FOOD PRODUCTION, BY COUNTRY, 1965-74

(1961-65 = 100)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	PRELIM. 1974
DOMINICAN REPUBLIC	92	99	99	96	117	122	133	135	137	139
HAITI	94	96	91	88	91	95	99	102	102	103
JAMAICA	107	107	99	94	87	84	87	89	84	88
TRINIDAD AND TOBAGO	104	98	96	107	114	96	92	99	83	84
CARIBBEAN	97	101	98	96	107	108	115	118	117	119
COSTA RICA	108	117	122	126	139	159	155	168	178	162
EL SALVADOR	106	117	118	128	122	136	143	130	155	153
GUATEMALA	108	113	121	130	135	141	155	158	166	173
HONDURAS	112	123	125	132	127	126	145	132	137	132
NICARAGUA	109	115	120	124	128	131	145	133	147	145
PANAMA	119	120	125	146	157	149	157	159	145	132
CENTRAL AMERICA AND PANAMA	110	118	122	131	134	140	150	147	155	150
CENTRAL AMERICA LESS PANAMA	109	117	122	128	131	139	149	146	156	153
ARGENTINA	97	106	117	108	117	117	114	107	117	124
BOLIVIA	103	104	101	103	111	110	113	114	119	117
BRAZIL	115	112	120	123	129	139	139	146	153	162
CHILE	108	109	113	119	112	123	126	113	100	113
COLOMBIA	107	109	113	118	120	125	131	135	135	153
ECUADOR	106	110	105	109	121	131	134	138	148	138
GUYANA	104	99	100	100	102	99	105	81	72	98
PARAGUAY	104	103	105	98	106	119	100	100	98	103
PERU	102	105	111	99	108	116	121	113	116	117
URUGUAY	107	95	80	98	97	114	96	91	97	108
VENEZUELA	115	120	128	133	136	145	151	148	149	160
SOUTH AMERICA	107	109	116	116	121	128	128	128	134	142
LATIN AMERICA (22 COUNTRIES)	108	111	117	118	123	130	132	131	137	143

1/Source: Economic Research Service, Indices of Agricultural Production for the Western Hemisphere, ERS-For. 264, Revised.

Table 3 -Western Hemisphere: Indices of total and per capita agricultural and food production by countries and regions, 1972-74 1/

(1961-65 = 100)

Country	Total						Per capita					
	Agricultural			Food			Agricultural			Food		
	1972	1973	1974	1972	1973	1974	1972	1973	1974	1972	1973	1974
Dominican Republic	132	137	138	135	137	139	101	102	99	103	102	100
Haiti	95	97	99	102	102	103	78	77	77	84	81	80
Jamaica	90	85	89	89	84	88	79	73	75	78	72	74
Trinidad & Tobago	100	83	82	99	83	84	94	77	76	93	77	78
Caribbean	116	117	118	118	117	119	95	93	92	97	93	92
Costa Rica	156	170	153	168	178	162	118	125	110	127	131	116
El Salvador	118	129	138	130	155	153	87	92	96	96	111	106
Guatemala	147	152	155	158	166	173	118	118	117	127	129	131
Honduras	138	138	137	132	137	132	102	99	95	98	98	91
Nicaragua	125	147	145	133	147	145	96	109	104	102	109	104
Panama	157	143	130	159	145	132	120	106	93	122	107	95
Central America	139	146	145	147	155	150	107	108	104	113	115	108
Argentina	104	113	120	107	117	124	91	97	102	94	101	105
Bolivia	119	127	126	114	119	117	96	100	97	92	94	90
Brazil	137	138	150	146	153	162	107	104	110	114	116	119
Chile	111	98	111	113	100	113	94	81	90	95	83	92
Colombia	132	129	145	135	135	153	99	[illegible]	102	101	98	108
Ecuador	137	145	138	138	148	138	101	[illegible]	95	102	106	95
Guyana	82	72	98	81	72	98	66	[illegible]	75	65	56	75
Paraguay	104	105	111	100	98	103	83	82	84	80	76	78
Peru	101	104	106	113	[illegible]	117	78	78	77	87	87	85
Uruguay	85	90	99	91	[illegible]	108	76	80	87	81	86	95
Venezuela	143	150	159	148	[illegible]	160	107	109	112	111	108	112
South America	123	126	136	128	134	142	97	97	102	101	103	106
Latin America a/	126	129	136	131	137	143	98	98	100	102	104	105
Latin America b/	126	129	137	132	138	144	98	98	101	103	104	106

a/ Production for 22 countries shown.
b/ Excludes Guyana, Jamaica, and Trinidad and Tobago.

1/ Source: Economic Research Service, Indices of Agricultural Production for the Western Hemisphere, ERS-For. 264, Revised.

Due to these forces, and high world food prices, most Latin American countries are giving high immediate priority to expansion of agriculture and food production. But for the immediate future, heavy dependence continues on agricultural imports, hemispheric and world-wide (Table 4).

B. Soil and Water Management as the Basic Ingredient of Improved Food Production Systems

Soil and water management are basic to all cropping systems. In this respect no cropping system (which includes pastures and livestock) can reach an optimum state of resource utilization without proper management in both respects. Therefore, the importance given to on-farm soil and water management can best be seen relative to its contribution to food (and agricultural) production. Tangible benefits also include better utilization of other resources. The benefits which can be gained include:

1. better conservation and use of water
2. improved water conveyance and on-farm delivery systems
3. better on-farm management of soil, leveling, and utilization of water
4. better land preparation and use of better cultural practices
5. applying water correctly as to timing and quantities
6. water quality control
7. control of drainage and salinity
8. development of appropriate institutions and knowledge.

These components of the farming operation require integration into more productive farming systems, considering costs, investments, and commodity prices, for potential benefits to be realized.

Table 4--Western Hemisphere: Agricultural exports and imports by principal countries, 1969-72

Country	Exports 1/				Imports 1/			
	1969	1970	1971	1972	1969	1970	1971	1972
	Million dollars							
Barbados	16.5	18.5	19.8	17.8	22.5	26.4	31.3	28.9
Cuba 2/	556.0	849.0	696.0	650.0	232.0	262.0	314.0	319.0
Dominican Republic	160.1	186.3	205.3	259.5	26.3	32.4	32.7	33.3
Haiti	20.6	22.6	25.9	28.9	11.0	10.1	13.4	16.6
Jamaica	69.3	69.7	69.7	79.3	70.9	83.9	91.9	112.1
Trinidad and Tobago	39.2	37.4	38.8	47.4	56.6	58.2	62.7	70.7
Caribbean 3/	861.7	1,183.5	1,055.5	1,08[illegible].9	419.3	473.0	546.0	580.6
Costa Rica	152.0	162.4	169.3	218.5	25.5	34.8	43.0	38.9
El Salvador	128.3	153.9	145.4	182.7	33.3	29.7	31.0	30.1
Guatemala	186.3	206.9	198.5	234.8	24.3	31.5	31.3	30.0
Honduras	121.7	121.8	142.1	141.8	21.3	24.6	18.6	20.9
Nicaragua	120.8	131.6	140.6	190.7	16.5	18.9	21.6	24.7
Panama	70.8	72.1	74.1	80.1	21.4	23.6	35.1	41.6
Central America 3/	779.9	862.7	870.0	1,048.6	142.3	163.1	180.6	186.2
Argentina	1,373.5	1,503.4	1,465.5	1,630.6	135.4	120.1	120.1	114.3
Bolivia	5.7	7.5	12.1	23.[illegible]	27.8	30.7	29.4	31.0
Brazil	1,758.4	1,945.7	1,921.7	2,725.6	299.8	292.9	318.4	350.1
Chile	52.3	58.2	80.6	68.4	187.7	171.1	218.1	207.0
Colombia	449.7	578.6	477.3	602.4	61.1	65.5	69.6	80.0
Ecuador	171.7	193.8	189.0	185.6	20.0	19.9	26.2	28.9
Guyana	54.9	48.6	60.1	67.1	19.7	20.0	22.5	21.4
Paraguay	30.5	40.3	41.8	62.7	6.7	6.3	5.6	5.4
Peru	366.0	506.4	485.9	428.0	133.4	125.6	130.2	128.0
Uruguay	180.8	210.4	191.1	194.7	27.6	24.4	21.1	36.8
Venezuela	30.1	43.2	33.4	56.8	173.3	171.8	179.6	192.6
South America 3/	4,473.6	5,135.1	4,958.5	6,045.2	1,092.5	1,048.3	1,140.8	1,195.5
Latin America 3/	6,877.8	7,869.2	7,572.9	9,035.6	1,789.3	1,911.1	2,071.0	2,236.3

1/ Exports and Imports include SITC categories for food, beverages (less distilled) and agricultural raw materials, excluding fish and manufactured tobacco.
2/ Estimates by Economic Research Service.
3/ For countries shown.

Sources: Food and Agricultural Organization, Trade Yearbooks, Country Trade books, and CEMA.

C. Socio-Economic Considerations in Water Management

Social conditions, often policy or politically related, operate as both attitudinal and conditional constraints, upon the development, rehabilitation and utilization of water. Among these are traditions, knowledge, legal access and rights, local leadership, and knowledge of farmers on how to handle water, develop improved irrigation systems, and provide maintenance and drainage. Irrigation projects frequently, also require farmers to associate and work together, a practice which may have no local common grounds.

There is, likewise, a host of interwoven and complex institutions and factor relationships involved. One of the foremost is the establishment of the proper technological package of water and soil management with respect to selected crops and/or multiple cropping. A second is how and for what purposes to involve farmers in the process of construction of infrastructure, and providing knowledge on better farming methods and practices to better utilize and conserve water. A third is tracing through of costs and benefits of water development and water management. A fourth is how to treat the problem of risk in farmer terms through appropriate policies and/or risk discounts, or in terms of more knowledge, or more stable and reliable technological packages.

In addition to the technical requirements of the irrigation system itself, and the bio-physical relations and interactions of the cropping system, it is important to remember that "on-farm" means dealing with farmers in the field. Most of these farmers may, characteristically, have a low level of education, not be accustomed to management, and are usually apprehensive about getting involved in costs which they may not be able to meet, but who are familiar, nevertheless, with price variance

and its consequences even though demand concepts may be beyond them. So, part of the water development and management problem may not be a problem of money, or a problem of technology, but a problem of

1) a need to change social conditions

2) a need to educate farmers

3) a need to organize farmers.

Thereby, in providing assistance, the assistance must be provided by people who understand the country and its people, can function meaningfully in country through understanding of country goals and objectives, and who can relate to the people. These goals and objectives, in socio-economics, as well as technical terms, must be carefully analyzed and thought through from the point of view of kinds of assistance, e.g., embedded in country plans, in proper prior fashion. This way of perceiving development of assistance on food production makes primary or basic research a means of support of on-farm adaptive research, technical assistance, and on-farm training. The traditional distinction usually made between research and extension, and between research and training has no meaning or place in this order of development.

Also, in the countries visited (Peru, Brazil, and El Salvador, and discussions with the USU workers in Guatemala and Ecuator), members of the governments, U.S. Missions, and researchers were in agreement on upgrading and increasing the welfare of the human factor. This means assistance on training, institution building and socio-economic concerns, towards all of which better soil and water management knowledge can contribute. As a consequence of these closely interwoven and multiple considerations foreign (external) assistance can not proceed as an isolated, technically focused project, it must at least have an "on-farm" ending

point. It also means determining assistance needs by assessing the goods and bads of alternative ways of solving on-farm problems. This is done by tracing out who is affected when, where and how, using both traditional input-output data and non-traditional socio-economic data, and by introducing appropriate measures of assessing aggregative impacts, e.g., number of people, and the amount and distribution of income. Formulation or reformulation of water management research should include, therefore, the technical aspects of soil and water, and the micro (farm) and macro (area) aspects as well.

III REVIEW AND ASSESSMENT OF USU FIELD AND ON-CAMPUS RESEARCH

A. Historical Summary: (Contract AID/csd-2167 and Succeeding Contract AID/ta-c-1103)

1. Introduction

A proposal for "Research on Agricultural Responses to Water Management in the Wet-Dry Climatic Zone of South and Central America" was submitted to AID by Utah State University, August, 1967. After AID review and approval, a contract (AID/csd-2167) for $779,550 initially, was negotiated between AID and USU and signed in June, 1968. The contract was later amended and funding was extended to March 27, 1974. During the period June, 1968 and March, 1974, USU spent $2,328,487 on water management research in Latin America. A subsequent contract (AID/ta-c-1103) was negotiated as a followup covering the period April, 1974 to June, 1976, with a funding level of $2,380,000. This contract was extended in March, 1976 to March 31, 1977, pending field on-campus review of progress and future on-farm water management research requirements (see Appendices 3a and 3b).

A. A. Bishop was on-campus project leader 1968-1973, then H. B. Peterson 1973-1975, followed by A. A. Bishop, 1975 to present. During the period 1973-1975, A. A. Bishop was stationed with AID/TAB in Washington, D.C.

B. H. Anderson was field project leader 1968-1970, succeeded by B. C. Palmer 1970 to present.

2. Field Program[1/]

The research was to be aimed at water management problems in the semi-arid lands of the Latin American region and applicability to similar conditions in other regions was to be considered. TDY visits were made

1/See Appendix 1 for chronology of the project.

to Argentina, Brazil, Chile, Colombia, El Salvador, Panama, Peru, and Venezuela during the first 18 months of the contract to discuss the possibility of indigenous country collaboration. Identified water management problems in Brazil, Chile, Colombia, and El Salvador were selected for initial research. Austin and Gilbert were assigned to Brazil; Kidman and Stutler to Chile; Olsen and Fullerton to Colombia; and Griffin to El Salvador (see Appendix 2a and 2b).

The field program has involved extensive travel to and from and within Latin American over the period of the contract by on-campus and field staff (see Appendix 3c).

The research emphasis in Brazil was assisting in the development of three irrigation research stations in the San Francisco Valley. This assistance was completed March 1973. A new agreement was then negotiated with EMBRAPA to assist with agreed upon on-farm water management research. TDY consultative assistance is being furnished, and Kidman is located at the EMBRAPA branch experiment station in Petrolina.

In Chile, the emphasis was on water conservation practice on farms. Kidman and Stutler, in collaboration with host country research and extension personnel, set up experimental plots on two private farms and demonstration plots on six communal farms in the Aconcagua valley. The project was prematurely terminated without conclusive results when AID closed out activities during the Allende regime.

In Colombia, drainage and crop management problems were investigated by Olsen and Fullerton on the Atlantico 3 irrigation project located between Barranquilla and Cartegena on the Atlantic coast. The work was completed July, 1973. Griffin went to El Salvador in June, 1970 and set up research on drainage, irrigation practices and water-fertilizer-variety experiments. In 1972 he was replaced by Stutler and Kidman.

David Daines, who was stationed in Ecuador in 1971, initiated the water law research in South America under the USU project. He assembled water law data from the five Andean Pact countries and has produced a water law digest in Spanish and English. Since January, 1975, Craig Anderson has been stationed in Ecuador to collect additional data on irrigation district organization and on-farm production from farmers and irrigation district officials.

In November 1974, Embry was assigned to Guatemala to collaborate with indigenous researchers in increasing irrigated agricultural production, generally. Olsen was assigned in February, 1975 to Peru to carry out a program of irrigated land reclamation.

On-Campus Programs and Support of Field Activities

3. On-Campus Program

In addition to the Department of Agricultural and Irrigation Engineering, the Departments of Soils and Biometeorology, and to some extent Agricultural Economics, are involved. The Departments of Sociology and Plant Science have, to a lesser degree, also been involved. The combined staffs have experience and capability in the areas of: 1) irrigation and crop water requirements; 2) soils, drainage, soil physics and chemistry; 3) water law, institutions, and economics.

Principal on-campus researchers on the project have been: Bishop, Christiansen, Hargreaves, Hill, Palmer, Peterson, Unhanand and Keller. Personnel from the Department of Soils and Biometeorology have included James, Hanks and Nielson. Principal researchers from the Department of Economics have included LeBaron, Whitaker and Wennergren.

All field staff are competent in Spanish and some speak Portuguese. In addition, four on-campus professors on the contract have a good working knowledge of Portuguese.

4. USU Observations on the Contract

a. Constraints

In addition to constraints implied by overseas work, specific conditions considered by USU as constraints, or to be constraining, include:

(1) No long term field personnel could be assigned during the first 18 months of the contract.

(2) USAID and country concurrence and support was required in each country.

(3) Low profile constraints by some ambassadors resulted in postponement of planned programs (El Salvador), unscheduled moving of staff (Ecuador and Chile), causing spreading rather than concentration of effort.

(4) Plans of work had to mesh with indigenous collaborating agencies' programs.

(5) Since USAID Mission and collaborating agency goals change constantly, marked shifts in emphasis within the field program were required.

(6) The need to station staff at "hardship" type posts, e.g. Petrolina, Brazil.

b. Costs and Benefits

The contract has benefited the University, benefits stated include:

(1) Increased understanding by faculty of on-farm water management problems found in foreign countries.

(2) Larger faculty which permits specialization and higher staff competence.

(3) New ideas and techniques brought into the state.

(4) International broadening of staff experience.

(5) Enhanced status of the university due to increased reputations for capability at the international level.

Costs enumerated included:

(1) Instabilities inherent in operating on "soft" money.

(2) Difficulties in scheduling overseas assignments, both long-term and TDY to avoid conflict with on-campus and in-state commitments.

(3) Foreign language requirements which place an extra constraint on staff recruiting options.

(4) The professional "costs" to a person assigned to a long-term foreign posting.

(5) Difficulty of ensuring high quality education for staff children posted overseas.

5. Previous Project Reviews

In addition to internal AID reviews, the AID Research Advisory Committee made an over-view review of the project in January 1972. The AID sponsored symposium on "Research Needs for On-Farm Water Management" held in Park City, Utah, October 1973, also reviewed the CSU and USU programs and presented suggestions. Both reviews influenced the orientation of the field and on-campus work.

This review is the first comprehensive field review of the project since its inception in June 1968.

B. Review and Comment on Field Research

1. Ecuador

The review team did not include Ecuador in its itinerary but instead requested that Craig Anderson, stationed in Quito, meet with the team while in Lima. Mr. Anderson arrived in Ecuador to assume his duties in January, 1975, to expand investigations initiated by David R. Daines. Daines started work in Ecuador in 1970 on a detailed water law digest for the Andean Pact countries. Dr. Daines' comprehensive review culminated in a publication entitled Water Legislation in the Andean Pack Countries co-authored by Gonzalo Falconi. This work has been translated into Spanish and made available to government agencies in Bolivia, Chile, Colombia, Ecuador, Peru, and Venezuela. Seminars also have been held on transfer of the information to users.

Mr. Anderson informed the team that his work was a continuation of the water law study with emphasis on institutional constraints that can affect rational use of water at the farm level. He has developed a survey technique based upon two questionnaires to obtain information on: 1) the water user and 2) the institutions or water organizations that serve the farm.

Currently Anderson is completing phase I (data acquisition and computer analysis) in Ecuador, Chile, Bolivia and Colombia. He will include Peru if current negotiations succeed. The purpose is to determine the water delivery constraints faced by the farmer. Mr. Anderson identifies so-called "inhibitors" and "facilitators." He believes he is getting reliable responses from farmers to his questions.

Phase II of this project includes implementation of identified solutions to institutional constraints on selected small irrigation

projects. What is done and how implementation is to be achieved will depend on data analysis and interpretation. It was not clear to the team how Mr. Anderson plans to conduct the field program described in his Plan of Work.

The team recognizes the importance of Mr. Anderson's work as far as it goes. However, it seems that an even greater "payoff" would be possible if his survey included physical measurements of water distribution and farm losses on selected irrigation projects or portions thereof in addition to socio-economic and institutional constraints. This procedure would require a technical, social and physical mapping of the irrigation district.

In this regard, the team sees an opportunity for contractor cooperation (USU and CSU) to explore possibilities of integrating the Anderson "institutional" survey with the "CSU-Lowdermilk" social-economic-physical approach. The watercourse surveys conducted by Lowdermilk, Early and Clyma in Pakistan created an awareness among responsible government officials by identifying critical problems and constraints facing the farmer if he is to improve his capacity to produce food in water short areas.

The situation in Latin American countries and, in particular, Peru is similar in many respects to that in Pakistan. The team feels that such an effort would serve to identify problems associated with on-farm water management at the "grassroots" level but recognizes also that a team approach is needed to effectively conduct such a survey. At this point, it would seem that Anderson, Daines, and Lowdermilk should meet at an early date to discuss their respective survey techniques and determine if the approaches are mutually re-enforcing.

2. Peru

In Peru the review panel met with Edwin C. Olsen who is the CSU staff member assigned to Peru. Dr. Olsen has been stationed in Peru since April 1975. He has worked closely with the USAID/Peru Mission and the Government of Peru (GOP). Olsen works closely with personnel in the Ministry of Agriculture (MINAG) which handles water development projects (note that there is also a Ministry of Food and most agricultural research is under this Ministry).

Olsen has four counterparts from MINAG that work with him. Three are agricultural engineers and one is an agronomist. The team talked with Ing. Julio Lostao Espinoza, in charge of the Direccion de Preservacion y Conservacion (DIPRECO) in MINAG and others on his staff. We were again told of the satisfaction and need for the USU project and the desirability of its expansion. We also talked to Ing. Luis Paz, Director, Agricultural Sectoral Planning.

In the USAID/Peru, the team talked to Milton Lau, Mission Agricultural Officer, and Donald R. Finberg, Mission Director. The Mission looks on Dr. Olsen as an asset to their program and as their main technical advisor on water problems. The Mission has formally requested additional assistance under the existing USU contract or from AID/Washington TAB as a contract supplement. Specifically, they request an agronomist oriented toward irrigation research and an irrigation engineer oriented toward extension.

a. Current Level of Input on Project

The research on which USU is working receives support from three sources. The PROAG gives an estimated budget of $152,000 from AID/Washington through the USU contract, $11,160 from AID/Peru, and $64,500

from GOP. This is a two year estimated budget. The team was impressed with the level of input provided by the GOP, particularly with the counterpart and other support through DIPRECO.

b. Current Thrust of USU-Peru Effort

The project thrust appears to be determined jointly by the Mission and the USU staff person on location. No annual project work plan is prepared by USU. While we applaud the close and effective cooperation between USU staff and Mission personnel, we see potential problems in USU keeping all facets of the project coordinated and on target in terms of contract objectives because USU is involved in several Latin American countries.[1/] Since the contract objectives are quite general, we recommend that a brief annual research work plan be developed for each project location, including the campus, so that the AID contract monitoring officer will better know what is planned. We are convinced that better communication is needed and could be achieved using an annual project work plan for each location. By distributing these work plans, approved by the USU project director, to each location, internal communication problems would be improved. Also, AID/Washington is kept current of plans.

Dr. Olsen has been working to obtain the necessary weather records for evapotranspiration calculations from the GOP meteorological office. Progress is being made, but it is slow, because source data is not readily available.

A major effort has also gone into advising USAID/Peru concerning an AID loan for improving irrigation in the high mountain valleys (see

1/Note that the contract objectives are so general that almost any work related to water management would be covered.

Appendix 5). AID has proposed a direct loan of $11 million for this project and the GOP will put up a similar amount.

One research plot of approximately one hectare has been assigned to the project by the experiment station at La Molina. There will be research and demonstration of irrigation methods on this plot. About one-third will be in drip irrigation and two-thirds in furrow irrigation. Irrigation methods need to be demonstrated. However, considering the cost and other problems in Peru, we question the advisability of the drip study. Perhaps more detailed economic and assessment analysis, than was available to us, should have gone into this effort.

The PROAG spells out that evapotranspiration (ET) will be a part of the research in Peru. We agree that ET estimates are essential to irrigation design and scheduling. However, study of past annual reports for the project indicate that a disproportionate part of the total project effort has gone into ET work. After the climatic data now being obtained are analyzed, a reassessment of the amount of effort that can justifiably go into ET work is in order.

Special problems in irrigation methods and efficiencies seem evident. This is true of coastal irrigation, where the water is in short supply and over-irrigation not only wastes water, but aggravates possible drainage problems. The same problems exist in the mountain valley irrigation.

The institutional problems related to water management are also severe in Peru and are to be studied by Mr. Craig Anderson. The institutional and socio-political aspect of the USU project is discussed under the section on Ecuador where Mr. Anderson is stationed.

c. Importance of USU Work to Peru

Water management no doubt is the key to future food production in Peru. The country can effectively use assistance in developing the water resources for irrigation. There appear to be some unusual problems in the three zones in Peru that can be irrigated, i.e., the coastal zone (Costa), the mountain valley areas (Sierra), and the upper jungle area in the East (Selva). Probably the greatest need for assistance and the most challenging problem is in the mountain valley area where the proposed AID loan will be implemented. Specific recommendations concerning relevant assistance are discussed later in this report.

3. Braz

a. Previc Research Programs in Brazil

At the request of USAID/Brazil and the Ministry of Interior's San Francisco Development Agency (SUVALE), USU was asked to assist in developing an irrigation research, training, and extension program. This involved the establishment of three new experiment stations at Pirapora, Formoso, and San Desiderio (Barreiras). The team observed current research activities by EMPRAPA personnel at the Barreiras experiment station, but time did not permit visits to the Pirapora and Formoso experiment stations.

Lloyd Austin (Engineer) and Norris Gilbert (Agronomist) were assigned to Brazil in April, 1971 (see Appendix 1), to collaborate with SUVALE with the primary task to determine the best crops and cultural practices for the area, to provide training of counterparts, and to assist in the establishment of irrigation methods and practices best suited to soils and climatic conditions in the respective areas being developed. After reviewing annual reports and appended trip reports, the

team recognizes the many difficulties and frustrations encountered in getting these experiment stations and experimental studies underway. Delays encountered in building poorly designed water delivery systems, acquisition of farm equipment, selection of counterparts, transportation to remote areas, etc., are but a few of the problems encountered.

In spite of these obstacles, experimental plantings under irrigated agriculture commenced by testing the adaptability of several varieties of each of 39 crops including avocado, banana, beans, black pepper, cabbage, canavalia, castor beans, cauliflower, citrus, corn, cowpea, cucumbers, eggplant, figs, forage grains, grapes, green pepper, guar, guava, jilo, mango, mint, okra, rice, safflower, salsa, soybeans, squash, sunflower, tangerine, tomatoes, watermelon, and wheat. Experiments were also conducted to assess adaptability and yield potential of a number of crops grown during the rainy season. One supplemental irrigation applied to corn resulted in a respectable yield compared to a complete crop failure under natural rainfall received.

Before the USU team left in March, 1973, the experiment station and its operation, Pirapora CTI, was well-in-hand when turned over to the Federal University of Vicosa in Minas Gerais on contract. The Formosa and San Desiderio (Barreiras) stations were still under the supervision of SUVALE technicians and were in the initial stages of carrying out water-fertilizer interaction experiments. A summary or checklist of both administrative and physical factors was also formulated as a guide for development of future research facilities.

b. Current Research Programs in Brazil

(1) Petrolina

In Petrolina, the review panel observed USU's research program on soil and water management being conducted by Don Kidman who was originally stationed on USU's staff in Chile and El Salvador. We also were briefed on EMBRAPA's research program at Petrolina, under the direction of Antonio Jose Simoes. This Research Center, in existence for only five months, represents one of 14 stations oriented on a commodity basis.

The review team also met with the Director of SUVALE where they were briefed on CODEVASF (Companhia de Desenvolvimento do Vale do São Francisco), a comprehensive plan for development of the San Francisco Valley by regions or areas. Various schemes are being used in project development to accommodate both small and large scale farm or plantation operations (small farms range in size from about 6 to 11 hectares, with sugar plantations up to 12,500 ha). Cooperatives also are being formed by combining small farmers into production and marketing organizations but the farmer does not own his land. Crop production levels on small holdings by the small farmer has been disappointing and there still appears to be considerable flexibility and experimentation on how the farmers or farm laborers will be organized on planned irrigated projects. The team was impressed by the great diversity of crops that can be grown throughout the San Francisco Valley and the tremendous soil and water resource that will ultimately be used in producing food products for domestic and for export consumption.

In addition to National Research Centers, each state has one or more experiment stations which deal primarily with the agricultural crops adapted to climatic and soil conditions found in respective areas. At

Petrolina, the National Center represents the semiarid tropics in the states of Permambuco and Juazeriro. The major emphasis is on production of irrigated corn, cotton, beans and rice. Annual precipitation is less than 400 mm. EMBRAPA staff also participate in research activities at two other state research stations, one in the sugarcane belt (1200 mm precipitation near coast), the other being cattle production in the caatinga (range or grass lands) which receives 400-800 mm precipitation. The principle problem in this area is range management.

Director Simoes indicated that one of the greatest problems facing utilization of research results to produce more food was the illiteracy or low educational level of the farmer. The three month training period was, in his opinion, not adequate to teach them irrigation science. Another observation he made concerning the small farmer was their low income ($50/month) and their inability to purchase the farm inputs needed.

The thrust of the USU research program at Petrolina (State of Pernambuco) and in Juazeiro (directly across the San Francisco river) involves multifactor experiments to identify response to and interactions among variables of fertility, irrigation water levels and plant populations. Near Petrolina, the panel observed a corn experiment in its second phase, namely to determine effects of residual N on plots previously in tomatoes. The factorial design includes four nitrogen application rates (0, 100, 200 and 300 kgms/ha), three soil water levels (irrigation applied at 1, 2, and 5 bar soil water suction) and three plant populations (tomatoes) and two, 71,500, 30,000 plants/ha for corn.

A Parshall flume is used to measure water conveyed in a lined plastic head ditch to each of three irrigation blocks replicated three

times. Sub-plots consist of plant population and fertility variables. The corn plots were being thinned to a uniform stand to measure response to residual applications of nitrogen as influenced by water treatments, soil samples to determine when to irrigate and for chemical analysis are taken as required.

The corn was about 15 cms tall at the time of our visit and showed moderate to severe signs of insect damage. Mr. Kidman indicated that insect control was a continuous battle through the growing season. Potential yield is not high (approaches two metric tons/ha). Varietal limitations are suspected as well as high minimum night time temperatures. The residual response to N was barely visible on most plots on this sandy site indicating excessive leaching during the rainy season. Also, the insect control problem may be so severe as to mask or alter results obtained.

(2) Juazeiro

At Juazeiro, the same experiment was being repeated with the difference that corn followed corn. The soils here were finer textured than at the Petrolina site. Residual response to nitrogen was strikingly apparent, the high fertility plots being about twice as tall (1 m) compared to nonfertilized plots.

According to Mr. Kidman, the experiments he is conducting will provide data input to the crop model being developed by USU. In response to pointed questions on the model, he admits that his concept of the model is vague. From a practical viewpoint, he sees recommendations of fertilizer rates, frequencies of irrigation, crop densities and water requirements at various stages of crop growth as outputs of his research program. He feels, however, that the impact could be even greater if time and

manpower would allow simple demonstrations including fertility and irrigation treatments at the farm level. He is a firm believer in adaptive research to achieve maximum exposure of good soil and water management practices.

Mr. Kidman's assignment in Petrolina has presented trying circumstances. He and his wife are the only Americans living in Petrolina. He feels very much isolated and believes his program would benefit by adding at least one professional. Kidman feels that he needs at least six to nine months to finish the work he currently has underway.

After visiting the two substations attached to the Research Center, the team was impressed with the food production potential of the area. There are, however, many problems to surmount, particularly disease and insect control. Observations of farming practices on farmers' fields indicated the need for extensive on-farm water management assistance including cropping systems, seeding procedures to achieve improved germination, and cultural practices to improve both flood and furrow irrigation.

The team was impressed also with the possibilities for growing many high valued, specialty crops such as cocoa, grapes, sugarcane, citrus, mangos, watermelons, tomatoes, onions, etc. Many of these could be exported and some, like tomatoes, can be handled by local food processing facilities. There already is a tomato processing facility in the area. Perennial crops like citrus, grapes, etc., would be easier to manage and in some cases might be better suited to the small farm operator. With these specialty crop possibilities, the team is concerned that USU is not creating the best image in concentrating on water-fertilizer interaction experiments on corn when good corn yields can be obtained elsewhere

in Brazil under natural rainfall conditions. The value of using corn as an indicator crop to study the fate of applied nitrogen and to develop soil tests undoubtedly has merit but the team wonders if this is the type of study that can make the greatest impact for increased food production at the farm level.

(3) Barreiras

The team travelled by air to Barreiras, enroute from Petrolina to Brazilia. Several hours were spent observing agronomic progress at the station near Barreiras. EMBRAPA agronomists had only been involved for five months at this experimental station, a station which USU helped set up. Cotton exhibited outstanding growth and production possibilities. However, so far fields planted by mechanical planters showed poor stands. Small forage plots indicated need for better cultural methods to obtain adequate stands on small plots. Flood irrigation created serious crusting problems.

Variety trials were being conducted on corn, grain sorghum (a selection of USA varieties), field beans and cotton. Field beans were seriously infected with a virus; however, some varieties were more susceptible than others. A date of planting (two week intervals) experiment on beans beginning at the start of the rainy season (November) to date was in progress to determine the degree of virus infection in the absence of irrigation. Brazilian agricultural scientists appear to have a good start on an effective research program at this station, apparently with little assistance needed except periodic short term consultants and advisers.

(4) Brasilia

(a) Introduction

Dr. Almero Blumenshein, Director of EMBRAPA (Empresa Brazileira de Resquisa Agroeguaria) in Brasilia indicated that three years ago a training program was initiated to develop scientists with M.S. and Ph.D. degrees. A total of 1200 students are in training in Brazil and abroad and 251 will be returning this year.

Director Blumenshein's philosophy is that returning students should direct their research program to farmers and that EMBRAPA should create the conditions (laboratories, equipment, etc.) to maximize their research output. He cautioned against doing research for the sake of research. He believes that students need academic training but that they need not necessarily continue to pursue their thesis problem. More importantly, they should identify the problems needing research by working directly with the farmer and extension personnel.

Blumenshein emphasized that the production system must be looked at as a whole at the farm level and that a multidisciplinary approach be used in solving problems identified. He encourages simple experiments on farmers' fields, the publication of simple, usable technology from technical publications and putting together a technological package that works at the farm level. Finally, he favors short term TDY visits from experts to work with counterparts in the planning and development of projects with return visits as needed to assist in the analysis of results and/or redirect program emphasis.

(b) Research Institutionalization in Brazil

In 1974, EMBRAPA completed the basic feasibility studies for the establishment of the new inscitutional and operative model through the National Research Centers and of the State Research Systems.

National Centers--The studies for the creation of the National Centers were carried out by 98 specialists integrating 16 work groups which prepared the drafts of the projects. These work groups, in turn, consulted 743 experts from a wide variety of national, foreign and international institutions of agriculture research.

EMBRAPA was thus able to create or define the organizational structure of the following Centers, already in operation or in the process of being established:

4. El Salvador

a. Introduction

The review panel met with the USU research staff in El Salvador, Kern Stutler (Research Engineer), Tom Fullerton (Agronomist), and Kent Ryan (graduate student in agronomy on a three month assignment). Stutler will complete a four year assignment in El Salvador in July, 1976, and will return to Logan. Fullerton has been in El Salvador for the past two years. Research responsibilities at the two major research locations, San Andrea and Atiocoya are divided between the two researchers on the basis of the technical requirement.

b. Coordination of the Research Program

Both researchers expressed concern and disappointment in counterparts assigned from CENTA and DGRD (see appendix table 4). Those who stayed long enough to be of use to the project were ultimately reassigned to higher institutional positions. Other counterparts appointed have served only on a short term basis and in the last two years have been almost absent from the scene. If the project were to terminate today, no trained counterparts would be in position to carry on the USU research program. In this regard, the USAID/El Salvador Mission Director (Ed Anderson) informed the team that he was not aware of this problem. Furthermore, his office does have mechanisms that can be used in helping resolve lack of sustained governmental commitment. This points to a need for better communication.

Other concerns expressed at the meeting with Mission Director Anderson, Assistant Mission Director Goldstein, Food and Agricultural Officer Whittle, and Mission Consultant Mac McLendon pertained to how USU's research results were to be applied at the farm. The question of

when extension-type publications would be available was also raised. A general feeling expressed was that more emphasis was needed on "delivery" systems; that it is one thing to do research, but another to make it available to the farmer. The Mission believes the USU research staff to be competent, but voiced concern as to how the project can have an immediate impact on increasing food production on farms.

Other matters of concern pertained to how the contract came into existence, the status of the present contract and lack of communication with USAID. He does not believe he has the right to direct USU-TAB/AGR contract personnel and projects to do something, but would like to have more input. On this point, Mr. Anderson said that he would like to have the USU project leader attend his weekly staff meetings.

c. Country Support

The team met in closed sessions with representatives of CENTA (the Centro National de Tecnologia Agropecuaria) and DGRD (Direccion General de Rego y Drenaje). Those representing CENTA included Ing. Jose Octavio Durante (Director General), Ing. Rudolfo Cristales Avelar (Director of Investigations) and Roberto Apontes (Director of Research). Those from DGRD included Andres Solorzana B. (Director General) and Rene Vidal Palma (Head of Small Irrigation Projects) on a field trip the following day.

Speaking frankly, Mr. Solorzano informed the panel that he looked at irrigation problems from a different point of view; that the "adaptive type" of research, in his opinion, was much more important than the kind of research being conducted by USU. Since his organization is involved primarily with the development of irrigation projects, both large and small, he feels the need for more assistance in the construction,

maintenance and use of water at the farmers' level. Some pilot projects being developed by a "community" of farmers (about 200 or less) are in need of assistance on how water being diverted for small irrigation schemes can best be used under difficult topographic and/or soil conditions. The priority of needs, in his opinion, are to teach the farmer how to handle water under such difficult conditions, how to maintain his irrigation system, how to handle excess water during the rainy season (1700 mm high intensity rainfall), how to train more specialists and technicians to assist the farmer and how to get such information applied at the farm level. He emphasized the need for external assistance to provide on-the-job training of extension personnel who are capable of working directly with the small farmer.

At CENTA, Mr. Durante told the team that a multidisciplinary approach to research is important, but the USU effort is not adequately meeting the country's needs for water management on irrigated lands. He indicated that they (CENTA) have had little or no input in identifying what research needs to be done, that they have had little voice in making decisions regarding research programs and that meetings between CENTA and USU have been few and far between.

Mr. Durante further stated that economic limitations of the country need to be considered in order to develop alternative solutions to problems on irrigated lands. He stressed the need for additional work on small irrigation projects; that CENTA does not know how to manage water for the different soils and climatic conditions where irrigation development is occurring and that answers are needed to the farmers' problem of using limited water supplies more efficiently. These are basic research needs that, in his opinion, should be considered before conducting the

kind of USU water-fertility interaction experiments currently underway. Finally, Mr. Durante emphasized the need for training technicians and specialists by working together (side-by-side) and not as an advisor.

d. Research Activities[1/]

Research efforts of Fullerton and Stutler have been concentrated on two irrigation projects, San Andres and Atiocoya. Experiments have included: 1) irrigation methods (sprinkler, drip and furrow) for corn, tomatoes, cantalopes and peanuts with fertility as a variable; 2) crop response to residual nitrogen during the wet season to N applied in dry season and vise versa; 3) studies to determine the interaction of water and nitrogen treatments; and 4) assessing the feasibility of using a "line" or "point" source water application field plot techniques as alternatives to generating crop response surfaces involving nitrogen and irrigation variables compared to traditional factoral experiments.

The review team observed current experimental efforts at the San Andres and Atiocoya locations in the Zapotitan Valley and the Nueva Concepcion District, respectively. Traditional cropping practices in these areas is to obtain one or, in some cases, two crops during the rainy season. Little or no production is possible during the dry season without irrigation.

An intensive corn irrigation experiment observed at San Andres included a continuous two-year study where crops (corn, sorghum and/or tomatoes) are grown to measure response to irrigation, natural precipitation, current fertilizer application and residual notrogen (see Appendix 6 for additional detail of treatments). The objectives of this

1/Appendix Table 4 summarizes USU personnel, counterpart personnel and on-farm water management research activities in El Salvador from July 1972 to date.

experiment are to determine water/nitrogen interactions and to develop crop response functions to water and nitrogen on a year around basis. The general appearance of the experiment and the uniformity in response to various N rates applied in the dry season indicated that excellent field plot techniques are being used. There appeared to be little carry-over of nitrogen from the three residual nitrogen rates applied during the wet season sorghum trial.

The soil at the San Andrea site has consolidated material at 18 inches which is permeable to water but not roots. This soil condition possibly could affect the interaction of water (irrigation frequencies and/or amounts of water applied) and the amounts of N available, compared to soils with unrestricted root development. Drip irrigation method is being used (irrigates one half of the experimental area) for precise control of water applied. There appeared to be little difference in crop growth between the drip or furrow irrigated plots. Clogging problems due to algae (or scum) in the 1974 dry season may have accounted for lower corn yields on the drip irrigated plots reported on page 6 of the 1975 Annual Report. Screens are now placed in each line of emittors to help prevent clogging, but require cleaning prior to each irrigation.

Insect control, with weekly application of herbicides, is necessary to achieve higher yields of corn. Extending the treatment period to even 10 days is not possible without damaging the crop yields.

The nearby line source experiment on corn should permit a direct comparison of crop response to comparable water x nitrogen variables in the more traditional factoral experiment discussed above. (See Appendix 6.) It appeared, however, that wind may have affected the water distribution

patterns judging from lack of symmetry in crop growth from the line source. It is the objective here to use a low cost, field plot technique to obtain a continuous water variable, i.e. overirrigated near the source and under-irrigated further from the line, as a substitute to the traditional, high cost factoral experiments.

At Antiocoya, two experiments were observed: the point source continuous water variable on upland rice and a N fertility experiment on Pangola grass. (See Appendix 6.) The point source experiment uses a single nozzle to apply water to six randomized nitrogen fertilizer treatments. This experiment, replicated three times, has fixed random nitrogen treatments rotated 120° from one circle to another. Response to nitrogen treatments at the time plots were observed was not high. In contrast, flooded rice grown in nearby basins had excellent growth.

At a nearby site, the possibility of growing Pangola grass year round with irrigation and adequate nitrogen fertilization is being studied. It has been found that nitrogen can double, or more than double, grass yields. (See 1973 Annual Report.) However, yields appear to be declining in 1975-76 for unknown reasons. The review team recommended several people informed on Pangola grass who might be contacted.

e. Field Trip to Small Irrigation Project

The review team under the guidance of Ing. Reve Vidal observed one of 10 small irrigation projects in various stages of development. The La Bamauca Project No. 1 diverts 700 l/sec from the La Bamauca River that flows through rough, hilly terrain. The diversion ditch, "hung" on steeply sloping land, is 3 kilometers long and currently commands 150 ha of irrigated grassland which is being used to pasture dairy cattle. The diversion ditch when complete

will be 8 kms. long and will irrigate 650 hectares, helping to support 80 families.

Ing. Vidal stressed the need for assistance in demonstrating how the farmer can best utilize this newly developed water supply. Irrigation conditions are difficult and will require good irrigation techniques to control and efficiently use the available irrigation water. Potentially 20,000 has. are in this area. The team was impressed with the food production potential of the area with supplemental water, but on-farm technical assistance and farmer training will be required to achieve satisfactory results.

5. Guatemala

a. Introduction

The team was unable to visit the research project in Guatemala. Problems subsequent to the earthquake prevented the team being scheduled there. However, Bert Embry, the USU staff member in Guatemala, was able to travel to San Salvador and meet with the review team.

Mr. Embry has been in Guatemala for approximately ten months. During this time he has been able to initiate research and demonstration work at three locations. The work is with ICTA (Institute de Ciencia y Tecuologia Agricolas), a semiautonomous organization designed to help small farmers. ICTA has teams that go into the field to work with the small farmers.

At the moment, Embry is concentrating on research related to vegetable production. There is, however, one experiment in corn in which four water levels and three fertility levels are maintained. Presumably, the data from the corn experiment will be usable in the model.

The vegetable research is at the ICTA farm in the Zapata Valley at an elevation of 700 feet. Vegetables studied include watermelon, honeydew melons, tomatoes, and bell peppers. Length of run studies are included in this experiment. The soil is very tight and Mr. Embry reports that water has not been found below 30 inches. It is a desert area during the dry season because the 20-inch mean annual rain falls from May to November.

There is serious lack of understanding of irrigation by the people who operate the water system on the ICTA farm. For example, the irrigation system supplies water 8 hours a day six days a week. This is a constraint to good research.

A second study is at Huehuegango at an elevation of 3,000 feet. Three levels of water are being investigated on onions and garlic. Also, cultural practices are studied there. This study is in the highlands with conditions differing from that in the coastal and valley areas.

A third experiment (a demonstration) is located at Seianta, 240 kilometers from Guatemala City. Here the ancient irrigation method of splashing water on the garlic is traditionally practiced. The demonstration shows how water can be applied in furrows.

b. Current Level of Input on Project

In 1975-76 Utah State University will put an estimated $63,500 in the project from their contract. USAID-Guatemala works closely with ICTA and presently supports four men at ICTA.

The project is relatively new in Guatemala, so there is no historical base for estimating the annual ICTA support of the project. The proposed annual budget provides for about $31,000 support from ICTA plus the value of land used for the tests. Two counterparts are proposed

for the project from ICTA, one agronomist and one agricultural engineer. Actually, only one counterpart is involved in the project so far.

c. Current Thrust and Importance of the USU Effort

The emphasis on studies of irrigation of vegetables seems appropriate but must also be economically evaluated. Since the review team did not visit Guatemala, we could not talk to representatives of ICTA or the Guatemala Mission. Also, we could not observe the experiments and demonstrations.

We do believe that the program Embry has started is important. The fact that ICTA personnel are not able to manage water to keep a high level of crop research and demonstration going at any one time on their Zapata Valley farm indicates the seriousness of the need for training of personnel through working with Embry.

We are told by Embry that the AID Mission in Guatemala believes that emphasis in the USU effort should be shifted from Zapata Valley to the highlands area (Huehuegango). The reason stated is because of need to get increased work going for the highland farmers. There apparently is relatively greater effort now underway in the Zapata Valley because other countries are involved in assistance programs there.

We suggest that serious consideration be given to this change. There certainly is real need for assistance on irrigation methods in the highland areas in El Salvador. We believe that this need also must be critical in Guatemala.

6. Other USU Field Research Projects

The team did not have an opportunity to observe, and review on site, the work in Colombia on heavy soils, or the Chile on-farm technical assistance projects. However, from reading the annual reports,

reviewing what was done and why with workers on these projects, and from other information, pictures, maps, etc., and by talking with informed people the team has these general observations:

(a) The work in each case would have benefits from a three pronged approach--soils, water, and agronomics, applied simultaneously.

(b) These projects, as with the other field projects, could have been materially advanced through use of selected consultants on each phase of the work--the Colombia project particularly where heavy metals toxicity problems were belatedly found to be a major deterrent to production

(c) No follow-up has been made to find out what has been the benefit carryover from the work done. An economic evaluation and consideration of alternatives was not done in either case.

7. The On-Campus Research Program

The on-campus part of the field review was held at Logan, Utah, March 22, 1976. The meeting was coordinated by Dr. Al Bishop, Project Leader. Bishop reviewed experience under the project and the relationship of the on-farm water management research to the activities of the 211(d) funded consortium on water management (CUSUSWASH). In addition to reviewing each country based project, the objectives and work progress on three subject matter areas also being researched were reviewed: (1) water law (Daines), (2) economics (Le Baron), and (3) transfer modeling (Peterson, Keller, Hill).

USU, in accordance with the terms of the contract, spent the first 18 months identifying water management problems in Latin America. This work was done by Howard Peterson, Al Bishop, and Bruce Anderson. The initial projects were selected from this "listing."

During the course of the evolvement of the field research, water management problems have continued to be identified in consultation with TAB, USAID's and Governments. These are being conducted under objectives 1 through 7 of the contract. Under objective 8, identification of institutional and policy factors, water law and the legal aspects of farmer irrigation associations, has been given major attention. Economic evaluation studies of on-farm water management alternatives and of irrigation systems, or their components, have received nominal consideration.

Following the emphasis on "modelling" in the 1972 overview panel report (Jensen et al) and the recommendations on technological transfer of the 1973 Park City, Utah, symposium on research needs for on-farm water management, an on-campus task group was formed at Logan to evolve a "strategy" for optimizing research on agricultural systems involving water management. A number of technical papers have been prepared on the concept (Jack Keller, L. N. Leininger, R. W. Hill, Howard Peterson, et al). The basic outline of the strategy is contained in a paper by Keller, D. Peterson, and H. Peterson, page 101, Park City proceedings, title as above.

The USU model in concept is a systematic way of identifying the kinds of data needed to answer "pre-determined" questions. It is neither quantitative or qualitative at this point in its development, being in nature a data taxonomy relative to a "set" of broad data class headings, e.g. technical, economic, social, and political (see sub-section 8 for notation on the USU model and models in general).

The on-campus review repeated much of the information obtained during the field review and from review of the annual reports and project publications. Additional insight was gained into the USU model, together with USU's specific reaction to its project experience, and an expression

of "gaines and losses" from the research experience. Both are believed to be significant in that they suggest participation of TAB in research on a more mutual partnership basis, than in the traditional manager-contractor mode.

a. Gains:

(1) Provided a bigger financial base of operations
(2) Widened the training base
(3) Increased graduate and under-graduate student training capability
(4) Increased inter-action with other departments
(5) Opportunity to expand the research frontier

b. Losses:

(1) Soft money makes it difficult to build and hold good staff
(2) Overseas and on-campus staff lose contact
(3) Language requirement is an added burden and cost
(4) Personal health and injury risk to staff overseas is increased measurably
(5) Need for more substantive depth in TAB monitoring staff

8. Observations on Modeling

a. The USU Model

The USU model can, from several points of view, be called a strategy for optimizing research on agricultural systems involving water management. USU has allocated considerable staff time and contract and 211(d) monies to the development of a concept of a model for improving technology transfer.

We are fully cognizant that Utah State University was guided into emphasizing research on use of physical-biological-chemical plant growth models for predicting crop growth and yields for a variety of climatic and local field conditions in the January, 1972, review by Jensen, Heady and Anderson. Utah State concluded that this recommendation called for

on-campus concentrated effort to develop applied models to be later checked with field data.

The report of the Park City Symposium reinforced the guidelines to USU that existing simulation models be adapted and modified or new ones developed for the purpose of evaluating the effects of water management on crop production. RAC subsequently endorsed the recommendation concerning model development coming from the Park City Symposium.

The above is presented to point out that USU has followed the guides of review groups in the on-campus work toward a model to facilitate transfer ot technology on water management problems. Had they not pursued this objective, they would clearly have ignored official guidance.

Our assessment of the model stems from a rather extensive field review of the USU research contract as opposed to relatively brief reviews on campus, in 1972 and at Park City in 1973. Our study does not show the concept to be wrong, but points to inherent weaknesses when applied over the short term of this contract, particularly if problems of the individual small farmer are to be addressed during any realistic time period.

After reading the material provided on the model and reviewing the model on campus, we are impressed with the laudible goals implied. We are also aware that only background data on various components are developed so far and that no actual results of model runs for validation purposes have been made. At this time the model is in the conceptual stage. The researchers on location in the field appear not to have a clear-cut notion of how their work interacts with the model.

Without criticizing the concept of the model, we believe it may be detracting from the effectiveness of this project in the field. The model has appeared to become the central focus for the on-campus effort

on the project. In other words, the need for coordinated planning of field experiments seems to be lacking.

We encourage continued thought on the objectives of models which, through simulation means, permit predictions of growth and yields of crops for a variety of local environment conditions. However, we do not believe the modeling underway will have major impact on the results of this particular research contract.

To assess and understand all the interactions of climate, soil, water, pests, diseases, and unknown factors is a tremendous task. It is for this reason that crop modeling is probably best done in the experiment stations in the so-called developed countries along with the few international research centers. Also, the model development should start recognizing a hierarchical development starting with a plant growth simulation model which considers all environmental, biological and physiological factors controlling plant growth and development. Next, comes a crop growth simulation model which considers insects, diseases and other competition factors along with data from the plant growth model.

Evidence that USU has adequately coordinated the modeling work under this project with existing modeling research in the USA and world is not evident. Particular reference to studies under regional research projects (cotton, soybeans, and corn) and systems simulation work at many universities such as Ohio State, Michigan State, Kentucky, and Case-Western and several ARS and ERS locations would be worthwhile.

We do not say that breakthroughs from modeling is not as important to developing countries as in the developed ones. To do so would miss the point. However, when open pollinated corn must be planted because of the dangers of uneducated farmers replanting the produced seed, using modeling

or even irrigation scheduling may be ahead of its time in those places where AID should be supporting field research.

Modeling in General

Given the complexity of agricultural development and the problems of information transfer, model development should be encouraged, guided by the fact that the demand for data and more precise information grows with every increase in production complexity, greater specialization of farms, and integration of agriculture into the whole of the economy. This poses two kinds of problems. The demands for improved agricultural information are often not of the kind to which the system has been designed to respond. For example, the capacity to describe integration of more complex irrigation practices into the farming system. The other problem is that many of these demands for information are in areas in which there never has been data collection of consequence or accuracy. Massive changes in the reality of agriculture must be matched by modeling efforts which provide an information system capacity to describe and contend with that reality. We not only must have the needed data but also the models and theoretical concepts capable of accurately portraying current agriculture and its behavior under changes in systems and operations. This information about the food system and its behavior is a necessary decision tool.

IV. DISCUSSION OF ISSUES AND OBSERVATIONS OF THE PROJECT REVIEW TEAM ON CONDUCT AND COORDINATION OF RESEARCH ON-CAMPUS AND IN THE FIELD

A. Introduction

The review team does not claim to be perceptive of specific details of the project history. We could only be concerned with what we saw to be the status of the project as it now stands comparative to country needs and the format of the project statement and evaluate and recommend accordingly. The issues posed for consideration by the team as part of the field and on-campus research evaluation were assessed in this frame of reference, namely:

a. The first thing recognizable about water is that it is an area problem. There are problems of water flows and availabilities, either on the surface or underground. There are problems of water collection, storage, and distribution, and there are problems of rainfall, climate, and soil type. There are also problems of drainage of excess water, collection of salts, and maintenance of water systems and facilities. And, above all, there are problems of land preparation, water utilization, and cropping patterns. One, therefore, must approach on-farm water management with a total concept of management.

b. Research on the components of an integrated on-farm program is essential, but these must also be "tested" on farms in a total food production scheme, which includes:

1. applicability of methods
2. benefits in yields and returns
3. costs and investments
4. farm organization and management requirements

5. farmer acceptance

6. technical personnel and training requirements

7. demonstrated value in aggregative production and economic terms.

c. These research and technical assistance activities encompass the following groupings of coordinate phases:

1. Improvement of quantity and quality of water delivered to the farm,

2. Improved application and water use efficiencies to increase crop production per unit of water available at the farm turn-out.

3. Continuous refinement of selection criteria, technical procedures, and socio-economic impact assessment, including personnel and training inputs, and efforts to organize and motivate farmers.

Several things were immediately apparent to the team:

1. The annual reports reflect a distinct change in format, focus, and project emphasis 1968-1970 and 1970 to present.

2. The field project selection process does not systematically relate on-farm water management to food production.

3. No underlying development theory or systematic procedures for project selection is in evidence in the reports and other written materials.

4. The project leadership is divided among a number of on-campus staff, has changed in madeup from time to time, and in one instance a designated project leader was employed by AID for a period of two years, returning as project leader.

5. AID's project monitoring has consisted mainly of operating on an overview and fiscal management concept with respect to both on-campus and field research.

6. USU and AID/TAB have not availed themselves of the broad range of previous in-country studies, consultant and advisory competence existing in other AID funded projects on soils, pests and diseases, and fertilizers, or which can be readily found in other Universities and the USDA.

B. Observations and Comment on the Issues

a. Issue 1: Lack of Research Strategy or Focus on a Problem

The team looks upon this issue as meaning a "lack of a systematic framework" which immediately makes the issue debatable from several points of view. However, taking the issue to mean problem identification and development of appropriate problem ranking criteria relative to on-farm water management problems on food production in some direct and immediate sense, the project cannot be placed directly into this context. The project has worked on specific "problems", some of which are data problems about production surfaces and some are said to be data problems relative to the on-campus "model".

The major problem is not that the "projects" have not been focused; but, rather, that they have been too narrowly, and perhaps idealistically, focused. They were not, as near as could be determined, formulated on the notion of on-farm systems, and they do not contain assessment of aggregative production and impact effects on a geographic area basis. Further, the indicator crop corn (or tomatoes) may not generally be a priority crop in the country or region. The work, also, may overemphasize "factoral" designed experiments and, in particular, the line and point source experiments.

A component in the original project and noted in the 1971 USU Annual Report, which has seemingly had little recent attention in the

research, is economic impact assessment of irrigation and irrigation research.[1/] Economic evaluation objectives were outlined in the original project work, and preliminary studies under the direction of Dr. LeBaron, in particular, were started. Among these were costs-returns estimates, institutional factors, and fiscal policy, and a large number of economic inputs on Latin American agriculture were collected.

Instead, however, USU moved into specific studies on the role played by water management institutions, e.g. water law and farmer organizations. The water law dimension was expanded and made a comprehensive undertaking covering a number of South American countries, but nothing further appeared in the reports and work plans on economics.

b. Issue 2: Training

It is difficult to evaluate the training aspects which have resulted from the USU work in Central and South America. USU has been involved in several countries and the counterparts with which the USU scientists have worked have often been in their research position for such a brief period of time before moving into other positions. The full impact of their experience on the research in a country is difficult to assess. However, the training they received will undoubtedly be of value in whatever jobs they may currently be doing in the country. There appears to be a real need to establish greater longevity in counterpart assignments so that the LDC's do develop capability to design and conduct their own essential experiments. It is impossible to address just how well the research would be carried out if the USU team left.

1/ Also restated in the 1972 overview review panel report (Jensen, et al).

We believe that the counterpart situation can be strengthened by having more joint planning with the home government and the local Mission concerning the work to be done. This has already been covered in another section of the report.

The question of water management for multiple cropping came up more than once during the review. The USU effort so far has been directed at many problems, but specific activity concerning unique problems of water management for multiple cropping in a small farmer setting have not been addressed. This should be given a high priority in future work.

The special problems related to small farm irrigation systems have not had the attention that would be desirable. Specifically, we are referring to systems in which only a handful of farmers may be involved. This is particularly important in the mountain irrigation areas and there is opportunity to do this kind of work effectively in Peru, and also in the Central America area of El Salvador and Guatemala.

c. Issue 3: The Value of the Consortium and/or Cooperative Approach to Water Management Research

The consortium, CUSUSWASH (now CID), was established under AID financing to assist the developing countries on their water management problems. The charter and agreement sets forth six specific objectives of the consortium to seek ways to assist developing countries, to provide information interchange, and to be a mechanism for possible exchange of students, staff, or graduate credits among the members. Formal action to establish CUSUSWASH was finalized in 1967 with three universities participating: Colorado State University, University of California, and Utah State University.

From our review of this project, and with a working knowledge of the consortium, we believe that a re-assessment of the cooperative

relationships as outlined, and, particularly, a reaching out and broadening of the resource base involving other universities and the USDA is needed. While we are painfully cognizant of the many difficulties involved in this kind of research it is our opinion that the cooperative aspects of this research project could be improved.

Difficulties are involved because the contractor has programs in numerous countries and in many cases has been in a country for only a brief period of time prior to being forced to discontinue operations for political reasons. This coupled with the additional problem of inter-university cooperation poses a formidable task when viewing cooperative work.

We believe, however, there are opportunities for improved cooperation in the planning stages as well as in staff exchanges and other coordinated activities. One example of where cooperation might be most effective concerns the institutional, socio-political aspects of the research which is being conducted by Mr. Craig Anderson. Closer cooperation with the research in Pakistan under the Colorado State University contract would be desirable.

d. Issue 4: Extension and Utilization of Results

The USU project is not geared directly to extension and utilization of results, except through distribution of publications and annual reports (either by USU or by TAB). This circumstance causes concern with USAID's host governments with the time lag and the correlation of the research with on-farm practices. Such concerns arise whenever research is not correlated and/or integrated with the country research programs, and with timely review and assessment of results in the field. For example, the research at the EMBRAPA station at Petrolina, Brazil,

is embodied in the overall program of work at the research station, with on-farm demonstrations and pilot projects in prospect. But there is little evidence that the research is based on on-farm problems, practices and preferred crops.

The key to management is education, demonstration, and incentive. This is exemplified by the early work in Chile. This ordering suggests a two-pronged approach: (1) training more people as water management specialists, and education and organizing farmers into viable water associations, and (2) proceeding on a parallel adaptive research and development course to rehabilitate water systems, establish new systems, and integrate water and crop management.

Governments (and USAID) are protesting the limited degree of flexibility the USU field people say they have -- they are posted to do research, publish, and more recently to supply data to the model--in a fixed ET and water/fertilizer factoral design format. On-farm water management does not appear to have had the highest priority. The concern appears more with perfection of data on a two variable interaction experiment, and also ET measurements.

e. Issue 5: Research Sites

One of the major problems in conducting research in LDC's relates to the question of just how site-specific the research is. Most research which is applied research has some element of being site specific, but that aspect of the research does not have to dominate. The degree to which the research is viewed by LDC governmental officials as being site-specific will depend on how well they understand the research. If they do not understand the rationale that went into planning the research, they are most likely to view it as quite site-specific and may

even believe it is not directed toward problems which are of high priority in their country. This means that joint preplanning for the research is absolutely essential. In our judgments this is one of the major considerations concerning site-specificness in research such as is being conducted under the USU contract.

Specifically, the concern of this issue with the question of continuing research in Brazil has been treated in the preceeding country review section, and is further handled in the following recommendations section. There is, however, a more over-riding question than site, and that is projects which relate on-farm water management and food production.

f. Issue 6: Specific Problems

The main consideration is not the magnitude of trade-off between items in a list of things of concern. Rather, the issue is where do micro-level identified problems fit into the macro-order of relationships between food and on-farm water management. Solving a particular problem may improve upon, or permit reordering of a farming system; it is, however, the macro-considerations which indicate systems changes and which determine aggregative impact on the main objective. On this point, the review team was not able to precisely pin down:

1. The extent to which the research was referenced in terms of priority on-farm water management problems.
2. The extent to which alternative technologies and practices were taken into account.
3. The extent of assessment of costs and benefits of the research on farms.
4. The extent to which complementary activities and technologies by the country, or other donors, were taken into account.

5. The extent to which alternative cropping, cropping systems, or alternative areas were considered in food production and farm employment and income terms.
6. The time point expectation of meaningful results, and who would benefit from the pay-off (time periods were given in terms of work plans, or duration of assignment in the country).
7. The extent of utilization of the findings in complementary research, or integration into on-farm production plans.
8. Precise plans on the development of on-farm demonstrations or establishment of area level pilot projects.
9. A specific plan to bring the findings meaningfully and usably to farmers.
10. The complementarity between field project, and the on-campus transfer model.

We have listed several things that we could not pin down during this review. To be helpful, we recommend that TAB specify in more detail what documentation should be provided to review teams. The Annual USU Reports did not prove sufficient for the needs of the team to get background information.

g. Issue 7: End of Project Status

The review team has outlined its thinking on this issue in the recommendation section which suggests a reformulated or "new" project, composed of: 1) a centralized multidisciplinary project in (a) Central America (centering on El Salvador, Guatemala, and Honduras) and (b) a centralized project in South America headquartered in Peru, and 2) the development of a core of senior level consultants (to the project and to other countries).

C. Notations and Observations

The review team has the following observations to make on certain aspects of water management research:

a. Drip Irrigation

A part of the experimental work in El Salvador and proposed in Peru includes drip irrigation. The stated purpose is because it gives good water control and not that it is a method with any reasonable probability of being economical for the LDC farmers. On more than one occasion the USU research was criticized by government officials as not being directed to the real needs and for not sufficiently considering the economic constraints of the samll farmer. We question the wisdom of including drip irrigation as a method under study, particularly in the LDC setting.

b. Evapotranspiration

The team is aware that ET research is invariably given high priority when research needs are listed by LDC leaders. The publications from the USU project, including reports, theses and journal articles, total 70. Thirty-five of these are related to evapotranspiration and climatic analysis.

The review team believes that there will always be the possibility of further refining evapotranspiration. However, we see other problems which are of much higher priority. We believe that there are numerous ways to adequately estimate water needs for various crops. When farmers do not understand the rudimentary principles of applying water, it is unwise to concentrate on greater refinement in determining water requirements. We think future effort in ET should be carefully reviewed.

c. Small Farmer Irrigation

A major complaint, perhaps the one most frequently heard in the conferences with government officials, was that they could not see how the USU research was going to help the small farmer. No doubt there will be differences of opinion concerning this We are sure the USU staff believes their work is directed at small farmer problems, at least in the long run. However, the fact remains that many in the LDC governments do not see the relation between the USU work underway and the priority needs of the small farmer. USU must recognize this fact and better communicate and coordinate with the governments on priority research needs. The problems of the small farmer today must be kept in better focus.

d. Field Effort Versus Campus Effort

The contract specifies the division of effort between field stationed and campus stationed personnel in man-years. USU is meeting this requirement. In general, we are not satisfied with what we learned concerning how the campus effort complements and supports the work in the field. This should have better documentation than was available to the review team.

e. Education and Training

USU has done a commendable job of developing courses given in Spanish on the USU campus, and has held profitable workshops and seminars in the field. However, both USU and TAB seem not to have evolved a systematic way of getting the results of their work to researchers and government and USAID decision makers. The project does not contain training components as such. Perhaps this is because the one or two staff in each place could not possibly find the time to work with

"counterparts" and also train country personnel. The short time period allocated to each field assignment precluded more than "setting up research" and getting results. Moreover, field personnel frequently act as advisors to governments and USAID on a variety of problems.

f. A Comment on the Issues

The 1975 annual report evidences an awareness of the influence of AID and the Park City Conference on the project direction and makeup, as follows:

"Research emphasis within the (consolidated) objectives has been significantly influenced during the past two years by subsequent suggestions from AID and the recommendations developed at the AID sponsored symposium on research needs for on-farm water management held at Park City, Utah, in October, 1973. The symposium recommendations, together with continuing counsel from the Technical Assistance Bureau of AID have been beneficial. Several USAID missions in Latin America and directors of collaborating LDC agencies have had a positive influence on the composition of the program."

"The Park City Symposium suggested that three sequential steps in decision making need to be considered in defining research purposes. These are: (1) technological systems, (2) delivery systems and (3) incentives. Early contract resources were focused on the first step; however, as technological systems became more clearly defined, attention began to be given to technology delivery. Recently data from the institutional and economic components have added the "incentives" step. This year (1975) the proportion of available resources devoted to each system and each objective has been the target of much careful planning. In general, all activities are organized to logically fit within the

"System Outline of On-Farm Water Management Research Program," with emphasis being a function of available financial and human resources, the research environment in a collaborating country, new breakthroughs in technology, and other factors."

V. CONCLUSIONS AND RECOMMENDATIONS

The major conclusions from the review of the USU research contract are given in this section. For convenience, the conclusions are divided in two sections, i.e., conclusions concerning the management aspects of the project and conclusions concerning the technical aspects of the project. However, in several cases the conclusions touch both technical and management aspects. The conclusions are not presented in a priority order, although there is some attempt to present them in logical order.

A. Management Conclusions

1. This review of the USU project is the first review in the field. A previous external review was held on campus on January 24, 1972, and in Washington, D.C., on January 26, 27, 1972. The review team consisted of Marvin Jensen, chairman, Earl Heady and Leland Anderson. They also reviewed the CSU research project during the same week.

The project had additional discussion and review by a panel of six, chaired by Jensen, as a part of the Park City, Utah, symposium in October, 1973. The recommendations concerning the USU research contract, included in the Symposium Proceedings, were subsequently endorsed by RAC.

It is unfortunate that a field review of the project was not held prior to this review in 1976. Utah State University has been denied benefits that could have accrued from an independent appraisal of the research by reviewers who talked with researchers in the field, the

Missions and the governments in the LDCs. We conclude that Utah State was encouraged to pursue objectives, such as a concentration on modeling, which were not well attuned to local priority needs for water management research in Latin America LDCs. The lack of probable immediate impact did not get sufficient attention from USU or AID.

2. USU and other AID contractors working in LDCs are caught in a bind because there is inadequate communication between TAB and the Missions in the LDCs and the L.A. Bureau. AID needs to strengthen internal communication to reduce confusion and problems for the contractors. AID also needs to strengthen its ability to better relate project substance to project purpose and objectives.

3. There is a problem of definition of research. AID/Washington, the various Missions and LDC governments may refer to basic research as, for example, how to apply water under certain field conditions. The contractor may have a different view, more related to new data needs. This confusion and misunderstanding has led to severe problems in this contract. This problem could better be handled by having an annual research work plan (see next conclusion).

4. There is a need for an annual research work plan for each research location, including on-campus activity. This plan should be brief but clearly give the team leader and other personnel, including counterparts, their role and objectives for the year, and a brief justification and statement of potential impact. This work plan should have the USU project leader and TAB approval. It should also have mission and LDC governmental concurrence. Failure to have such work plans portends future problems.

The PROAG has not met this need and confusion has existed. Distribution of all these annual work plans to all locations will fulfill still another internal communication need among field personnel.

5. There is a need to better respond to changes in research needs in LDCs. We recognize the difficult position in which a contractor may find himself when he works with numerous governments and Missions on a single, centrally funded contract. USU, having worked in eight countries under this contract, finds itself in this difficult position. There should be an improved way to assure that the LDC governments and Missions do not believe the contractor is unresponsive to changed needs. We believe a well conceived annual research plan will go far to eliminate any appearance of reluctance by USU to respond to research need changes that may be perceived by the LDC government.

We support broad objectives in TAB research contracts, such as those in the USU contract. They provide opportunity to adjust effort if needed and agreed to by all appropriate parties. However, when project objectives are broad, an annual research work plan is essential to provide the specific focus for a given effort.

6. Several USU researchers feel there is a lack of attention to specific problems of the country. This stems partly from lack of understanding of the transfer model by the USU staff in the field, their counterparts, and LDC officials responsible for research in their country. The review team, while attempting to understand the model and its state of development, remains uncertain concerning its level of use.

Problem identification needs to be an on-going part of annual project review and development of annual research work plans. More is given on this in the technical conclusions which follow.

7. Numerous trips have been made concerning managerial aspects as well as technical aspects of this project. Brief, but definitive, trip reports need to be made immediately after the trip to keep TAB informed and, through information copies, keep the Missions informed of conclusions from each trip. Field workers on the project need better briefing on the project overview and details of activities at other locations. Trip reports will be helpful to keep all field personnel informed (see Appendix 3a on travel on the project).

8. USU personnel have a good relationship with their counterparts. However, the number of counterparts needs to be increased. Also, there is excessive turnover of counterparts--a problem which USU cannot directly control. We do believe, however, that closer communication and collaboration with the LDC government leaders in planning the research may well improve this. If the research is not the highest priority in the eyes of the government, the counterparts' participation will be minimal. Also, the Mission directors may help if they are kept informed.

9. The USU personnel in the field are well qualified on their assignments. All communicate well in Spanish or Portuguese, as appropriate. The technical backup to them could stand improvement. The on-campus backup is good in logistical terms; however, it would appear that more consultants and specialists from inside and outside USU could effectively be used. Examples are consultants in horticulture, plant pathology, entomology, emphasizing tropical crops and specialists in modeling and on-farm production economics.

10. The USU contract specifies the man-months of home office professional and field staff professional personnel to go into the contract. The same is specified for home office and field staff

nonprofessionals. USU has met these specified commitments, according to our analysis. Roughly 56 percent of the professional staff is to be on-campus. In any future contract or renewal, this might well be changed to increase the relative field staff commitment.

B. Technical Conclusions

1. The need for an annual research work plan at each location, as mentioned under management conclusions, is repeated here for emphasis.

2. The annual reports for the USU contract have been prepared in accordance with AID/TAB guidelines. TAB should request an annual report concerning the technical aspects of the research at each location and on campus. We conclude that the TAB format for annual reports does not adequately provide for routine reporting of technical progress from the research.

3. Much work has been done on evapo-transpiration (ET) and analyses of climatic data and probabilities for the countries. The governmental officials are happy with these analyses. Also, the governments still tend to identify water requirements of crops as a major need for their country. Presumably, there is still a need to better understand how to use the data developed.

4. We note that half of the publications from this research project relate to ET or climatic analyses. It appears that, with the possible exception of Peru, work on ET should not have such high priority in the future.

5. The project started with the inclusion of analysis of economic impact of various improved on-farm water management practices that might result. This aspect of the study has not received substantive attention and, therefore, little more than subjective estimates of the impact of

the project on food production and the economic situation of the small farmer can be made.

6. Implied in the original project was the need to develop procedure to identify research needs in each of the countries where research was to be conducted. The contract specified that no staff was to be assigned to the field for the first 18 months of the contract for reasons of project formulation. We conclude that progress on this aspect of the project is only possible when research priorities are anchored to some base of analysis such as water use efficiency, per capita food production or economic output of agriculture.

7. Early work had a larger component in field demonstration of irrigation methods and practices. However, the project has drifted from the goal of improving on-farm water management. For example, too much relative effort has gone into factoral experiments on fertilizer-water-yield interactions, both in randomized plot and point or line-source experiments. The field review indicates that these studies, while good and worthwhile, are too idealistic for the LDC setting. More emphasis on adaptive research and development and "how to" demonstrations seem to be desired. Perhaps USU has tried too many things considering the maze of problems in international work.

8. The role of the counterparts needs to be reassessed and is repeated under technical conclusions for emphasis.

9. USU is commended for the technical seminars and field workships that have been held. We encourage these. We encourage finding other ways and means of getting results to farmers, and especially the small farmer. The qualification of USU staff to teach courses in Spanish is good and is commended.

10. The technical coordination on the project is diffuse and needs strengthening. The administrative and technical responsibility of all on the project personnel needs to be more clearly stated and made known to those in the field. Stronger research coordination is needed and more definite research responsibilities assigned to those in the field.

11. Each individual project should relate to others to ensure a focus of all component projects to the objective of immediately improving food production through better on-farm water management. All staff should be informed on what is being attempted, where the work is being done, and how it relates.

12. The Missions appear to not be adequately advised of the findings from the research contract. This may well be because they have not read reports sent to them or the TAB (or USU) has not made sufficient point in providing material to them. We conclude this to be another communication problem to be solved without pointing to anyone as being at fault. Field staff should make certain that all pertinent findings are brought to the attention of Mission personnel, possibly through participation in Mission staff meetings.

C. Recommendations

The following recommendations are made as a result of the field review of the USU research contract. Nothing in the field review indicated that on-farm water management research was anything but the highest priority for USAID effort. In fact, in Peru and El Salvador, two of the three countries visited, improved water management is the highest priority key to improving food production. These are countries with either inadequate water or such poorly distributed water supply

that irrigation is essential to achieve the full potential for crop production. The same appears to be true in Guatemala. Brazil has greater resources, but irrigation is also essential in the San Francisco Valley and technical assistance is desirable there, although of a lesser priority than in the other places.

Specific recommendations follow:

1. Work under the present contract should be continued as programmed to provide for proper completion of the present effort and the arrangement for proper counterpart takeover of the experimental effort desired in the countries. Proper reports on the work should be written.

2. Subsequent to the completion of the above on the existing contract, followup work is needed. This would entail formulating and preparing a new project. Two major efforts should be planned--one dealing with programs to assist small farmers in on-farm water management in Central America and another in South America. In addition, the socio-political studies underway should be continued to their completion, but restructured along socio-economic and impact assessment lines. Finally, provision for short term high level expertise to address specific, clearly defined problems in all Latin American countries should be provided.

3. Specifically, we recommend the following:

a. Peru should be carefully and fully considered as a base for the South American project. Needs exist for work in the high mountain irrigation areas to illustrate how to best manage water under those difficult conditions. Basic research should not be a part of this project. Rather, it should be directed toward applying what is known, or can reasonably be determined. Work collaboratively conducted on the

sites in the Andes where AID is considering a direct loan seems an ideal site. A research team effort of four to six persons should be planned, two engineers, an agronomist, a horticulturist, a soils specialist, an economist, a sociologist, with a minimum of four being full time, under a project leader in the field with full responsibility. The team should be integrated with the GOP program underway.

Water management problems in the coastal area of Peru are also important, while of less immediate urgency than the mountain irrigation problems, they should be programmed in on a time and money availability basis.

b. The Central American effort should have the same emphasis as the South American effort. Again, emphasis should be on demonstrating how to apply knowledge, mostly existing, rather than obtaining new knowledge.

The Central American project should be located in the El Salvador-Guatemala-Honduras area. We suggest a team coordinated effort with perhaps four people involved. The team might include one or two agricultural engineers, an agronomist and/or a horticulturalist, and an agricultural economist. One or more of these should have extension experience, and a team leader should be appointed with full responsibility for the program.

It is conceivable that these people might not all be stationed at precisely the same location. With the proximity of Guatemala and El Salvador, it could be that the team could coordinate work in both countries with one or more stationed in each.

c. We recommend that the socio-political work of the project be expanded and better coordinated with similar work in Pakistan being

conducted by Max Lowdermilk as a part of the Colorado State University project. Further, we suggest that if Peru is chosen as a location for the South American work, as suggested in recommendation b.(1) above, the base for the socio-political work be shifted to Peru. Then the work under the AID loan for small high mountain irrigation projects would serve as an effective base for this work.

d. We recommend the socio-economic considerations of these recommendations be assigned commensurate status and that any new project provide for conducting assessments and evaluations on production economics; assessments of alternative practices and cropping systems; make area aggregative impact assessments on production, income, and employment; make farm size and resource endowment comparisons; deal with risk and uncertainty constraints on decisions; and help specify necessary institutional and training arrangements.

2. Several countries expressed the need for short term (one to three months) highly qualified consultants to address specific, well defined problems. An example might be a plant disease problem or insect control problem on a specific crop. We recommend that AID/TAB consider preparing a contract under which this expressed need can be met. This matter becomes relatively more important if the recommendation concentrating teams at fewer locations, one in Central America and one in South America is adopted.

Appendix 1 [1/]

SUMMARY OF CHRONOLOGY OF CONTRACTS

AID/csd-2167 and AID ta-c-1103

Initiation Phase

June 1968 - Contract signed.

Aid imposed constraint "No long-term overseas researchers for first 18 months.

A. A. Bishop, Project Director
B. H. Anderson, Field Director

June 1968 - January 1969

Collecting all available data related to contract objectives including 140,000 pages of water rights legislation.

USAID missions invited by TAB to review program objectives and propose field activities consistent with their in-country objectives.

February 17- March 25, 1969

USU Team - Bishop, Anderson, Peterson, visit El Salvador, Honduras, Venezuela, Colombia, Peru, Chile, Argentina and Brazil at the invitation of the AID missions.

Major priority items identified by USAID Missions.

Implementation Phase by Major [2/] Country

Brazil

March 1969:

USAID/Brazil identifies Northeast Brazil, especially the Sao Francisco Valley as number one priority area for on-farm water management research. Requests assistance to Sao Francisco Development Agency (SUVALE) in design and operation of research stations in the valley.

1/ Prepared by USU Staff.

2/A "Major" country is one where USU stations long-term researchers--Brazil, Chile, Colombia, Ecuador, El Salvador, Guatemala, Peru.

September-October 1969:

Anderson, Nielson and Peterson visit Sao Francisco valley and recommend station preliminary designs and research procedures.

February-March, 1970:

Peterson and Nielson conduct a training seminar for SUVALE researchers. Station designs further developed. Agreement made to put in a two-man USU team as soon as possible.

April 1970:

Engineer Richard E. Griffin scheduled to a two-year assignment in Brazil to begin June, 1970.

June 1970:

On eve of Griffin's departure, USAID/Brazil requested delay of approximately six months to evaluate SUVALE's ability to collaborate with USU team based on a USBR team-SUVALE collaboration problem not yet resolved. (Griffin reassigned to El Salvador).

April, 1971:

Engineer Lloyd Austin and agronomist Norris Gilbert assigned to Brazil to collaborate with SUVALE.

April 1971 - March 1973:

Three research stations developed at Sao Desideria, Formoso, Pirapora. Thirty-nine crops planted for variety, supplemental irrigation, uniformity, water and fertilizer experiments.

March 1973:

Stations in full operation. SUVALE turned over research responsibilities to other national agencies. The stations were also to be used for training.

July 1973:

Agreement signed between USU-USAID/Brazil, Minag to assist their research department (EMBRAPA) to

1. Inventory existing water management activities in Northeast.
2. Recommend appropriate research activities.
3. Upgrade Brazil's capability to perform crop water requirements analyses.
4. Provide a long term assignment of an agronomist.

October - December, 1973:

Hargreaves visited Brazil and collected crop water requirements data. Prepared several technical reports.

March 1974:

Hargreaves participated in SUDENE sponsored seminar in Recife.

April-May 1974:
Palmer evaluated all agricultural research activities in Northeast and recommended central research facility and program to EMBRAPA.

July 1974:
USU conducted Water Use Management Research Seminar for EMBRAPA and SUDENE staff.

July 1974 - Present:
Agronomist Don C. Kidman assigned to Brazil (Petrolina) to assist EMBRAPA with water management field experiments.

February, May-September, July, 1975:
Unhanand, James, Palmer make support trip to assist in program and review agreement.

July 1975:
Wingo collected water law digest data.

Chile

March 1969:
Bishop, Anderson, Peterson visited Chile. USAID/Chile listed as top priority, research to conserve water in irrigation districts because of serious drought in country. Also strong interest was shown in water rights studies and water fertilizer interactions.

June-September, 1969:
E. C. Olsen worked with research staff at La Platina and drafted work plan including improving soil moisture storage capability and other water conservation practices.

August, 1969:
Kidman began a short-term assignment.

December, 1969:
Stutler was assigned to Chile and Kidman assigned to long term.

March, 1970:
Drought eased. USAID requested program be reoriented to focus on water and other management inputs to increase crop yield. Minag asks for corn research in Aconcagua Valley. Two private farms and six communal farms were selected for research and demonstration.

April 1970-April 1973:
Water x fertilizer x plant populations and irrigation methods research by Stutler, Kidman and Chilean counterparts.

July, 1972:
Political situation resulted in the transfer of Kidman and Stutler to El Salvador.

Colombia

February 1969:
Bishop, Anderson, Peterson visited Colombia where USAID strongly recommended locating a team in Atlantico 3 project to work on drainage problems and help identify feasible crops and water and fertilizer management strategies

June-November, 1969:
Darrell Watts began salt leaching studies on Atlantico 3 project.

February 1971:
Embry introduced mole plows at Bogota research station.

May 1971:
E. C. Olsen assigned to Atlantico 3 project to begin drainage and salinity studies.

July 1971:
T. Fullerton assigned to Colombia to begin water management studies.

November 1971:
J. P. Riley developed a hydrologic model for simulating the effect of alternative management strategies on ground water levels in Atlantico 3 project basin.

May 1971-July 1973:
Drainage system research. Leaching research. Field plot research. Work completed. Reports written. Fullerton to El Salvador and Olsen to Logan.

July 1974:
Follow up visits by James and Fullerton to resample source problem soil areas and complete reports.

Ecuador

October 1970:
In response to USAID requests D. R. Daines visited Ecuador and Bolivia.

January 18, 1971:
Daines located headquarters in Ecuador. National Hydraulics Department (INERHI) assigned its chief legal counsel, Gonzalo Falconi, to work half time on Daines water law program. The purpose was to produce a comparative water law digest of the Andean Pact countries.

November 1973:
U.S. ambassador to Ecuador instituted a "low profile" policy and reduced the number of U.S. personnel in country. Daines moves to Colombia and finished the water law digest draft from there.

August 1970-December 1973:
Short term visits by economists LeBaron, Wennergren, Aitken, gathered data on the economics of alternative methods of water management especially in rice culture.

January 1975:
C. Anderson located in Ecuador to begin regional institutional study of nature and effectiveness of farmer irrigation district organizations.

El Salvador

February 1969:
Visit by Bishop, Peterson, Anderson. Mission urged assistance in water management in Zapotitan Valley.

December 1969:
USAID/El Salvador advises to delay sending in long-term staff because of "head count" policy of ambassador (related to timing of local elections).

June 1970:
Griffen (originally scheduled to locate in Brazil) reassigned to El Salvador.

June 1970-July 1972:
Griffen, with short-term assistance from other staff, worked on drainage, irrigation methods, water fertilizer interactions, crop-water requirements and training.

February 1971:
Embry introduced mole drain design and equipment.

July 1972:
Two graduate students studied sprinkler uniformity patterns as influenced by wind.

August 1972:
Stutler and Kidman arrived in El Salvador from Chile. Expand water x fertilizer interaction work.

July 1973:
Kidman returned to Logan and was replaced by Fullerton.

June 1971 to End 1975:
Several short-term visits by economists to collect data on pasture. Trips were made by Alfaro, James, Nielson, Hargreaves and Peterson to assist in the research design and evaluation and in conducting field days and seminars.

Guatemala

September 1973:
Palmer visited Guatemala. ROCAP requested collaboration and advise it would send formal request.

November 1974:
Request received to assist Minag (ICTA) in irrigation development.

February 1975:
Embry assigned to Guatemala. Developed work plan details to supervise irrigation method and crop management experiments.

Peru

February 1969:
Bishop, Anderson, Peterson visited Peru. Political situation inhibited development of formal agreement.

February 1975:
Olsen sent in to negotiate working agreement at request of USAID. Developed plan of work and initiated research program.

Venezuela

February 1969:

Bishop, Anderson, Peterson, visited Venezuela. AID mission was anxious to utilize research monies on water management of heavy soils.

Ray Miller, already on assignment posted at Guanare with OAS fundin modifies program to include heavy soils research.

September 1969:

AID deemphasized work in Venezuela.

Logan

During these field activities, the facilities at Logan were used to support the field activities.

Reports were prepared for publication, translations were made to Spanish, etc. The staff going to the field was given intensive language training and otherwise prepared for the field assignment.

Christiansen and Hargreaves were collecting data from many countries for crop water requirement analyses. The data is used by field teams going to the various countries.

LeBaron, Whitaker, Wennergren, and Aitken collected economic data from Bolivia, Colombia, Ecuador, El Salvador and Venezuela.

Unhanand and students developed mole plow technology.

Peterson, Hill, Keller and Palmer began developing predictive techniques to aid farm management decisions and for information transfer.

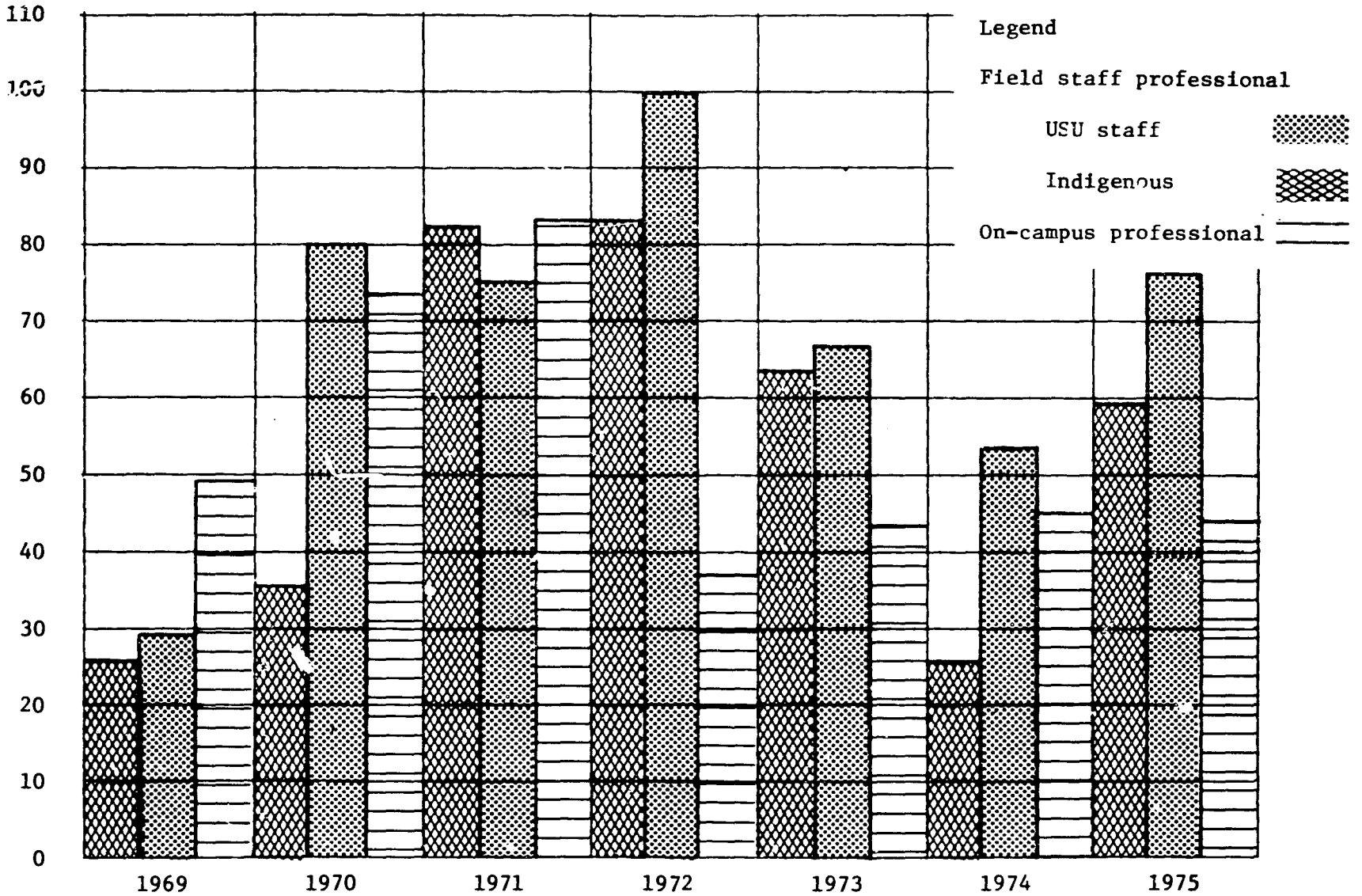
Burt investigated low pressure sprinkler nozzle design.

H. B. Peterson replaced A. A. Bishop as Project Director, January 1973--July 1, 1975.

Bishop returned as project director, July 1, 1975.

Appendix 2a[1/]

Person Months of USU and Indigenous
Country Effort on Contract Activities



1/ Prepared by USU Staff.

Appendix 2b 1/

Contracts AID/csd-2167 and AID ta-c-1103
Estimated Level of Indigenous Country Support
Months per Year of Professional (P) and Subprofessional (S) Collaboration

Country	Est 1976		1975		1974		1973		1972		1971		1970		1969	
	P	S	P	S	P	S	P	S	P	S	P	S	P	S	P	S
Bolivia	2		1		1		1									
Brazil	14	50	14	40	6	10	40	60	30	60	30	60	3			
Chile	2	8							12	40	15	60	12	60	4	
Colombia									24	48	24	48	2		2	
Costa Rica			3													
Dom. Republic					3											
Ecuador	4	5	3	5			8		8		4		1		1	
El Salvador	12	60	12	60	10	50	10	50	6	30	8	40	3			
Guatemala	15	40	5	20	2		2									
Honduras	2		1		2											
Nicaragua			1		1		1									
Panama							2		2							
Paraguay	1															
Peru	24	30	12	15	1											
Puerto Rico			5													
Uruguay			1								1					
Venezuela			1										15	30	20	30
	76	193	59	140	26	60	63	110	82	178	82	208	36	90	27	30

Total months professional = 451 = 37.6 yr.
Total months subprofessional = 1009 = 84.1 yr.
1/ Prepared by USU Staff.

Appendix 3a 1/

TA/AGR Support of the Water Management Research Contract
Utah State University

	Contract AID/csd-2167						Contract AID/ta-c-1103		
	7-1-68 to 6-30-69	7-1-69 to 6-30-70	7-1-70 to 6-30-71	7-1-71 to 6-30-72	7-1-72 to 6-30-73	7-1-73 to 3-31-74	4-1-74 to 3-31-75	4-1-75 to 12-31-75	Totals
Salaries and Wages	29,804	130,943	259,773	282,628	244,427	163,657	220,645	220,347	1,552,224
Staff Benefits	2,534	10,653	22,930	25,772	22,226	24,833	31,726	38,009	178,683
Allowances		300	26,419	32,249	32,303	12,475	13,750	37,808	155,304
Travel	8,799	38,328	53,310	37,339	35,987	28,302	36,821	50,113	288,909
Equipment and Supplies	1,518	35,370	41,075	25,424	15,323	22,534	7,059	7,337	155,640
Other Direct Costs		2,193	44,855	24,964	34,539	41,057	31,350	38,176	217,134
Overhead	15,796	66,957	119,165	132,801	101,748	77,266	108,507	99,832	722,073
TOTALS	58,451	284,654	567,528	561,177	486,553	370,124	449,858	491,622	3,269,967

1/ Prepared by USU Staff.

Appendix 3b [1/]

FISCAL ON-OFF CAMPUS ANALYSIS

	1976		1975		1974	
	on	off	on	off	on	off
Salaries and Wages						
Professionals	119,000	194,000	90,000	174,000	77,000	107,000
Contract Cler.	9,000		10,000		8,000	
Technicians	11,000	4,200	14,000	5,700	6,000	4,500
Travel (In and Out of US)	1,880	35,000	5,000	37,000	4,000	50,000
Current Expenses	16,000	17,000	23,000	11,000	30,000	25,000
Capital	12,000	18,000	10,600	7,200	10,000	20,000
Overseas Allow.		79,000		71,000		60,000
	158,880	347,200	152,600	242,000	135,000	266,500

	1976	1975	1974
Ratio of $\frac{\text{off-campus}}{\text{on-campus}}$	2.19	1.59	1.97

Notes:

Overhead and employee fringe benefits not included.

"Off-campus" is defined for purposes of overhead calculation as being off-campus for a continuous period of 6 months or more. The above salary figures include in the "off-campus" columns, salaries of short-term travellers. Because of this and other differences in accounting procedures the above figures should be considered as estimates only. They will not coincide with official USU invoices to AID.

1/ This information was provided by USU to the review team and is reproduced here as provided.

Appendix 3c - Travel 1/

1976 INTERNATIONAL ROUND TRIP

TA #	Dates	Traveler	Amount	Destination	Purpose
301226	1/5/76-1/21/76	D.C. Anderson	926.00	Ecuador, Peru, Chile	Water Inst. Study
331015	1/6/76-1/26/76	D.R. Daines	1,838.73	Chile,Peru,Ecuador	Water Inst. Study
331069	1/7/76-3/31/76	K. Ryan	3,520.00	El Salvador	Research work
331064	1/16/76-4/16/76	R. Tew	4,402.00	Bolivia	Water Inst. Study
331063	2/8/76-2/13/76	D.R. Daines	1,155.00	Venezuela	Int. Conf. on Law
331057	2/24/76-2/9/76	J. Hanks	1,035.12	El Salvador	Team Assistance
331023	2/27/76-3/18/76	A. Lebaron	2,004.00	Brazil, El Salv., Bolivia	Data collection
331055	2/27/76-3/16/76	A. A. Bishop	2,418.24	South and Central America	Indepth Review

1/ **Prepared by USU Staff.**

1976 NATIONAL ROUND TRIPS

TA #	Dates	Traveler	Amount	Destination	Purpose
331062	2/1/76-2/4/76	H.B. Peterson	459.73	Washington	Attend. Prog. Review
331019	2/9/76-2/9/76	D.R. Daines	27.75	Salt Lake City	Rev. Res. Aid Progress

1975 INTERNATIONAL ROUND TRIPS

TA #	Dates	Traveler	Amount	Destination	Purpose
302473	1/26/75-2/10/75	H.B. Peterson	998.24	El Salvador & Guatemala	Review Research Work
301245	1/26/75-2/10/75	R.F. Nielsen	975.00	El Salvador & Guatemala	Review Research Work
301251	2/2/75-2/23/75	K. Unhanand	2,027.24	Brazil	Consult on project
302466	2/2/75-2/28/75	B.L. Embry	1,378.24	Guatemala & El Salvador	Prep. Plan of Work
301250	2/2/75-2/13/75	D.W. James	1,683.24	Brazil	Consult on Res. Project
301267	2/17/75-3/1/75	E.C. Olsen	234.20	Lima, Peru	Prepare relocation
301273	3/7/75-3/16/75	A. LeBaron	795.24	El Salvador	Part. in Field Res Wrk$
301284	3/17/75-4/17/75	D.R. Daines	1,861.24	Chile,Boliv, Peru,Col.	Arr. for Inst. Study
301230	4/1/75-4/30/75	E.C. Olson	1,016.60	Peru	Irrig. Consulting
301114	4/13/75-5/9/75	D.W. James	1,868.24	El Salv., Guat, Brazil	Team advisement
301167	5/12/75-8/12/75	K. Unhanand	4,374.44	Brazil	Consult on Res. Project
301190	7/3/75-9/30/75	R. Wells	2,928.84	El Salvador	Research work
317520	7/9/75-9/5/75	W. Wingo	3,812.81	South America	Research work
301299	7/15/75-8/29/75	Tom Fullerton	3,042.25	Arkansas from El Salv.	Home Leave
317593	8/30/75-9/16/75	H.B. Peterson	1,852.00	Spain	Water Law Conference
317591	8/31/75-9/6/75	B.C. Palmer	1,803.45	Brazil	Renotiate Agreement
317590	8/31/75-9/6/75	D.W. James	1,803.45	Brazil	Renegotiate Agreement
317569	10/11/75-10/18/75	A. LeBaron	922.67	San Salvador	Part. Irrig. Seminar
317572	10/13/75-11/7/75	A.A. Bishop	2,556.00	Brazil,Guat, Peru	Review Project
331067	12/4/75-12/8/75	J.J. Jurinak	626.56	Brazil	Team advisement

1975 AREA TRAVEL

TA #	Dates	Traveler	Amount	Destination	Purpose
22028	1/6/75-1/8/75	D.C. Kidman	242.94	Petrolina to Recife	Research work
301110	2/75	D.C. Kidman	1,179.47	Brazil vicinity	Research work
22026	12/74-3/75	D.C. Kidman	206.64	Petrolina to Pernambuco	Research work
302467	3/4/75-3/14/75	D.C. Anderson	245.00	Quito vicinity	Research work
301271	3/10/75-3/14/75	J.F. Alfaro	192.84	Guatemala to El Salvador	Part. Field Res Wrkshp
301272	3/17/75-3/29/75	R.K. Stutler	367.50	San Salvador	Reimb. Emerson Shipe
301158	3/19/75-3/25/75	D.C. Anderson	128.53	Ecuador vicinity	Project work
301182	4/1/75-4/30/75	D.C. Kidman	221.88	Brazil vicinity	Project work
301180	4/15/75-4/18/75	D.C. Anderson	60.00	Ecuador vicinity	Consultation
317525	5/5/75-5/18/75	D.C. Kidman	717.55	Petrolina vicinity	Project business
317579	6/75-8/75	D.C. Kidman	1,309.51	Brazil vicinity	Project work
317528	6/17/75-6/25/75	B.L. Embry	196.30	Guat, El Salvador	Consultation
302471	7/4/75-7/31/75	D.C. Anderson	386.08	Quito vicinity	Project work
301115	7/8/75-7/31/75	B.L. Embry	112.00	Escpa, San Jeramino	Project research
301144	8/5/75-8/27/75	B.L. Embry	96.00	Zacapa	Project work
301116	9/2/75-9/30/75	BL.L. Embry	96.00	Zacapa	Project work
331005	9/29/75-10/3/75	D.C. Anderson	105.95	Area travel	Project work
331071	9/31/75-10/4/75	D.C. Kidman	209.58	Area travel	Project work
301224	10/7/75-10/17/75	D.C. Anderson	199.19	area travel	Project work
331068	10/19/75-10/24/75	D.C. Kidman	542.90	Area travel	Project work
301124	10/20/75-10/29/75	B.L. Embry	144.00	Area travel	Project research
21734	10/29/75-10/30/75	R.K. Stutler	54.00	Guatemala	Deliver soil samples
301129	11/1/75-11/26/75	B.L. Embry	160.00	Area travel	Project work
301225	11/1/75-12/5/75	D.C. Anderson	954.12	Ecuador, Colombia	Project work
30117	12-2/75-12/23/75	B.L. Embry	168.00	Guatemala	Project vehicle
2815	12/10/74-12/11/74	T.M. Fullerton	50.20	El Salvador, Guatemala	Deliver soil samples

1975

INTERNATIONAL RELOCATION

TA #	Dates	Traveler	Amount	Destination	Purpose
302472	1/10/75	D.C. Anderson (fam)	1,428.50	Ecuador	2 yr. assignment
301268	3/75-	E.C. Olsen	4,231.35	Lima, Peru	2 yr. assignment
301113	4/6/75	B.L. Embry (wife)	826.68	Guatemala	post assignment

1975 NATIONAL TRAVEL

TA #	Dates	Traveler	Amount	Destination	Purpose
302456	1/4/75-1/18/75	B.L. Embry	822.98	Washington	Overseas orientation
302464	1/13/75-1/15/75	A.A. Bishop	222.74	Riverside, Calif.	CUSUWASH Meetings
302465	1/13/75-1/15/75	H.B. Peterson	262.74	Riverside, Calif.	CUSUWASH Meetings
302463	1/12/75-1/16/75	D.R. Daines	307.74	Riverside, Calif.	CUSUWASH Meetings
301246	1/22/75-1/29/75	D.R. Daines	557.98	Washington-Denver	Meet with RFF ANd UnivC
301253	2/17/75-2/23/75	H.B. Peterson	514.00	Washington	AID WaterMgnt wrkshop
301252	2/17/75-2/23/75	A.A. Bishop	537.24	Washington	AID WaterMgnt Wrkshop
301102	3/17/75-3/19/75	H.B. Peterson	90.00	Twin Fall, Idaho	Research
301183	6/23/75-6/24/75	D.R. Daines	57.94	Salt Lake and Provo	For Interviews
317599	8/6/75-8/6/75	D.R. Daines	102.00	Ft. Collins	Water Law Conference
301298	8/24/75-8/29/75	T.M. Fullerton	268.58	Arkansas to Tennessee	Present paper
317566	8/25/75-8/29/75	D.W. James	464.48	Knoxville, Tennessee	Seminar on Soil Prob
317549	8/29/75-9/8/75	B.C. Palmer	16.30	Salt Lake City	Airport
317554	9/2/75-9/5/75	A.A. Bishop	399.98	Washington	Confer with AID
317592	9/2/75-9/4/75	R. Larsen	434.98	Washington	Confer with AID
317551	9/18/75-9/22/75	A. Lebaron	247.97	Denver	Finalize report
317581	9/21/75-9/27/75	B. Thompson	376.34	Tucson, Arizona	Info. Net Symp.
331001	9/27/75-9/27/75	W.H. Wingo	34.44	Logan from Provo	Project work
317564	10/1/75-10/4/75	R. Shaw	189.67	Logan from Iowa	ATTU Project team
317561	10/1/75-10/3/75	Les Leininger	192.10	Logan from Nebraska	ATTU Project team
331003	10/1/75-10/1/75	J. Keller	23.24	Salt Lake City	Airport
317563	10/1/75-10/3/75	Ken Solomon	43.00	From California	Consulting
317562	10/3/75-10/3/75	R.W. Hill	23.24	Salt Lake City	Airport
331002	10/13/75-10/13/75	H.B. Peterson	25.24	Salt Lake City	Airport & Conference
317553	10/15/75-10/18/75	D.R. Daines	524.97	San Francisco	Environmental Law Wrksh
317560	10/22/75-10/24/75	B.C. Palmer	310.00	Denver	Retrieval workshop
331007	10/22/75-10/24/75	D. Spence	152.73	Denver	Retrieval workshop
331006	11/3/75-11/3/75	R.W. Hill	119.98	Denver	Visit fields
331065	12/31/75-1/7/76	Bruce Brown	222.47	Logan from Lakewood	Work with LeBaron

Appendix 3c-8

INTERNATIONAL TRAVEL ROUND TRIP

TA #	Dates	Traveler	Amount	Destination	Purpose
48190	3/2/74-4/9/74	G.H. Hargreaves	2,154.92	Brazil	Part. in Conference
53144	3/28/74-7/15/74	E.C. Olsen	4,135.92	Central America	Part. in Seminar
48107	4/18/74-5/1/74	Mrs. R.K. Stutler	427.86	To Grand Junction	Care of ill father
53145	4/21/74-7/6/74	B.C. Palmer	4,019.96	Brazil	Plan first phase
18261	6/2/74-6/28/74	D.R. Daines	395.00	Chile,Bolivia,Peru,Ec,Col.	Present Prog to AID Mis
21013	6/17/74-7/17/74	D.C. Kidman	2,486.77	Brazil	InitiateRresearch
18668	6/18/74-9/15/74	C.M. Burt	3,457.00	El Salvador	Research project
18256	6/24/74-7/12/74	D.W. James	1,062.92	El Salvador	Team advisement
21010	6/27/74-8/27/74	R.K. Stutler (fam)	2,129.42	From El Salvador	Home leave
21003	6/28/74-8/31/74	R.K. Stutler (fam)	180.75	From El Salvador	Home leave
21008	7/6/74-7/30/74	S. Allen	1,911.69	Brazil	Conduct workshop
46784	7/20/74-8/1/74	G.H. Hargreaves	2,138.42	Brazil	Conduct workshop
21012	8/19/74-8/24/74	D.R. Daines	854.36	Ecuador, Colombia	Rev. Water Law Program
22042	9/29/74-10/11/74	D.W. James	857.92	El Salvador, Guatemala	Advise Teams
302454	12/23/74-3/23/75	R. Wells	3,250.00	El Salvador	Conduct field research

Appendix 3c-9

TA #	Dates	Traveler	Amount	Destination	Purpose
45956	1/16/74-1/17/74	E.C. Olson	1,368.96	Logan from Colombia	Termination of Assign.
22030	8/15/74	D.C. Kidman (fam)	2,712.39	Brazil	2 yr. assignment

AREA TRAVEL

TA #	Dates	Traveler	Amount	Destination	Purpose
45979	1/10/74-1/11/74	E.C. Olsen	89.28	Colombia area	Research work
48108	3/31/74-4/6/74	R.K. Stutler	267.75	San Salvador to Costa Rica	AID Irrig. Seminar
22024	9/25/74-9/29/74	C.D. Kidman	527.23	Petrolina area	Research work
22023	10/22/74-10/26/74	D. C. Kidman	239.57	Petrolina to Recife	Researchwork
22029	11/5/74-11/26/74	D.C. Kidman	276.70	Petrolina to Recife	Research work

1974

NATIONAL ROUND TRIPS

TA #	Dates	Traveler	Amount	Destination	Purpose
48165	1/7/74-1/10/74	H. B. Peterson	216.42	Tucson, Arizona	CUSUSUWASH Meetings
48180	1/25/74-1/25/74	E.C. Olsen	13.28	Salt Lake City	Pick up cargo
302457	2/26/74-1/4/75	Bruce Brown	210.00	Logan from Denver	Consult with LeBaron
48191	3/74 - 4/74	J. F.Alfaro	355.00		AID UN Irrig. Seminar
48192	3/12/74-3/16/74	D.R. Daines	436.92	Washington, D. C.	Publication of Digest
18265	6/4/74-6/7/74	A. Krambule	79.70	Salt Lake City	IBM Training Session
18270	6/6/74-6/6/74	B.C. Palmer	17.00	Salt Lake City	Digest - Printers
21004	6/20/74-6/20/74	B.C. Palmer	22.68	Salt Lake City	Digest - Printers
21720	7/17/74-7/17/74	B.C. Palmer	20.00	Salt Lake City	Digest - Printers
21009	8/4/74-8/9/74	R.K. Stutler	261.72	Logan from Grand Junction	Consultation
308008	10/11/74-10/14/74	A. LeBaon	150.00	Denver Colorado	Work on report of mod
22049	10/21/74-10/26/74	L. Rammell	512.00	Washington, D. C.	Conf on LDC exchange
22048	10/21/74-10/25/74	H.B. Peterson	510.24	Washington, D. C.	Conf on LDC Exchange
305922	10/25/74-10/25/74	A. LeBaron	20.00	Salt Lake City	Pick up Bruce Brown
305921	10/25/74-10/29/74	Bruce Brown	170.00	Logan from Lakewood	Consult with LeBaron
22043	11/11/74-11/15/74	D.W. James	386.52	Chicago	Att. Int. Sec. NSA
308020	11/17/74-11/27/74	D.C. Anderson	640.24	Washington	Overseas orientation

1973 INTERNATIONAL ROUND TRIPS

TA #	Dates	Traveler	Amount	Destination	Purpose
37865	3/11/73-3/31/73	A. LeBaron	1,091.30	El Salvador	Develop plan for next yr
37864	3/31/73-4/14/73	D. W. James	932.10	Colombia, El Salvador	Develop plan for next yr
37852	4/11/73-4/30/73	J.E. Christiansen	949.20	Colombia	Consult on leaching
43940	5/31/73-6/11/73	E.C. Olsen	2,288.94	Logran from Colombia	Home leave
45955	6/13/73-9/9/73	E.C. Olsen	1,512.97	Logan from Peru	TDY prior to home leave
2818	6/24/73-8/7/73	T.M. Fullerton	2,624.50	Arkansas from Colombia	Home leave
45989	7/23/73-9/15/73	D.R. Daines	2,236.60	South America	Dev. Water Law Seminar
45992	8/6/73-8/28/73	A. LeBaron	1,048.60	El Salvador	Write Economic section
45993	8/6/73-8/28/73	P. Aitkin	1,032.00	El Salvador	Write Economic section
2813	8/7/73-10/4/73	T.M. Fullerton	1,319.12	El Salvador	Transfer
4958	8/19/73-9/9/73	D.W. James	1,159.25	El Salvador, Colombia	Meet with teams
11209	8/23/73-8/24/73	D.C. Kidman	706.00	Logan	Return home
2814	9/8/73-9/9/73	T.M. Fullerton	1,735.81	Logan from El Salvador	Home leave
48135	9/19/73-12/15/73	G.H. Hargreaves	3,730.00	Brazil	Evaluation of Research
48137	10/1/73-12/31/73	G.R. Hanson	3,312.38	El Salvador	Economic Survey
48163	12/7/73-12/15/73	J. Hanks	733.00	El Salvador	Staff Assistance

1973 AREA TRAVEL - IN-COUNTRY

TA #	Dates	Traveler	Amount	Destination	Purpose
11184	2/73	L.H. Austin	395.28	Brazil vicinity	Research
2808	1/73	T.M. Fullerton	80.11	Colombia vicinity	Meet with AID officials
11164	2/73	M.W. Gilbert	200.75	Brazil Vicinity	Research
2806	2/73	T.M. Fullerton	125.16	Colombia vicinity	Research
11092	2/73	E.C. Olsen	128.51	Colombia vicinity	Meet with AID officials
2809	4/3/73	T.M. Fullerton	134.80	Colombia vicinity	Research
11090	4/73	E.C. Olsen	88.87	Colombia vicinity	Meet with AID officials
48132	4/16/73	R.K. Stutler	149.60	Guat. from El Salv.	Research
43938	5/25/73	E.C. Olsen	63.95	Colombia vicinity	Research
2820	5/25/73	T.M.Fullerton	60.97	Colombia vicinity	Research
2819	6/15/73	T.M. Fullerton	60.89	Colombia vicinity	Research
11229	6/20/73-6/23/73	D.C. Kidman	75.00	Guatemala	Regional work
48131	8/22/73	R.K. Stutler	112.20	El Salv to Guat.	Research
2811	9/10/73-9/10/73	T.M. Fullerton	102.80	Colombia vicinity	Meet with AID Officials
2812	9/27/73-9/28/73	T.M. Fullerton	47.67	Colombia vicinity	Meet with AID Officials
45953	9/27/73-9/28/73	E.C. Olsen	90.40	Colombia vicinity	Research

1973 NATIONAL - IN-STATE TRAVEL

TA #	Dates	Traveler	Amount	Destination	Purpose
37883	1/2/73-1/6/73	B.C. Palmer	270.60	San Francisco	Research Review
37867	1/22/73-1/23/73	B.C. Palmer	314.00	Washington, D.C.	Review Plan of Work
37870	1/31/73-2/2/73	D.R. Daines	366.00	Washington, D. C.	Rev. Prog for Seminars
37822	3/7/73-3/7/73	B.C. Palmer	5.50	Burley, Idaho	Irrig. Equip. Show
37821	3/12/73-3/13/73	JE.CChristiansen	22.50	Kimberly, Idaho	Research Review
2810	7/24/73-8/2/73	T.M. Fullerton	380.45	Logan from Arkansas	Consultation
4918	8/20/73-8/24/73	B.C. Palmer	137.50	Ft. Collins, Colorado	Dev. Rev. Res. Prog.
4916	8/20/73-8/24/73	H.B. Peterson	204.10	Ft. Collins, Colorado	Dev. Rev. Res. Prog.
48138	9/26/73	C. Johnson	19.92	SLC Airport	Pick up consultant
45507	9/28/73-10/9/73	H.B. Peterson	35.00	Park City, Utah	Symposium
48139	9/31/73-10/8/73	B.C. Palmer	35.00	Park City, Utah	Symposium

1973 Relocation

TA #	Dates	Traveler	Amount	Destination	Purpose
11183	3/73	L.H. Austin	106.30	Logan from S.A.	Completion of Assign.
302455	10/19/73-10/22/73	T.M. Fullerton	344.76	El Salvador	Transfer of vehicle

1972 INTERNATIONAL -

TA #	Dates	Traveler	Amount	Destination	Purpose
29756	3/10/72-3/13/72	G. Glenn	2,128.60	Ecuador	Research
32433	4/15/72-4/30/72	R.F. Nielson	1,219.60	Brazil	Consult with team
29756	3/13/72-5/26/72	J.E. Christiansen	687.00	Guatemala	Monjas Irrig Dist.
32463	5/1/72-6/3/72	D.W. James	1,704.04	South America	Research teams
32441	5/3/72-6/5/72	J.E. Christiansen	1,221.00	Guatemala to Panama	AID Request
32445	6/6/72	LeeAnn Daines	632.00	Logan from Ecuador	Illiness
34224	7/12/72-7/31/72	H.B. Peterson	1,516.58	South America	Monitor Res. work
34187	8/24/72-8/28/72	D.W. James	935.60	Colombia, El Salvador	Set up soil analysis
39211	9/10/72-9/22/72	G.H. Hargreaves	1,341.32	Brazil	Renegotiate contr.
39210	9/10/72-9/26/72	B.C. Palmer	1,341.32	Brazil	Renegotiate contr.
39214	9/22/72-9/24/72	P. Aitken	100.00	Ecuador	Rice Seminar
39213	9/22/72-9/24/72	E.B. Wennergren	100.00	Ecuador	Rice Seminar
39217	9/23/72-10/25/72	D.R. Daines	1,888.73	Spain	World Water Law D.
39215	10/11/72-10/15/72	M.H. Whitaker	165.00	Ecuador	Seminar
2817	10/27/72-11/4/72	T.M. Fullerton	436.25	Miami from Colombia	Research
37877	11/5/72-11/22/72	J.P. Riley	1,185.40	Central & South America	Review and Res.
37847	11/21/72-12/15/72	G.H. Hargreaves	761.40	Brazil	Lecture & Consult
37895	11/30/72-12/2/72	R.E. Griffin	707.24	El Salvador	Install equipment
37881	12/17/72-12/19/72	G.D. Gardner	108.25	El Salvador	Economic Component

1972 AREA TRAVEL - IN-COUNTRY

TA #	Dates	Traveler	Amount	Destination	Purpose
11205	1/72	D.C. Kidman	202.56	Chle vicinity	Research
11195	1/72	L.H. Austin	121.69	Brazil vicinity	Research
11172	1/72	N.H. Gilbert	174.00	Brazil vicinity	Research
11238	2/72	D.C. Kidman	117.48	Chile vicinity	Research
11192	2/72	L.H. Austin	90.00	Brazil vicinity	Research
11171	3/72	N.W. Gilbert	439.22	Brazil vicinity	Research
11191	3/72	L.H. Austin	400.00	Brazil vicinity	Research
11207	3/72	D.C. Kidman	187.08	Chile vicinity	Research
34176	3/72	R.K. Stutler	38.67	Chile vicinity	Research
39283	4/72	R.E. Griffin	65.00	Guatemala vicinity	Research
111098	4/72	L.H. Austin	162.00	Brazil vicinity	Research
11170	4/72	N.W. Gilbert	298.01	Brazil vicinity	Research
34177	4/72	R.K. Stutler	40.82	Chile vicinity	Research
11206	4/72	D.C. Kidman	141.36	Chile vicinity	Research
29761	4/17/72-5/2/72	E.C. Olsen	560.70	Colombia-to Guatemala	Eval. drnge problem
39284	5/72	K. Stutler	35.00	Chile vicinity	Research
11190	5/72	L.H. Austin	254.67	Brazil	Research
11097	5/72	E.C. Olsen	71.50	Colombia	Research
11059	5/72	D.R. Daies	774.15	Ecuador, Peru, Bolivia	Research
2801	5/30/72-6/2/72	T.M. Fullerton	59.50	Colombia	Mtg on Epdentures
39281	6/72	R.E. Griffin	239.50	Guatemala	Research
11187	6/72	L.H. Austin	306.12	Brazil vicinity	Research
11169	6/72	N.W. Gilbert	473.61	Brazil vicinity	Research
2803	6/24/72-6/25/72	T.M. Fullerton	82.18	Colombia vicinity	Renewal of Contract
11084	6/26/72-6/27/72	E.C. Olsen	20.00	Colombia	Pick up fertilizer
11058	6/72	D.R. Daines	248.00	Peru	R&R
11096	7/72	E.C. Olsen	82.98	Colombia	Research
11168	7/72	N.W. Gilbert	147.95	Brazil	Research
11189	7/72	L.H. Austin	303.55	Brazil	Research
39278	7/1/72-7/14/72	T.M. Fullerton	877.00	Nicaragua, Panama, C.Rica	R&R
11167	7/31/72-8/7/72	N.W. Gilbert	643.76	Brazil	Research
11188	8/72	L.H. Austin	279.37	Brazil	Research

1972 AREA TRAVEL - IN-COUNTRY Page 2

TA #	Dates	Traveler	Amount	Destination	Purpose
11163	9/72	N.W. Gilbert	435.92	Tickets for BCPalmer and GGHargreaves	
11185	10/72	L.H. Austin	150.18	Brazil	Research
11165	10/72	N.W. Gilbert	338.84	Brazil	Research
11234	10/72	D.C. Kidman	130.92	Chile vicinity	Research
11185	11/72	L.H. Austin	115.92	Brazil	Research
11166	11/72	N.W. Gilbert	331.75	Brazil	Research
11095	11/72	E.C. Osen	151.12	Colombia	Research
2821	12/72	T.M. Fullerton	105.62	Colombia	Research
11094	12/72	E.C. Olsen	110.68	Colombia	Research

1972 NATIONAL - IN STATE TRAVEL

TA #	Dates	Traveler	Amount	Destination	Purpose
2884	1/9/72-1/12/72	J.E. Christiansen	219.50	Tucson, Arizona	CUSUSWASH Meetings
2886	1/9/72-1/12/72	A. LeBaron	219.50	Tucson, Arizona	CUSUWASH Meetings
2883	1/9/72-1/12/72	B.C. Palmer	263.10	Tucson, Arizona	CUSUSWASH Meetings
29737	1/20/72-1/20/72	J.E. Christiansen	16.60	SLC	Pick up AID person
29733	1/26/72-1/28/72	B.C. Palmer	325.62	Washington, D.C.	Project Review
29734	1/26/72-1/28/72	H.B. Peterson	314.00	Washington, D.C.	Project Review
32432	5/4/72-5/5/72	H.B. Peterson	146.50	Denver, Colorado	Res. Planning
34237	7/5/72-7/7/72	H.B. Peterson	186.62	Ft. Collins	CUSUSWASH meetings
32448	7/5/72-7/6/72	D.W. James	96.50	Ft. Collins, Co.	CUSUSWASH meetings
32439	7/5/72-7/6/72	R.F. Nielson	96.50	Ft. Collins, Co.	CUSUSWASH meetings
32447	7/5/72-7/6/72	A. LeBaron	96.50	Ft. Collins, Co.	CUSUSWAHH meetings
34238	7/7/72-7/7/72	B.C. Palmer	151.00	Ft. Collins, Co.	CUSUSWASH meetings
39205	7/2/72-7/72	D. Douglas	16.60	SLC Airport	AID supervisor
39261	7/20/72-8/3/72	R.K. Stutler	152.25	Logan from Colorado	Consultation
39201	7/27/72-7/28/72	B.C. Palmer	96.50	Ft. Collins	Dis. Joint program
39293	7/27/72-7/28/72	B.C. Palmer	32.90	Ft. Collins	Dis. Joint Program
39206	8/2/72-8/2/72	C. Broderik	16.60	SLC Airport	Aid supervisor
39299	8/31/72-8/31/72	R.E. Griffin	25.20	SLC	Pick up hsld things
39277	9/14/72 - open	H.B. Peterson	407.00	Washington	Prep. Proj. report
30944	9/18/72-9/20/72	J.P. Riley	364.16	Texas	Discuss linkages
39243	9/25/72-9/29/72	G.H. Hargreaves	218.31	Spokane Washington	Irrig. Spec. Conf
39269	10/3/72-10/3/72	K. Bach	10.00	Cache Valley	Field tour-Brazil
39181	10/28/72-11/5/72	R.L. Smith	572.60	Miami	Agronomy meetings
11208	12/72	D.C. Kidman	337.40	Miami	ASA Meetings
37898	12/11/72-12/15/72	J.E. Christiansen	335.60	Chicago	ASAE Meeting

1972 RELOCATION

TA #	Dates	Traveler	Amount	Destination	Purpose
34189	9/1/72	Stutler family	568.56	El Salvador	Return to post
11061	12/72	D.R. Daines	1,343.20	Logan from Ecuador	Complete assignment

1971 INTERNATIONAL ROUND TRIP

TA #	Dates	Traveler	Amount	Destination	Purpose
17731	1/24/71-2/28/71	G.H. Hargreaves	1,100.73	South America	Research
11140	2/17/71-3/2/71	R.E. Griffin	405.00	Chile and Panama	Visit Project
17789	2/22/71-3/7/71	B.L. Embry	887.20	Colombia and El Salvador	Consult. & Research
17744	3/31/71-4/31/71	B.C. Palmer	332.50	Guyana	Research
17748	4/11/71-5/22/71	P. Aitken	871.00	Chile, Ecuador, El Salv.	Finalize Contract
17742	4/11/71-5/9/71	J.E. Christiansen	1,107.60	El Salvador, Colombia	Consulting
17746	4/11/71-4/17/71	A. LeBaron	307.00	Bolivia, Chile, El Salv.	Finalize contract
17745	4/11/71-4/17/71	B. Wennergren	307.00	Bolivia, Chile, El Salv. Ec.	Finalize contract
13675	4/13/71-5/1/71	B.C. Palmer	1,980.00	Central and South America	Admin. field act.
17769	5/11/71-5/25/71	J.E. Christiansen	529.00	Ecuador	Consulting
11235	5/15/71-5/17/71	Dorothy Kidman	480.37	Chile	Join husband
19452	6/22/71-6/24/71	T.M. Fullerton	203.65	Colombia from Bogota	Consult with ECO
19528	7/21/71-9/20/71	G. Glenn	2,345.00	El Salvador	Field research
19529	7/21/71-8/21/71	P. Aitken	1,467.00	Ecuador	Conduct field res.
19548	8/2/71-9/13/71	B.L. Embry	1,724.00	Colombia and El Salvador	Res on Mole Drain
19530	8/3/71-9/1/71	B. Wennergren	174.00	Ecuador	Set up economic res
19550	8/10/71-9/15/71	D.W. James	1,846.00	ElSalvador, Chile, Colombia	Plan for next year
19549	8/10/71-9/9/71	R.F. Nielsen	1,962.00	Brazil	Rev. Plan of work
11054	9/10/71-9/11/71	D.R. Daines Jr.	302.00	Logan from Ecuador	Educational Travel
3346	10/1/71-10/23/71	M.D. Whitaker	1,484.00	Ecuador and El Salvador	Compl. First Phase
3361	10/6/11-10/23/71	R.J. Hanks	1,043.54	El Salvador, Colombia, Ecua.	Consulting
2822	10/10/71-10/10/71	T.M. Fullerton	2.50	Colombia	Research
3365	10/18/71-12/18/71	J.E. Christiansen	673.84	Ecua., Brazil, Col., El Salv.	Research
2893	12/11/71-12/15/71	A. LeBaron	106.00	Ecuador	Research
11099	12/18/71-12/30/71	E.C. Olsen	621.76	Miami, Florida	R&R

1971 NATIONAL

TA #	Dates	Traveler	Amount	Destination	Purpose
14635	1/8/71-1/15/71	B.C. Palmer	307.30	Arizona	CUSUSWASH meetings
17723	1/8/71-1/10/71	J.P. Riley	145.80	Arizona	CUSUSWASH meetings
17730	1/14/71-1/14/71	A. LeBaron	17.22	Provo, Utah	Interv. Pros. Emp.
14648	1/24/71-1/26/71	B.C. Palmer	145.00	Arizona	CUSUSWASH meetings
17732	1/24/71-1/26/71	R.W. Hill	145.00	Arizona	CUSUSWASH meetings
14790	1/24/71-1/26/71	R.L. Smith	145.00	Arizona	CUSUSWASH meetings
13629	1/24/71-1/26/71	K. Unhanand	145.00	Arizona	CUSUSWASH meetings
14794	1/24/71-1/26/71	B. Wennergren	145.00	Arizona	CUSUSWASH meetings
14791	1/24/71-1/26/71	A.A. Bishop	185.60	Arizona	CUSUSWASH meetings
14644	1/24/71-1/26/71	H.B. Peterson	161.60	Arizona	CUSUSWASH meetings
14643	1/24/71-1/26/71	B.H. Anderson	145.00	Arizona	CUSUSWASH meetings
14645	1/24/71-126/71	D.F. Peterson	161.00	Arizona	CUSUSWASH meetings
14646	1/24/71-1/26/71	D.W. Thorne	145.00	Arizona	CUSUSWASH meetings
14642	1/24/71-1/26/71	A. LeBaron	145.00	Arizona	CUSUSWASH meetings
17720	2/22/71-2/22/71	M.D. Whitaker	13.37	SLC	
17782	2/28/71-3/18/71	M.W. Gilbert	208.50	Arizona	Prepare for Rio Tp
17791	3/5/71-3/15/71	N.W. Gilbert	127.60	Arizona	Prep. for Assign.
12237	6/11/71	M.A. Mately	355.30	Louisiana	Del. Daines car
19535	7/7/71		100.00	Miscellaneous area	Motor pool
19540	7/13/71-7/13/71	R.J. Larsen	19.35	SLC	Set up Int. money
19534	8/18/71-8/27/71	A. LeBaron	296.00	Washington from Illinois	Rev. Econ. Phase
19456	8/7/71-8/18/71	T.M. Fullerton	545.89	Logan from Arkansas	Meet with our staff

1971 AREA TRAVEL PAGE 2

TA #	Dates	Traveler	Amount	Destination	Purpose
11157	7/71	N.W. Gilbert	117.97	Brazil	Research
11204	7/71	D.C. Kidman	87.00	Chile	Research
11174	7/11/71	N.W. Gilbert	147.25	Brazil	Research
11195	7/11/71	L.H. Austin	135.00	Brazil	Research
11175	7/21/71-7/31/71	L.H. Austin	224.88	Brazil	Research
11176	7/21/71-7/29/71	L.H. Austin	179.83	Pirapora, Brazil	Research
11152	7/18/71-	L.H. Austin	3.22	Brazil	Inspect Apartment
11156	7/21/71-7/3/71	N.W. Gilbert	276.89	Brasilia, Brazil	Research
11106	8/71	E.C. Olsen	22.67	Colombia	Research
11158	8/71	N.W. Gilbert	119.57	Brazil	Research
11177	8/17/71-8/21/71	L.H. Austin	94.50	Brazil vicinity	Research
11244	8/71	D.C. Kidman	177.96	Chile	Research
11196	9/71	L.H. Austin	263.45	Brazil	Research
11105	9/71	E.C. Olsen	252.72	Colombia	Research
11202	9/8/71-9/18/71	N.W. Gilbert	202.44	Brazil	Research
11242	9/71	D.C. Kidman	157.80	Chile vicinity	Research
19532	9/11/71-9/16/71	M.D. Whitaker	260.00	El Salvador, Rio	Research
11100	10/71	E.C. Olsen	64.00	Bogota, Colombia	Research
11240	10/71-	D.C. Kidman	190.32	Chile vicinity	Research
11199	10/71	N.W. Gilbert	288.99	Brazil vicinity	Research
11200	10/71	N.W. Gilbert	88.11	Brazil vicinity	Research
11197	10/11/71-10/25/71	L.H. Austin	198.18	Brazil vicinity	Research
11102	10/71	E.C. Olsen	115.55	Colombia	Researhh
11198	11/71	N.W. Gilbert	92.67	Brazil	Research
11101	11/71	E.C. Olsen	69.34	Colombia	Research
29764	11/71	R.K. Stutler	25.45	Chile vicinity	Research
11232	11/71	D.C. Kidman	168.36	Chile vicinity	Research
11233	12/71	D.C. Kidman	199.20	Chile vicinity	Research
29763	12/71	R.K. Stutler	12.73	Chile vicinity	Research
11173	12/71	N.W. Gilbert	250.10	Brazil vicinity	Research
11194	12/71	L.H. Austin	256.80	Brazil vicinity	Research

1971 AREA TRAVEL

TA #	Dates	Traveler	Amount	Destination	Purpose
17770	1/71	D.C. Kidman	170.50	Chile vicinity	Research
11241	1/6/71	D.C. Kidman	181.90	Chile	Research
17797	1/1/71-1/30/71	R.K. Stutler	184.06	Santiago vicinity	Research
11135	1/1/71-1/30/71	R.E. Griffin	6.80	El Salvador vicinity	Research
11051	1/1/71-1/30/71	D.R. Daines	12.67	Ecuador vicinity	Research
17771	2/71	D.C. Kidman	176.30	Chile	Research
24103	2/71	E.C. Olsen	2.91	Colombia	Research
11124	2/71	R.K. Stutler	26.50	Chile	Research
17765	3/71	R.E. Griffin	4.40	El Salvador	Research
11079	3/71	E.C. Olsen	4.78	Colombia	Research
17779	3/71	D.C. Kidman	162.80	Chile	Research
11154	4/71	N.W. Gilbert	33.86	Brazil	Research
11081	4/12/71-4/15/71	E.C. Olsen	116.33	Colombia	Research
19509	4/71	D.R. Daines	2.82	Ecuador	Research
17780	4/71	D.C. Kidman	177.70	Chile	Research
11149	4/12/71-4/16/71	L.H. Austin	89.25	Brazil	Research
11153	4/12/71-4/16/71	N.W. Gilbert	89.25	Brazil	Research
11141	4/71	R.E. Griffin	15.60	El Salvador	Research
17781	5/71	D.C. Kidman	62.10	Chile	Research
11151	5/71	L.H. Austin	1.97	Brazil	Research
11080	5/71	E.C. Olsen	6.24	Colombia	Research
11142	5/71	R.E. Griffin	10.40	El Salvador	Research
19510	5/71	D.R. Daines	7.62	Ecuador	Research
11052	5/31/71-6/18/71	D.R. Daines	77.34	Ecuador to El Salvador	Research
11053	5/31/71-6/18/71	D.R. Daines	431.60	Ecuador to El Salvador	Research
11155	5/17/71-5/20/71	N.W. Gilbert	84.00	Brazil	Research
11150	5/17/71-5/20/71	L.H. Austin	84.00	Brazil	Research
19508	5/3/71-5/5/71	D.R. Daines	66.99	Guayaquil	Research
19537	6/71	R.E. Griffin	145.60	El Salvador	Research
11245	6/71	D.C. Kidman	73.10	Chile	Research
11082	7/71	E.C. Olsen	14.77	Colombia	Research
11083	7/71	E.C. Olsen	3.51	Colombia	Research

1971 RELOCATION

TA #	Dates	Traveler	Amount	Destination	Purpose
17729	1/17/71	D.R. Daines	487.42	Quito, Ecuador	2 year assignment
17728	1/20/71	E.C. Olsen family	1,517.60	Barranquilla, Colombia	2 year assignment
17799	3/18/71	N.W. Gilbert	1,077.38	Rio de Janeiro, Brazil	2 year assignment
17721	3/27/71	L.H. Austin	1,668.20	Rio de Janeiro, Brazil	2 year assignment
19507	6/12/71	D.R. Daines family	1,315.20	Quito, Ecuador	2 year assignment
19457	8/23/71	T.M. Fullerton	1,048.46	Barranquilla, Colombia	2 year assignment

1970 INTERNATIONAL ROUND TRIP

TA #	Dates	Traveler	Amount	Destination	Purpose
08456	2/24/70-3/13/70	R.F. Nielsen	1,520.86	Brazil, Chile, Ven.	Short term consult
08455	2/24/70-3/13/70	R.E. Griffin	1,520.86	Brazil, Chile, Ven.	Short term consult
08454	2/24/70-3/21/70	H.B. Peterson	1,613.00	Brazil, Chile, Ven.	Short term consult
05430	3/17/70-3/28/70	D. Watts	1,099.60	Colombia	Short term consult
05429	3/17/70-3/28/70	E.C. Olsen	1,099.60	Colombia	Short term consult
100950	3/28/70-4/3/70	D.C. Kidman	721.00	Logan from Chile	Emergency-& consult
05416	4/5/70-5/1/70	B.H. Anderson	1,279.04	South America	Short term consult
05422	5/4/70-5/19/70	D.R. Daines	1,264.20	Bolivia	Short term consult
03465	5/16/70-7/2/70	B. Wennergren	1,091.60	Boliv. Ecua. Col. Ven.	Consulting
03464	5/30/70-7/2/70	A. LeBaron	841.60	South and Central America	Consulting
03329	5/30/70-8/1/70	P. Aitken	1,350.00	Bolivia	Field Research
03332	6/9/70-9/15/70	T. White	2,165.66	Ecuador	Field Research
03462	6/9/70-9/15/70	E. Gomez	2,150.00	Bolivia	Field Research
07846	7/2/70-8/16/70	R.J. Hanks	982.26	South America	Seminar
14910	11/15/70-12/9/70	H.B. Anderson	537.48	South America	Review Program
14933	11/17/70-12/9/70	E.C. Olsen	112.00	Colombia	Short course
13621	11/27/70-12/22/70	L. Davis	1,035.10	Ecuador,El Salvador	Plan research
13611	11/27/70-12/22-70	A. LeBaron	588.60	Ecuador	Plan research
05420	12/1/69-3/29/70	D.C. Kidman	2,130.00	South America	Short term consult
12799	12/6/70-12/13/70	D.W. James	587.00	El Salvador	Consult

1970 NATIONAL

TA #	Dates	Traveler	Amount	Destination	Purpose
08459	2/13/70-	DRDaines	25.70	Salt Lake City	Confer water law spec
08402	3/2/70-3/21/70	D.R. Daines	819.60	Washington	Review program
03457	4/28/70-4/28/70	D.R. Daines	16.60	Salt Lake City	Microfiche arrangement
03460	5/12/70-5/13/70	B.H. Anderson	25.00	Washington	ASEE meetings
03330	6/4/70=6/5/70	B.H. Anderson	25.00	Washington	Meetings
06998	7/1/70-7/3/70	B.L. Bassett	217.00	Pullman, Washington	Interv. for Employment
08427	7/11/70-7/30/70	R.E. Griffin	732.00	Washington	AID orientation
07842	7/12/70-7/14/70	K. Larsen	270.04	San Francisco	Convey Automobiles
07751	7/26/70-8/8/70	D.R. Daines	615.00	Washington	Meetings
07502	7/26/70-8/8/70	L. Austin	606.20	Washington	AID orientation
02511	8/9/70-8/22/70	E.C. Olsen	579.20	Washington	AID Orientation
07004	8/12/70-8/15/70	A.A. Bishop	143.00	Colorado	CUSUSWASH
07021	8/21/70-8/21/70	J.F. Alfaro	218.00	New Mexico	Interview for Employment
13599	11/9/70-11/14/70	E.C. Olsen	75.00	Nebraska	Nat. Irrig. Symp.
13600	11/9/70-11/14/70	L.H. Austin	75.00	Nebraska	Nat. irrig. Symp.
13631	11/30/70-12/5/70	M.D. Whitaker	544.60	Texas, Mich, Iowa	Gather data
14788	12/29/70-12/30/70	N.W. Gilbert	172.60	Arizona to Logan	Job Interview

1970 AREA TRAVEL

TA #	Dates	Traveler	Amount	Destination	Purpose
14736	9/70	R.K. Stutler	23.86	Chile vicinity	conduct research
14737	10/70	R.E. Griffin	2.40	El Salvador vicinity	conduct research
14654	10/70	R.K. Stutler	100.36	Chile vicinity	conduct research
14652	10/70	D.C. Kidman	294.96	Chile vicinity	conduct research
14650	11/70	R.E. Griffin	4.60	El Salvador	conduct research
14651	11/70	R.K. Stutler	5.19	Chile vicinity	conduct research
17734	11/70	D.C. Kidman	267.12	Chile vicinity	research & inspec
14649	12/70	R.E. Griffin	4.20	San Salvador vicinity	research & inspec
17735	12/70	D.C. Kidman	244.32	Chile vicinity	research & inspec

1970 RELOCATION

TA #	Dates	Traveler	Amount	Destination	Purpose
04977	7/13/70	R.K. Stutler	3,044.25	Santiago, Chile	2 year assign.
07022	8/11/70	R.E. Griffin	1,320.00	El Salvador	2 year assign.

Appendix Table 4: On Farm Water Management Research - El Salvador[1/]

	Wet July-November 1972	Dry December 1972-June 1973	Wet July-November 1973	Dry December 1973-June 1974
USU Personnel				
Kidman	→	→	→	
Stutler	→	→	→	→
Fullerton			→	→
Counterpart Personnel				
CENTA	→	→	→	→
DGRD	→	→	→	→
Research Activities				
San Andres		Irrigation Methods: Sprinkler, Drip and Furrows on Corn, Tomatoes w/4 levels N fertilizer	Residual Nitrogen Evaluation on methods site using corn Initiate rainy season portion of interaction experiment (Sorghum) 4 levels N fertilizer	Continue Irrigation Methods study Dry Season phase of Interaction-2 methods 4 soil moisture levels 4 N levels and residuals
Atiocoyo		Irrigation Methods: Sprinkler and Furrow on Corn, Cantaloupes and peanuts w/various fert. levels	Residual fert. evaluation using corn on methods area Surface and Sprinkler Irrig. on Pangola w/4 levels N fert. →	Sprinkler and furrow irrigation on corn, beans, soybeans w/ various fertilizer levels

1/ Prepared by Kern Stutler.

Appendix Table 4: (Continued) On Farm Water Management Research - El Salvador

	Wet July-November 1972	Dry December 1972-June 1973	Wet July-November 1973	Dry December 1973-June 1974
USU Personnel	[illegible]	Amount Destination		Purpose
Kidman	[illegible]	437.[illegible] Quito, Ecuador		2 year assignment →
Stutler	[illegible]	1,317.[illegible] Barranquilla, Colombia		2 year assignment →
Fullerton	[illegible]	1,077.[illegible] Rio de Janeiro, Brasil		2 year assignment
Counterpart Personnel	[illegible]	1,6[illegible].20 Rio de Janeiro, Brasil		2 year assignment
CENTA	[illegible]	1,315.20 Quito, Ecuador		2 year assignment →
DGRD	[illegible]	1,[illegible].46 Barranquilla, Colombia		2 year assignment
Research Activities				
San Andres	Second season of sorghum on Interaction exp. Evaluate residual N from Methods exp.	Second season w/corn on Interaction exp. Initiate Line Source exp. w/sprinklers on corn-4 levels N	Third season of Sorghum on Interaction exp.	Third dry season on Interaction exp. Second season Line Source exp. w/corn
Atiocoyo	Evaluate residual fert. on methods area using corn and rice Point source supp. irrig. on rice 2/6 levels N →	Furrow irrig. on corn variety X fert, soy beans and beans Point source water variable on rice Sprinkler irrig. w/ 3 irrigation rates and 8 nitrogen levels-Pangola	Residual N evaluation using corn on previous corn area	Point Source water variable w/6 levels N on rice →

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT PAPER FACESHEET

TO BE COMPLETED BY ORIGINATING OFFICE

1. TRANSACTION CODE (X) APPROPRIATE BOX)
[X] ORIGINAL [ ] CHANGE [ ] ADD [ ] DELETE

PP

DOCUMENT CODE 3

2. COUNTRY/REGIONAL ENTITY/GRANTEE
PERU

3. DOCUMENT REVISION NUMBER

4. PROJECT NUMBER
527-0156

5. BUREAU
A. SYMBOL: LA
B. CODE: 3

6. ESTIMATED FY OF PROJECT COMPLETION
FY 79

7. PROJECT TITLE - SHORT (STAY WITHIN BRACKETS)
Improved Water & Land Use in Sierra

8. ESTIMATED FY OF AUTHORIZATION/OBLIGATION
A. INITIAL MO. 10 YR. 75 B. FINAL FY 76

9. SECONDARY TECHNICAL CODES (MAXIMUM SIX CODES OF THREE POSITIONS EACH)

020	066	067			

10. ESTIMATED TOTAL COST ($000 OR EQUIVALENT, $1 = 43.38)

A. PROGRAM FINANCING	FIRST YEAR B. FX	C. L/C	D. TOTAL	ALL YEARS E. FX	F. L/C	G. TOTAL
AID APPROPRIATED TOTAL			11,000		7,800	11,000
(GRANT)	( )	( )	( )	( )	( )	( )
(LOAN)	( )	( )	(11,000)	(3,120)	(7,880)	(11,000)
OTHER U.S. 1.						
OTHER U.S. 2.						
HOST GOVERNMENT				-	12,500	12,500
OTHER DONOR(S)						
TOTALS			11,000	3,120	20,380	23,500

11. ESTIMATED COSTS/AID APPROPRIATED FUNDS ($000)

A. APPROPRIATION ALPHA CODE	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE	FY 78 D. GRANT	E. LOAN	FY 79 F. GRANT	G. LOAN	FY 80 H. GRANT	I. LOAN	ALL YEARS J. GRANT	K. LOAN
FN	110	064		11,000						11,000
TOTALS				11,000						11,000

12. ESTIMATED EXPENDITURES

13. PROJECT PURPOSE(S) (STAY WITHIN BRACKETS) [ ] CHECK IF DIFFERENT FROM PID/PRP

To improve water and land use in the sierra through: (a) an increase in productive land area; (b) an increase in crop yields; (c) expansion of cropping alternatives; (d) an increase in the efficiency of water use; (e) reduction in soil loss from erosion; and (f) the strengthening of GOP technical capacity at the regional level.

14. WERE CHANGES MADE IN THE PID/PRP FACESHEET DATA NOT INCLUDED ABOVE? IF YES, ATTACH CHANGED PID AND/OR PRP FACESHEET.

[ ] YES [X] NO n/a

15. ORIGINATING OFFICE CLEARANCE

SIGNATURE
Leonard Yaeger

TITLE
Acting Director

DATE SIGNED MO. 9 DAY 15 YR. 75

16. DATE RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION
MO. DAY YR.

AID 1330-4 (5-75)

B. Recommendation: USAID/Peru recommends that a $11.0 million loan be authorized in FY 76 under the Food and Nutrition funding category (FAA Section 103) for the purposes of planning and implementing the Loan Project proposed in this Project Paper.

C. Description of the Project: The proposed Loan will contribute to the planning and implementation of a program of improved water and land use in the sierra conceived and initiated by the Dirección General de Aguas (DGA) of the Ministry of Agriculture (MOA). The Project will be implemented in two project areas --Cajamarca and Mantaro-- in the rural mountain regions of Perú (the "sierra"), and will include 1) construction of irrigation and drainage works for up to 27 sub-projects; 2) implementation of a complementary program of protective afforestation to prevent erosion, to conserve water, and to protect irrigation structures in the sub-project areas; 3) strengthening of regional irrigation offices in the two Project areas with additional personnel and required machinery and equipment; 4) establishment of a special fund in the Agrarian Bank (AgBank) for sub-lending to participating farmers for investments in on-farm land development; 5) 102 man-months of U.S. or third-country high-level technical advisory services to the DGA in planning and project analysis and 72 man-months of locally-procured advisory services to the DGA sub-project teams in both the Lima office and the 2 Regional Project offices; 6) approximately $155,000 for long and short-term training of MOA staff. 7) an informally conducted on-farm demonstration program of technical assistance to benefitted farmers in efficiency of water use; and 8) approximately $250,000 to finance watershed planning studies.

The Project will be directed and administered by the DGA in the MOA, with primary administrative responsibility vested in the Dirección de Preservación y Conservación (DIPRECO). (See Organizational Chart, Part IV A.) DIPRECO engineers will draw up plans and specifications for the irrigation and drainage works in each sub-project, organize the local labor force for the construction of works in the sub-project areas, and provide necessary technical expertise and supervision of construction. DIPRECO will collaborate with the Dirección de Distrito de Riego (DDR) and DDR counterparts in the Agrarian Zonal Offices to set up strengthened regional irrigation offices in the two Project areas. The purpose of these regional offices is to assist in supervision of construction, to organize water-user associations in sub-project areas, to monitor routine operation and maintenance of irrigation systems, and to provide required technical assistance in water-use and on-farm improvements.

Participating with the DGA in implementation of the Project will be the Dirección General de Forestal y Fauna (DGFF-General Directorate of Forestry and Fauna), which will provide technical advice in designing and implementing the program of protective afforestation in sub-project areas.

Additionally, the AgBank will participate as financial agent for the special credit fund established for sub-lending to benefitted farmers.

The Project is designed with the objective of providing the optimum number and level of inputs to complete up to 27 integrated sub-projects to improve water and land use in two Project areas. These inputs will include construction materials and equipment, construction labor costs, tree plantings, credits for investments in on-farm improvements, staff and equipment for regional offices, and technical assistance in planning to the DGA and in efficient use of water to farmers.

Construction of small dams will enlarge capacity to store water for use in between rainy seasons and for regulation of water flow throughout the year. Construction and improvement of canal systems, including the installation of water weirs to measure and distribute water, will minimize loss of water through seepage and run-off and will assure efficient distribution of water. Construction of drainage systems will channel off excess water in low-lying areas for use as irrigation water and will serve to avert salinization of the soil. Afforestation of selected hillsides in sub-project areas will control soil erosion, conserve run-off rain water, and protect irrigation structures from landslides and torrential water courses during heavy rains.

The results of achieving these Project outputs -- an increase in on-farm water supply with a regularized flow throughout the year and an improved water distribution system -- will make possible the anticipated Project purpose, i.e . improved water and land use in the Project areas, through an increase in the total amount of sierra land in productive use, an increase in the crop yields on land already productive, and an assurance of adequate water supply which will encourage farmers to commit labor and costly agricultural inputs to what had heretofore been high-risk, rain-fed cultivation.

In addition, Loan-financed technical assistance and equipment, machinery, and materials, together with GOP budget and staff support, will be designed to strengthen institutional capacity in both Lima and at the regional level in the two Project areas in the identification, planning, and designing of sub-projects, the construction and supervision of sub-projects, the organization and administration of water user associations, and the monitoring of routine system operation and maintenance. The anticipated result of the placement of these inputs will be strengthened regional offices, with adequate support staff and equipment and machinery to perform on-going functions of providing necessary expertise and technical assistance to implement this Project and to assume increasing responsibility for the performance of field operations of the Lima office of the DGA.

D. Summary Findings

After working closely with the DGA staff in the design and feasibility study of this Project, the Project Development Committee is

confident that sufficient technical and management capacity exists to execute the Project effectively and efficiently. Given this determination, the Mission has decided to proceed with the Project after a careful examination of 5 sub-projects for technical, economic/financial, and social feasibility. These 5 are judged to be representative of all (up to 27) sub-projects to be financed under the Project in their technical, economic/financial, and social characteristics. Determination of their feasibility (summarized below and more fully presented in Part III - "Project Analyses") is considered by the Mission to reflect first, the existence of feasible sub-projects of this type in the Project areas; and, second, the capacity of the DIPRECO staff to identify sub-projects and to establish feasibility according to acceptable professional standards.

Project funds will be provided to finance an on-going process of sub-project identification and feasibility study while actual construction of previously analyzed sub-projects is undertaken, Moreover, since the current DGA program of operation allows for simultaneous sub-project study and construction, using distinct teams for each, this procedure is best adapted to the existing GOP implementation procedures.

1. Technical Analysis

The planning, design and cost calculation for construction which the DGA has done to date on the 5 sub-projects analyzed has essentially followed irrigation planning practice which has been used and refined in Perú over the past years and which is now accepted as standard for small irrigation projects. From the Mission's close working association with the DGA staff engineers, the Project Development Committee has concluded that they approach sub-project planning with professional competence in each of several engineering disciplines. Their field investigations have been in sufficient depth to assure that adequate data is available to their planning engineers for laying out all elements of irrigation and drainage requirements for each sub-project.

In their approach they make maximum use of Standard Designs. USAID/ENG has reviewed the DGA standard designs which will be used on these sub-projects and find them to be technically satisfactory. The technical soundness embodied in their standards indicates that when unusual conditions are met in the field during construction they will generally be quite capable of designing to meet those conditions. All new designs or modifications to existing standards made by the DGA will be reviewed by USAID engineers to assure their adequacy.

The DGA engineers normally develop their own construction specifications for each project rather than relying on Peru's standard construction specifications in use throughout the country. Their practice is to start with the closest applicable standard specifications

and re-write them tailoring
each paragraph to their particular requirments of the project or several sub-projects. USAID/ENG has reviewed examples of these specifications and find them technically sound and quite appropriate for the specific works for which they were intended for the 5 sub-projects analyzed. There is every reason to believe that the DGA will develop satisfactory construction specifications properly tailored to all the small sub-projects to be financed under the Loan.

2. Economic/Financial Analysis

The economic and financial acceptability of sub-projects will be determined through a sequence of 4 basic tests. The first, an economic rate of return to the economy as a whole, must be at least 15% to insure that the sub-project is an efficient use of the economy's resources. If a sub-project passes this first test, 3 financial rates of return will be tested: the first and second measure the financial incentives to the farmers in the sub-project areas, and show the rate of return to their labor, managment, and investment and the rate of return to their management and investment; a third measures the financial rate of return on the sub-project per se (not the incremental benefits) to insure that it will generate sufficient cash flows to repay any amortization costs.

5 representative sub-projects were submitted to this sequence of analysis, and each was found to have an economic rate of return of over 15%, thus demonstrating its utility to the economy as a whole, and sufficient financial incentives to the farmers to warrant the supposition that they will collaborate with the Implementing Agency in the construction and maintenance phases of Project implementation.

Analyzing the results of the economic and financial tests, it was found that in each case the sub-project will provide the following benefits to farmers in the selected areas:

(1) increase farm-generated income; (2) provide for expanded employment opportunities in agriculture; (3) increase overall production and expand consumption opportunities.

In terms of the macro-economic benefits to accrue to society as a whole, the Project will act to increase the amount of land suitable for agricultural production, increase yields on sub-project lands, allow for some multiple-cropping, and serve to reduce risks associated with agriculture solely dependent on rainfall. The combination of these will result in increases in agricultural production, most of which will be sold and consumed locally providing for increased food consumption in the Project areas. Moreover, both Project areas serve important urban areas-- the Mantaro area markets production in the

Lima-Callao metropolitan area, and Cajamarca markets to the northern coastal centers of Trujillo and Chiclayo-- and the growing population in each of these will insure that surplus production has a ready outside market. To the extent that this increased production can be substituted for currently imported foodstuffs, the Project will have a positive effect on Peru's balance of payments and foreign exchange situation.

3. Social Analysis

An analysis of 5 illustrative sub-project areas shows considerable interest in and community support for the proposed irrigation and drainage sub-projects. The awareness on the part of local farmers of their dependence on irrigation water supplies and the potential benefits from increases in these supplies is very well-developed in most of the communities to be benefitted by sub-projects, and, in general, enthusiasm for water-related projects is high.

Farmer experience in operating and using rustic, often highly inefficient, irrigation systems is extensive and surprisingly successful, contributing to a solid foundation of familiarity with at least the basic concepts of irrigated agriculture. Effective and quite sophisticated norms of communal organization exist in most communities providing a sound basis for efficient social organizational infrastructure for farmer participation in sub-project construction and assumption of responsibility for routine system operation and maintenance. In several communities, communal construction of water works and other infrastructure is currently underway with minimal, if any, outside assistance.

Some problems in inter-and intra-community cooperation exist, however, These problems spring from a variety of sources which can be expected to be common for most sub-projects in both Project areas; resentment against neighboring communities due to long-standing rivalries, or new rivalries created by land ownership changes effected under the Agrarian Reform; minor disputes over commonly-held land; and disproportionate benefits within and among communities accruing as a result of irrigation and drainage investments are the most frequent sources.

Such minor conflicts are inevitable in the Project, given its broad provision for extensive local participation and its significant socio-economic impact. The Project Development Committee believes, nevertheless, that the value of the Project derived from its social involvement and impact makes it worthwhile and possible to cope with these potential social conflicts. Moreover, the Committee is confident that the economic motivation for and awareness of potential benefits from participation in the Project is sufficiently powerful to outweigh the tendencies toward minor social conflict apparent in 2 of the communities studied.

The DGA staff is highly sensitive to these potential social conflicts and has indicated its interest in financing the services of experienced social scientists to advise and assist the regional staff in identifying and resolving them. With the DGA's careful collaboration with community leaders and local farmers, and with the financial incentives demonstrated in the rates of return analyses of sub-projects, the Committee considers the Project, as designed, socially feasible.

E. Project Issues

1. Responsibility for Project Administration - The issue of assigning central operational responsibility for Project administration (cited on pp. 16-17 of the IRR) has been resolved by limiting the selection of sub-projects to only those technically non-complex sub-projects the design and implementation of which are fully within the technical and administrative competence of the DGA. Consequently the final Project design does not envision any dependence on support and/or technical input from the General Directorate of Irrigation (Dirección General de Irrigaciones- DGI), which has responsibility for planning and executing large-scale technically complex irrigation projects. By excluding the need for DGI participation in Project implementation, then, the problem of devising adequate coordination among these MOA offices is obviated, as is the possibility of duplication of and/or conflict with a possible second-stage IDB loan tentatively programmed for 1978 to finance medium-scale irrigation projects to be administered by the DGI.

2. Respective Roles of Project and IDB "Linea Global" - As cited in the IRR (pp. 12-13), the IDB is currently financing medium-scale irrigation projects in the coast and the sierra, providing under a 1971 loan a $9.0 million contribution to a line of credit totalling $23.3 million. 12 projects have been identified and are being studied or are under construction, 7 in the sierra* and 5 on the coast. 10 of these, including all those in the sierra, are to be or are being constructed by contractors, all under the supervision of the General Directorate of Irrigation (DGI). The IDB staff in Lima expect that 2 more years are required before the loan will be completely disbursed.

In early 1975, the IDB and the GOP initiated discussion relating to the possibility of extending a second-stage loan to continue and expand activities begun under the "Linea Global" program. Shortly thereafter, the IDB expressed concern that the present Project, as proposed in the IRR, may duplicate or conflict with a second-stage "Linea Global," in the event such a loan was made. After several discussions with IDB staff in which USAID officials clarified aspects of the proposed A.I.D. Project design, the IDB was satisfied that activities under the A.I.D.

* 1 in Arequipa, 2 in Ayacucho, 1 in Apurimac, 2 in Cuzco and 1 in Puno.

Project would not disrupt or duplicate a continuation of the "Linea Global" program, given the following considerations.

First, "Linea Global" is under the exclusive supervision of the DGI, which, as noted above under Issue #1, is not expected to be participating to any significant extent in this Project. The dangers of duplication of efforts, straining existing DGI technical personnel capacity, and lack of administrative coordination are thus eliminated.

Second, the natures of "Linea Global" projects and those sub-projects to be financed under the A.I.D. Loan are quite dissimilar. Those financed under the IDB loan are of a medium scale and considerable technical complexity, requiring a degree of technical expertise and sophistication not anticipated to be required under the A.I.D. Project. Owing to this degree of complexity, dependence on outside contractors for both design and construction has characterized most of these "Linea Global" projects. The technical simplicity of sub-projects under the A.I.D. Loan, on the other hand, will permit reliance on the DGA staff both for design and construction and will maximize participation of local communities in sub-project implementation, which has not been contemplated under the IDB loan.

These factors clarify the respective roles of the proposed A.I.D. Project and of the current and proposed activities under IDB's "Linea Global," which have been judged by IDB and USAID officials to be quite distinct and independent. However, a minimum of coordination will be required in the identification of sub-projects under each loan to maintain the distinctive roles of each program, and USAID, in conjunction with the IDB, will take appropriate steps to assure collaboration between the DGA and the DGI on identification and selection of sub-projects under their respective jurisdictions.

3. Effect of the Agrarian Reform on Project Implementation - The GOP's Agrarian Reform program aims: i) to expropriate large holdings for the benefit of those who work the land and ii) to consolidate the minifundio into economically viable production units. These efforts may have an impact on implementation of this Project, In the short term, Agrarian Reform activities invariably create some instability of land tenure in affected areas and some confusion in the initial months of operation of newly-created production units. This disrupts agricultural production whenever an adjudication process is underway or only recently completed. (About one year is needed to finalize the adjudication process.) However, where the Agrarian Reform has established new production units, the aggregation and mobilization of small farmers in these new structure should, the medium-to long-term, remove the traditional structural constraints of latifundia and minifundia land tenure patterns and the short-term constraints imposed by instability and organizational disruption.

It is expected that most, if not all, of the sub-projects to be implemented under the Project will be in areas where adjudication of land-holdings affected by the Agrarian Reform has been completed, where determination of new boundaries for new production units has been made, if not formally adjudicated, or where official certificates of "non-affectibility" have been issued, indicating that no land ownership changes will be effected. Prior to USAID approval of individual sub-projects the Mission will require assurance that land ownership in the sub-project area is stable or has been firmly established.

4. Inclusion of Sub-lending Program - Reference was made in the IRR (p. 18) to the possibility of including under the Project a program of sub-lending to farmers for investments in on-farm improvements, including construction of distribution canals, water weirs, and land-shaping. This possibility was further explored in subsequent discussions with the DGA and the Ag Bank, which confirmed both the desirability and feasibility of such a program. (Please refer to Part II - B for a full description of the proposed credit program.)

5. Effect of Division of Ministry of Agriculture - Shortly before the IRR was submitted, the MOA was split into two Ministries: the MOA was charged with responsibility for carrying out the Agrarian Reform and for establishing norms and implementing programs affecting the use of renewable resources, while a new Ministry of Food (MOF) was created to increase the production of food crops and to design and implement programs for the processing and marketing of such crops. As noted in the IRR (p. 18), it was unclear at the time how this reorganization would affect the Project. Subsequent clarification of the delineation of responsibilities of the respective Ministries indicates that the Project lies entirely within the administrative competence of the MOA; the implementation of Project activities both in Lima and in the Project areas will be carried out by MOA staff.

6. Inclusion of Sub-Projects with a Power Component - An issue cited in the IRR (pp. 18-19) was whether or not to finance under the Project sub-projects which included the development of hydroelectric power potential. Since the selection of sub-projects was limited to those technically non-complex sub-projects within the DGA's designing and construction capacity, this issue disappeared. None of the selected sub-projects involve the development of hydroelectric power potential, so there is no need to provide for coordination with the Ministry of Energy and Mines.

7. Four-Year Loan Disbursement Period - While USAID/Perú fully recognizes the thrust of A.I.D's preferences for short (3-year) disbursement periods, the Project Development Committee, after careful consideration of this preferred option, determined that a 4-year disbursement period is appropriate for this Loan to assure quality Project

implementation. Several key considerations must be taken into account when reviewing this determination.

First, the activities to be undertaken in the context of the Project comprise what is essentially a comprehensive new GOP program, involving the establishment of new (or the significant strengthening of former) lines of inter- and intra-agency coordination. The principal institutional objective of the Project is to achieve a significant and much needed de-centralization of technical functions in water and land resource management. While this de-centralization is enthusiastically supported at all levels of the DGA,* functional de-centralization is a time-consuming effort, requiring careful execution of individual steps all along the way.

Moreover, such a process requires build-up of technical and administrative capability at the regional levels. In this Project, teams of experienced technicians will be created to work in the Project areas to carry on continuous identification and pre-feasibility studies of potential sub-projects, which has previously been done by Lima staff. These teams will progressively train and turn over to permanent field staff personnel those responsibilities, which will assure continuation of these activities beyond the life of the Project itself.

A second institutional development goal of the Project is that of up-grading the technical capacity of DGA Lima staff in planning, and, especially, economic analysis of water related projects. This, too, requires long-term training.

Particularly severe constraints to reducing the disbursement period are imposed by the nature of the sub-projects and the peculiar conditions of their implementation. First, some sub-projects will require the improvement of large areas which are already being cultivated. It can be expected that the work in the cultivated areas will be slower than in those areas which will be irrigated for the first time. Second, in pursuit of maximum employment effect and farmer participation in the Project, most of the sub-project workers will be farmers. We must expect that these will return to their farms from time to time in accordance with their traditional farm schedules and practices. This will undoubtedly lengthen construction periods required for sub-projects. Third, all sub-project construction will be under the harsh conditions imposed by the topography and weather of the Andean mountains. Each year from mid-December to March, construction in the Peruvian sierra slows down considerably. Heavy rains and floods often make it advisable to stop all field activities during this period. Consequently, based on the number of sub-projects which will be financed and characteristics of

* It was proposed in a 1973 report by the Sub-Dirección de Manejo de Cuencas which was officially adopted as a DGA proposal in 1974.

those already analyzed, USAID/ENG considers that the investment schedule submitted by DGA -- which covers a period from July 1976 to June 1980 -- is appropriate and realistic, necessitating a 4-year disbursement period of Loan funds for sub-project implementation.

B. DETAILED PROJECT DESCRIPTION

1. LOGICAL FRAMEWORK

Life of Project:
From FY 76 to FY 79
Total U.S. Funding $11.0 million
Date Prepared: September 1975

Project Title & Number Program for Improved Water & Land Use in the Sierra

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes: 1. Increase income & employment opportunities of the rural sierra population. 2. Increase food production in the sierra.	Measures of Goal Achievement: 1. Increase in imputed gross per capita income in the rural sierra 2. Increase in number man-days worked in rural sierra 3. Increase in total food crop production in the sierra	1. INP Statistics 2. MOL and MIO Statistics 3. ONERN baseline data 4. Project monitoring 5. Planning model developed under USAID agriculture grant program	Assumption for achieving goal targets: 1. High GOP priority to sector 2. High GOP priority to regions 3. No disruptive effects of Agrarian Reform 4. No adverse changes in real farm prices.
Project Purpose: Improve water & land use in the Project areas through: 1. Increase in productive land area 2. Increase in crop yields 3. Expansion of cropping alternatives 4. Increase in efficiency of water use 5. Reduction in soil loss from erosion 6. Strengthened technical capacity at regional level.	Conditions that will indicate purpose has been achieved: End of Project status: 1. 14,900 has. newly irrigated 2. 13,000 has. under improved irrigation 3. Increase in total production 4. Average increase in yields per ha. 5. Increase in length of growing season 6. More optimal cropping patterns	1. Agrarian Zonal Offices data 2. MOA and MOF Statistical Reports 3. AgBank data on sub-borrowers 4. Regional research centers' data 5. Project monitoring 6. Feasibility studies data 7. Evaluation conducted as part of watershed planning studies financed under Project	Assumptions for achieving purpose: 1. Adequate supply of seeds, fertilizers, water, credit, and technical assistance 2. Willingness and ability of farmers to use water efficiently. 3. Adequate research and extension services 4. Favorable climatic conditions 5. Absence of major socio-political instabilities or conflict.
Outputs: 1. New irrigation structures & canal networks 2. Improved existing system 3. Water wiers installed 4. Area drained 5. Dams to increase reservoir capacity 6. Forestry program 7. Regional Project Offices staffed 8. On-farm land development investments	Magnitude of Outputs: 1. 650 kms. of new canals 2. 500 kms. old canals improved 3. 1,500 has. drained 4. 8 dams built 5. 1,200 has. afforested 6. 2 offices established and staffed with irrigation & agronomist specialist & extension technicians. 7. $4 million sublending credit for on-farm land development	1. Statistical Offices of MOA & MOF 2. Project monitoring a) by AID & DGA b) by regional project offices c) by Zonal Offices 3. Sub-project feasibility studies data	Assumptions for achieving outputs: 1. Acceptance of sub-projects by local communities 2. Availability and adequacy of local labor 3. Adequacy of feasibility studies 4. Prompt availability of equipment, machinery, and materials 5. Willingness of trained MOA staff to work in regional offices 6. Consultants' availability and MOA approval 7. Adequate promotion of credit fund & effective demand for on-farm invest. cred.
Inputs: 1. USG: TA (Consultants, training, studies) Construction materials, machinery & equipment Tree plantings Contribution to special credit fund 2. GOP: Staff & offices TA to Regional Project Offices & farmers Local materials & equipment Local labor costs Local cost support of research, advisory, and evaluation services	Implementing Target (Type and Quantity): 1. TA Advisors in DGA 90 days after Loan Agreement signed. 2. Regional Project Office Staff in place 120 days after Loan Agreement signed 3. Equipment & materials purchased before 1st disb. for s-p construction 4. Tree planting purchased 5. GOP budgetary support for 77-78 biennium approved by mid-76 6. Credit fund in AgBank established by mid-76	1. Project monitoring 2. Contraloria reports	Assumptions for providing inputs: 1. Inflation within project estimates 2. AID/W backstopping 3. Timely GOP decree authorization of budgetary and staff support

Utah State University/USAID On-Farm Water Management Research-

El Salvador

Project Work Plan 1975-76[1/]

I. San Andres

A. Intensive irrigation trial on corn.

1. Third and final season of project involving drip and furrow irrigation, four irrigation levels and eight nitrogen fertilizer plots. (N treatments include 3 residual N rates from wet season sorghum trial, 1 continuous 150 Kg N rate every season, 4 current season N rates on plots with no residual N effects).

(a) Data collections: net total water applied in each irrigation treatment; periodic soil moisture tension each irrigation block; yield and protein content of corn.

B. Irrigation line source trial on corn.

1. Irrigation applied by sprinkler to provide continuous variable irrigation rate; 4 randomized N rates applied at right angles to line source water variable.

(a) Data collection. Water applied as function of distance from line source, corn yield, soil moisture tension.

II. Atiocoyo irrigation district

A. Pangola grass

1. Overhead sprinkler during dry season. Partial replication of 3 irrigation rates and 8 N treatments (including rate and frequency of N application).

(a) Data collection: net water applied to each irrigation treatment, total dry matter grass production on six or seven week growth cycles; protein content.

B. Point irrigation source trial on upland rice.

1. Circular plots, continuous water variable and 5 N rates.

(a) Data collection: net water applied as function of distance from point source; rice yield.

C. Line irrigation source trial on corn (tentative).

1. Two or three corn varieties having widely different maturity dates; 3 N levels; continuous water variable.

(a) Data collection: net water application as function of distance from line source; corn phenological development; corn yield

---

1/ Prepared by USU Staff.

III. Characterization of evaporative demand.

A. Lysimeter, maintenance and tabulation of data.

1. Santa Cruz Porrillo
2. San Andres
3. Atiocoyo

B. Other climatological data.

1. RH, T, net energy

IV. Summarization and reporting of research results.

A. Mostly during wet season when there will be no new field projects initiated. (Multiseasonal rice and pangola grass trials at Atiocoyo will be concluded during the wet season).

B. Publication of all ancillary crop and soil data (to be published in various forms as circulars, bulletins and technical journals).

1. Crop results
   - (a) San Andres
     - (1) Sorghum
     - (2) Tomatoe
   - (b) Atiocoyo
     - (1) Soya
     - (2) Beans
     - (3) Corn varieties
2. Soil and climatoc data
   - (a) Soil physical properties and colligative water relationship.
   - (b) Soil chemical data, especially nitrate-N soil test calibration.
   - (c) Evaporative demand data--Lysimeter, evaporation pan, climatology.

V. Educational and extension related activities.

A. Field days. During irrigation season to utilize demonstrational values in field trials.

B. Short courses and workshops. Number and content based on expressed interest in CENTA and DGRD.

Work Plan 1976-77 and ff

I. Summarization and reporting of research results.

A. Finalize ancillary projects carried over from 1975-76.

B. Publication of long-term or continuous field project results.

1. Pangola grass pasture.

2. Upland rice.

3. A general article on irrigated corn production management in El Salvador, including economics.

4. Modeling of irrigated corn yield potentials in El Salvador and contiguous contries.

(a) Predicting corn yields (in mass and economic terms) as a function of corn variety (days to maturity); residual soil nitrogen (soil test index); supplemental N; other soil fertility and chemical factors; irrigation method, rate, and frequency (rate and frequency as related to evaporative demand, total soil moisture storage capacity; and soil moisture release characteristics

II. Dry season irrigation demonstrations.

A. Crop production on private farms.

1. Two each corn trials in Atiocoyo and Zapotitan irrigation districts. Intensively managed in cooperation with land operators and agriculture officials in the irrigation districts.

2. Other crops and locations
Conducted exclusively by CENTA or DGRD extension personnel with suggestions from USU staff.

III. Education and extension.

A. Field days.
Examine demonstration plots and other irrigation activities.

B. Short courses and workshops.
Number and content based on expressed interest in CENTA and DGRD.

IV. Lysimeters and climatology

A. Maintain instrumentation and tabulate data.

V. 1977ff. Continuing assistance beyond project termination

A. TDY visits of USU staff to assist CENTA and DGRD in planning and conducting continued irrigation research and demonstration work.

Utah State University Staff Requirements

I. First year of proposed project extension

A. Full time staff

1. Tom Fullerton
2. Kern Stutler until July 1976

B. TDY

1. Charles Burt January-March 1976.
2. Rick Wells July-September 1976.
3. Al LeBaron, D. W. James, others as required, 2-4 weeks, each.

II. Second year of proposed extension

A. Full time staff

1. Tom Fullerton until August 1977
2. Replacement for Kern Stutler

B. TDY

1. Rick Wells, six months.
2. José Alfaro, three months.
3. Al LeBaron, D. James, others as required 2-4 weeks each.

III. Post project termination.

A. TDY

1. As requested through USAID, six man-months maximum (Engineer replacement for Kern Stutler may continue in El Salvador to end of his two-year assignment but he would be working also in other Central American countries.

/mrdc

50 %