

ANNUAL TECHNICAL REPORT
1976-1977

(Final Report for Grant Terminal Year)

IMPROVING CAPACITY OF CID UNIVERSITIES
FOR WATER MANAGEMENT
FOR AGRICULTURE

REPORT NUMBER VIII
COLORADO STATE UNIVERSITY

Grant No. AID/csd 2460
June 30, 1977



FOLIO
TA7
CG 75/76-11
CER-
ESBL

211(d) Final Annual Report

Date Due: June 30, 1977

Date: July 15, 1977

Grant Title:

OPTIMUM UTILIZATION OF LAND AND WATER
RESOURCES FOR AGRICULTURE: WITH SPECIAL
EMPHASIS ON WATER DELIVERY AND REMOVAL
SYSTEMS OPERATED UNDER CONDITIONS
CHARACTERISTIC OF DEVELOPING COUNTRIES

Grantee:

Colorado State University

Grant Program Director:

E. V. Richardson

Sponsoring Technical Office:

Technical Assistance Bureau
Office of Agriculture

Statistical Summary:

Period of Grant: 23 May 1969 to
30 June 1977

Amount of Grant: \$1,050,000

Expenditures for Terminal Year: \$127,686

Accumulated: \$1,050,000

Anticipated for Next Year:

Not applicable: Terminal Year

TABLE OF CONTENTS

	<u>Page</u>
I. NARRATIVE SUMMARY	1
A. Principal Accomplishments	1
1. Terminal Year	1
2. Life of Grant	1
II. DETAILED REPORT	4
A. General Background and Description of Problem	4
B. Purpose of Grant.	6
C. Objectives of the Grant	6
1. Objectives Restated	6
2. Review of the Critical Assumptions.	7
III. ACCOMPLISHMENTS	8
Introductory Statement.	8
A. Information Capacities, Objective/Output no. 1. . . .	8
1. Narrative Description	8
2. Targets for the Terminal Year	8
3. Accomplishments	9
a. Terminal Year	9
b. Accumulative.	10
c. Total Expenditures.	10
i. Terminal Year)	
ii. Accumulative.)Appen. D.	73
iii. University and Other Sources.)	
B. Education and Training, Objective/Output no. 2. . . .	11
1. Narrative Description	11
2. Targets for the Terminal Year	11
3. Accomplishments	11
a. Terminal Year	11
b. Accumulative.	14
c. Total Expenditures.	14
i. Terminal Year)	
ii. Accumulative.)Appen. D.	73
iii. University and Other Sources.)	
C. Expanded Knowledge Base, Objective/Output no. 3 . . .	15
1. Narrative Description	15
2. Targets for the Terminal Year	15
3. Accomplishments	16
a. Terminal Year	16
b. Accumulative.	19
c. Total Expenditures.	19
i. Terminal Year)	
ii. Accumulative.)Appen. D.	73
iii. University and Other Sources.)	

	<u>Page</u>
D. Advisory Capacity, Objective/Output no. 4	20
1. Narrative Description	20
2. Targets for the Terminal Year	20
3. Accomplishments	21
a. Terminal Year	21
b. Accumulative.	24
c. Total Expenditures.	24
i. Terminal Year)	
ii. Accumulative.)Appen. D.	73
iii. University and Other Sources.)	
E. Linkages and Networks, Objective/Output no. 5	25
1. Narrative Description	25
2. Targets for the Terminal Year	25
3. Accomplishments	26
a. Terminal Year	26
b. Accumulative.	31
c. Total Expenditures.	32
i. Terminal Year)	
ii. Accumulative.)Appen. D.	73
iii. University and Other Sources.)	
IV. IMPACT OF GRANT SUPPORTED ACTIVITIES IN ACHIEVING GRANT PURPOSE	33
V. OTHER RESOURCES FOR GRANT-RELATED ACTIVITIES.	37
VI. UTILIZATION OF INSTITUTIONAL RESPONSE CAPABILITIES IN DEVELOPMENT PROGRAMS.	41
A. Requests for Assistance (Tables III-A and III-B). . .	41
B. Specific Information.	45
1. Number of Foreign Graduate Students from LDCs . .	45
2. Number of On-Campus Visitors or Consultations . .	46
3. Known Use of Research Developed Under Grant . . .	47
4. Significant Graduate Roles.	48
5. Professors Working on Development Programs. . . .	49
a. Terminal Year	49
b. Utilization of Colorado State University's Competence.	50
6. Progress in Establishing and Maintaining Linkages.	50
7. Utilization of Institutional Response Capacities during and after Grant Expiration	50
VII. NEXT YEAR'S PLAN OF WORK AND EXPENDITURES ANTICIPATED (Not applicable: This year's report marks termination of grant)	51
VIII. INVOLVEMENT OF MINORITY PERSONNEL AND WOMEN	52
IX. TABLES I, II-A and II-B (Tables III-A and III-B shown in Sec. VI).	54

	<u>Page</u>
Appendix A--Original Grant Objectives.	59
B--Description of the Five (5) Objective/Outputs Specified for the CSU/211(d) Grant	62
C--Report Distribution.	69
D--Total Expenditures by Objective/Outputs.	72
E--Abstracts, Summaries, Introductions.	74
F--International School Students.	96
G--CSU Staff Consultants.	100
H--CSU International Education Activities	104

I. NARRATIVE SUMMARY

A. Principal Accomplishments

1. Terminal Year

Every effort was made during this year to complete all financial and other obligations under the 211(d) Grant contract which terminated June 30, 1977. Emphasis was placed on seeking alternative ways of continuing research work specifically related to water delivery and removal systems and practices applicable to the small farmers, and to concentrate on identification of simple systems easy to operate and maintain and best adapted to the varied conditions of LDCs.

2. Life of Grant

The first five (5) years of the grant were spent in improving the competence of the University in water delivery and removal systems while the last three years were spent in utilizing this competence. A characteristic of the first five (5) year period was the development of a strong interdisciplinary team approach to research in the full dimension of water resource problems as they pertained to the economic, social, and engineering fields of knowledge. During the period of competence development, Colorado State University increased its faculty by twenty-two (22) new professional personnel working in the area of water resources development of which thirteen (13) were fully or partially supported by University funds. The employment of these faculty enabled the participating departments to expand and greatly increase CSU's competence and capabilities in the grant area. As a result of new faculty, eighteen (18) courses were improved and eleven (11) new courses were added. Research on water delivery and removal systems was greatly expanded by a wide variety of new funding generated by the faculty as a result of the

grant funds. The 211(d) funds also stimulated a strong interest to develop an approach to research in the full dimension of water resources problems through delineation of research areas including joint research programs with the other participating universities. The interdisciplinary seminar held once a week for a two (2) hour period over a span of more than five (5) years was a strong factor in molding an effective interdisciplinary team approach to solving complex economic, social, and engineering problems in the agricultural area of LDCs. A prime example of this type of approach is the highly successful work of the CSU Water Management Team in Pakistan. Looking back on the five (5) year period, though there were many frustrations, it now appears that an excellent foundation was laid for technical assistance abroad. In the early days few professional educators were willing to undertake long or even short term assignments in foreign countries. The judicious use of 211(d) funds helped greatly to break down the existing barriers both as it pertained to the individual and to the entire university system which formerly was not too sympathetic to a professor leaving the campus for a tour of duty in a LDC. Further details of the first five (5) year period may be found in the Annual Technical Report for 1973-74.

With regard to the next three (3) year period to termination of the 211(d) grant, the comprehensive review of July 1974 by AID/W drastically changed the former thrust of the grant program at CSU, resulting in the elimination of generalized studies and activities in the field of water resources development, management and research. At this time, the emphasis was changed from one of increasing University competence to one of utilization of the developed competence. The most significant step taken was the channeling of institutional response capability away from

large and complicated water delivery and removal systems and practices to smaller and simpler systems more likely to win popular acceptance and make a major contribution to the improvement of the quality of life of the small farmer in the LDCs. To assist CSU to make the above changes, AID/W required each year's accomplishments to be reported by a specific set of five (5) objectives/outputs. These were basic to work plans and budget estimates developed for each of the three (3) year periods. A description of CSU's progress and accomplishments under 211(d) grant funding for the first two (2) years of the last three (3) years of the grant, may be found in Annual Technical Reports for 1974-75 and 1975-76. The third and final report is contained herein (1976-77).

II. DETAILED REPORT

A. General Background and Description of Problem

Water management has long been recognized as a problem, particularly in LDCs, but only in the last decade have International Technical Assistance Agencies given serious attention to the problem through funding of water related programs. Reports indicate that as much as 60 percent of the world's arable lands are deficient in soil moisture during all or some part of the growing season and that much of the remainder suffer from floods and lack of drainage.

In 1969, Colorado State University, Utah State University, and the University of Arizona received funds through the 211(d) Section of the Foreign Assistance Act of 1961 to increase competence in their selected field of interest within the entire water cycle. Colorado State University's emphasis was in "water delivery and removal systems including relevant institutional development;" Utah State University was in "on-farm water management;" and the University of Arizona was in "watershed management." The University of California joined the Consortium but was not a recipient of grant funds. Six years later Oregon State University and Texas Tech University joined the Consortium. This group of universities has been known as the Consortium for International Development (CID) for several years and is incorporated as a non-profit organization directed by an executive director selected by a board composed of representatives from each member university.

The field of study, research and concentration by Colorado State University sought to find the optimum utilization of water resources for agriculture with special emphasis on water delivery and removal systems and relevant institutional development. The relevance

of water delivery and removal systems and the need for expertise in this area to increase food production and benefit the small farmer was reflected in a statement recently published in an International Source Book on Irrigation and Drainage to the effect that in typical earth channels under usual conditions, about one-third ($1/3$) of the total water diverted would be lost by seepage, operational waste and evaporation. Actually, in many lesser developed countries, the proportionate loss of water is even larger because seepage and waste are greater. Poorly constructed and managed conveyance systems, over-irrigation, and many other factors contribute to the loss of irrigation water, which must be considered a vital resource in those areas of the world sufficiently arid to require irrigation for the land to be productive. This wastage and seepage of water not only is nonproductive but waterlogs the soil and results in the deposition of salts and minerals adverse to plant growth. Salinity, both as it affects the land and return flows, is a major factor in decreased food production through the loss of thousands of acres each year in the LDCs due to this problem alone.

Complicating the above is that too often, especially in developing countries, irrigation conveyance systems are only partially completed. For example, many dams, reservoirs, and large canals are skillfully engineered only to pass the water on to small farmers who must on their own, be responsible for the last few miles of a much lower standard and incompleted system. In addition, the terminal end of the irrigation system, the small laterals, and the on-the-farm distribution system all receive more sediment than they can transport. It is to this aspect of the problem that Colorado State University has and will continue to confine its studies for the improvement of these small conveyance

channels so important to the small farmer and consequently to the resolution of the existing world food problem.

Another problem is a lack of trained people for adequate transfer of water management knowledge. This lack of technology and information continues to be a deterrent to expanding food production.

B. Purpose of Grant

The overall purpose of the institutional grant program was to develop confidence and expertise within U.S. research and educational institutions to help solve critical water problems of less developed countries. The specific purpose of the CSU grant was to develop competence and expertise in water delivery and removal practices through a process of system analysis, with special emphasis on improving the quality of life of the small farmer in the LDCs. In addition, to cooperate fully with CID universities on problems of watershed management and on-farm water management.

Now that the end of the three (3) year period has been reached, and the 211(d) grant fund terminated, it has been determined by AID that CSU has reached the apex of institutional response capability in this specialized category and from now on can supply from its talent bank personnel on a world-wide basis without further 211(d) grant support. However, this viewpoint is not entirely shared by CSU, although every effort will be made by the University to maintain a high level of response capability.

C. Objectives of the Grant

1. Objectives Restated

The initial grant program (first 5 years) had as its main objective a broad scale plan to increase and expand the existing

competence of Colorado State University in the science and technology concerned with water delivery and drainage systems. The specific objectives as listed in the original grant document are stated in Appendix A, page 59.

After a comprehensive review by an AID/W team in July 1974, the original grant objectives were rearranged into five (5) objective/outputs. These are defined, including verifiable indicators, and important assumptions, in Appendix B, page 62.

2. A Review of Critical Assumptions

A principle critical assumption is that AID will work closely with the university in carrying out the mutually agreed upon objectives of the grant. This cooperation will include, but not be limited to, supplementary funding from AID for AID approved projects that utilize university competence, but do not fall within the funding scope and planning of the 211(d) grant. Such funding may be provided directly or through CID by a Basic Ordering Agreement, purchase order or other appropriate mechanisms. The assumption is made that AID will respond in a timely manner in the funding of approved activities.

It is also assumed that AID will assist the university in making appropriate contacts in LDCs, international research centers and elsewhere concerning efforts involving advisory services, research projects, training programs, symposia and other appropriate activities. Additional assumptions are shown in Appendix B.

III. ACCOMPLISHMENTS

Introductory Statement

During the past three (3) years CSU has channeled institutional response capability away from complicated water and removal systems to simpler practices which have proved to be far more practical and acceptable to LDC farmers. Thus, the AID objective of building university competence for the express purpose of utilizing that competence effectively in LDCs worldwide, has largely been accomplished. Hopefully, this level of competence/utilization at CSU can be maintained without future 211(d) grant support through the mechanisms of CID and viable LDC programs.

The terminal year accomplishments in order of the five (5) objective/outputs are as follows:

A. Information Capacities, Objective/Output no. 1

1. Narrative Description

See Appendix B, page 62 for description and definition

2. Targets for the Terminal Year

a. To reach a satisfactory and acceptable standard in computerized information storage and retrieval procedures which can be used interchangeably among the CID universities concentrating on hydrological and irrigation factors affecting agriculture and food production on a worldwide basis.

b. To incorporate within the regular CSU library system, the continuing practice of collecting and cataloging specific information on water delivery and removal systems useful for improving food production and living conditions of the small farmer on a world-wide basis.

c. To find a satisfactory means for the continued dissemination of water resources and management publications by CSU to interested national and international institutions without 211(d) grant funding.

3. Accomplishments

a. Terminal Year

— An information network called CIDNET was established last year by representatives from each of the CID universities. The first steps were taken by an exchange of journal lists among the member universities including computerized indexing of pertinent articles in selected journals, technical reports and book holdings. This index has now been designed to be fully compatible with the MUSAT index compiled at the University of California, Riverside. The computerized index limits its coverage in the main to the fields of hydrology and irrigation including items on food, agriculture and other resources deemed useful to developing countries. In October 1976, Marjorie Rhoades, Engineering Sciences Librarian, Barbara Burke, Engineering Sciences Branch Librarian, and Barbara Fraley, indexer-typist published a preliminary edition of an index to selected materials in CSU libraries, entitled, "Water and Soil in Arid Regions (WASAR)." This index consists of 641 pages and is divided into four (4) separate indexes (1) Subject, (2) Author, (3) Title, and (4) Geographical. By June 1977 the above library personnel had increased the listing to nearly 4000 entries. The complete set now consists of six (6) volumes broken down by author (2 vol.), subject (2 vol.) and geographical area (2 vol.).

— Colorado State University in cooperation with CID universities has and will continue to disseminate publications in limited quantities to LDC researchers and libraries, to FAO, AID missions and others. Throughout each year series of papers on such subjects as hydrology, hydraulics, water resources, economics, and agronomy are published by the various colleges of CSU, and the experiment station. Funds from the grant

are used to furnish these reports to participating CID universities, to LDC libraries, International Centers, and to AID. Some of these reports especially those produced by grant funds are sent to AID's office of publication and dissemination service in Washington, D.C. A sample of the distributing of reports documenting research results may be found in Appendix C, page 69. There remains, however, a real problem of how to fulfill requests for such library services from foreign countries. Assignment of responsibility and adequate funding are needed if this aspect of library service is to remain viable.

b. Accumulative

From the beginning of the 211(d) program, CSU has recognized the necessity of developing a computerized information storage and retrieval system, especially for the items relevant to the concerns of the grant. Librarians were trained in the skills required to implement the computer processes and collection of selected library materials was increased under the centralized control and funding of the general library system. These improvements resulted in CSU's ability to enter effectively into the CIDNET computerized information center making more easily available, in much less time and cost, valuable information formerly thought to be virtually unobtainable.

c. Total Expenditures

Please see Appendix D, page 73 for breakdown.

B. Education and Training, Objective/Output no. 2

1. Narrative Description

See Appendix B, page 62 for description and definition.

2. Targets for the Terminal Year

a. Continue to maintain and strengthen the International School for Water Resources and Associated Programs to provide training to professional personnel from developing countries who seek improvement of their capabilities.

b. Give a short course involving practical aspects of irrigation water delivery and removal systems, the concepts of which can be applied to the small farmer in LDCs.

c. Develop a course on project planning for the LDCs with emphasis on techniques for identifying, preparing, evaluating, and implementing water and other projects.

d. Cooperate with CID universities in reviewing courses, reports, or studies on watershed management, on-farm water management and other research aspects which are not considered CSU's primary responsibility.

3. Accomplishments

a. Terminal Year

— The International School for Water Resources and associated programs, administered by the College of Engineering and the Department of Civil Engineering, continued its excellent performance in providing, on a flexible basis, needed additional education for many professional personnel from around the world seeking improvement of their knowledge in order to return to their organization and perform their role in a more effective manner. The school is an interdisciplinary nondegree school for short or long term (2 weeks to 2 years) training of LDC people

in all phases of water resource including other phases of engineering and the applied sciences. Courses chosen for participants are selected because of their practical or applied nature. The International School has no faculty of its own, but utilizes the regular faculty in the various departments of the nine colleges on campus. The School is entirely state funded and no 211(d) grant funds are utilized.

Perhaps the most outstanding development in the School's program of continuing education is the departure from a relatively narrow field of instruction to a much broader base including the following academic fields:

- Water Resources and Development
- Hydraulic and Fluid Mechanics
- Hydrologic and Hydraulic Modeling
- Hydrology
- River Mechanics
- Water Resources Systems
- Groundwater
- Environmental Engineering
- Control of Air and Water Pollution
- Agricultural Engineering
- Agronomy
- Soil Science (Agricultural Soils)
- Urban Water Management
- Water Law and Related Administrative Aspects

Since initiation of the International School, students from forty (40) countries have participated in various school programs. Some of the programs were only for several weeks, others were for several years. Still others who so desired and had the requirements, were absorbed into the University system and went on to obtain a Masters or Ph.D. degree. Over the past several years, 96 students have enrolled at the International School for Water Resources and Associated Programs. During the reporting year seventeen (17) engineers, holding very responsible positions in their home countries, attended the International School. Six (6) were from India; two (2) from each of the following countries: Egypt, Ethiopia, and

Brazil; and one (1) each from Afghanistan, Cameroon, Thailand, Libya, and Botswana. A brochure giving detailed information is available upon request. Next year, Dr. Warren Hall will replace Professor V. Koelzer as the new Director of the School.

— Drs. Arthur T. Corey and Wayne Clyma, Agricultural Engineering, conducted a two-week summer course in August 1976 on irrigation water delivery and removal systems. This course was first given in 1975, repeated in 1976, and will be given again in 1977. The purpose is to observe many of the irrigation and drainage systems now in use in Colorado and to show how they can be adapted to similar world-wide conditions. The field trips covered commercial and experimental installation in Grand Canyon, The San Luis Valley, the Arkansas Valley, eastern Colorado, the Platte River, and the Grant Range.

— Dr. Willis W. Shaner, Mechanical Engineering, published a preliminary draft of his course on Project Planning for Developing Economics. The chapters follow his lectures on a course entitled Project Planning for the Developing Countries that have been given at CSU over the past four (4) years. The material in Project Planning for Developing Economics is suitable for middle and upper management levels for those responsible for project planning in the LDCs. The bulk of the students who have taken the course have either been from the developing countries or plan to work there on behalf of one of the aid-giving organizations. Discussions have been held with USAID officials about offering this course to USAID staff as well as to developing countries.

— At the request of the Direccion General de Agnas (DGA) in Lima, Peru Dr. Shaner and Dr. Warren Hall gave a short course in July 1976 in water resources engineering.

— Dr. Shaner was also requested to assist in the follow-up work for the program for improved water and land use in the Sierra of Peru in two (2) ways. One (1) to develop a computer program for analyzing the many sub-projects going into the overall loan program, and two (2) provide technical assistance during the implementation of the program. Details on both accounts are still being worked out.

— Dr. Shaner has an added responsibility at CSU having accepted the position of Associate Director of CID starting 1 June 1977.

b. Accumulative

Due to persistent refocusing on the real needs of developing countries, more effective and greater utilization of research results took place.

c. Total Expenditures

See Appendix D, page 73 for breakdown.

C. Expanded Knowledge Base, Objective/Output no. 3

1. Narrative Description

See Appendix B, page 62 for description and definition.

With regard to this category, emphasis during the terminal year was placed on state-of-the-art (SOTA) studies and, in so far as possible, to complete them before the end of the fiscal year.

During the past several years CSU has produced SOTA reports on (1) low cost water removal and low energy demand pumps, (2) sediment control in delivery systems, (3) water delivery-rules and procedures, (4) waterlogging and salinity and, (5) project planning.

From these studies, handbooks are in varying stages of development. The above topics are of great concern to LDCs and the practical application of research results are bringing major benefits to developing countries. Hopefully these SOTA studies and handbooks in the making can be completed through CID university contracts with LDCs. Though the primary responsibility lies elsewhere, CSU continues to cooperate with the other CID universities by participating in their SOTA efforts on (1) soil erosion, (2) water harvesting, (3) irrigation methods, and (4) water oriented food production technology.

2. Targets for the Terminal Year

- a. SOTA study on waterlogging and salinity problems
- b. SOTA study on conjunctive use of saline and non-saline waters
- c. SOTA study of irrigation in a LDC.
- d. SOTA study on water law and influence on an irrigation system
- e. Irrigation discharge study
- f. Reclamation and water management on saline-sodic soils study
- g. Appraisal of an irrigation scheme in a LDC

- h. Feasibility of an on-farm water management project in a LDC
- i. Project Planning for LDCs study
- j. Low energy demand pumps, pump efficiencies study

3. Accomplishments

a. Terminal Year

— The purpose of this Master's thesis, a SOTA study on Investigating Agricultural Waterlogging and Salinity Problems by Mark T. Svendsen is to detail a procedure for investigating waterlogging and salinity problems through centering on the nature of the water cycle on irrigated agriculture and the problems of waterlogging and salinity. The concept of water and salt budgeting is employed to identify data needs and to connect the various techniques described. The thesis does not attempt to find solutions. The technical information collected must be taken together with inputs of complementary social, political, and economic data before solutions can be developed. An abstract of the thesis may be found in Appendix E, page 74 of this report.

— The State of Agricultural Science for Conjunctive Use of Saline and Non-saline Water study by Dr. Maurice L. Albertson and Jim Riley of CSU is presently under review. The study points out that when only one or two irrigations with saline waters are needed, the damage from salinity may be much less than that which would have been caused by lack of irrigation water and therefore the possibility of the conjunctive use of saline and non-saline waters for the irrigation of crops is very much a reality.

— Some Aspects of Irrigation Techniques in Afghanistan by Mark T. Svendsen is an examination of the SOTA of irrigation in Afghanistan and its effect in constraining increased agricultural

production through discussing practices and problems which are fairly widespread. Examples are given to illustrate these points which are taken from different parts of the country. See Appendix E, page 74 for an introductory statement.

— A paper entitled Moslem Water Law and Its Influence on Spanish Water Law and the Irrigation System of Valencia was presented several years ago to the Seminario la Legislacion y Administracion de las Aguas en las Paises del Grupo Andion, Quito, Ecuador. For additional see Appendix E, page 74.

— Discharge through Inclined Gates. This is a Master's thesis by Chia-Shyun Chen. Four gates, one rectangular and three circular, installed at 45 degrees to the channel bottom, were investigated. See Appendix E, page 74 for an abstract of the thesis.

— The study, Reclamation and Water Management Studies on Coarse-Textured Saline-Sodic Soils in the San Luis Valley of Colorado was made by Dr. W. T. Franklin and Dr. Robert S. Whitney, Department of Agronomy, CSU. The report deals with the effects of water table levels; amendment and leaching applications; irrigation and irrigation rates; and fertilizers and fertilizer rates on soil reclamation and the yield of crops. For a summary and conclusions drawn by the report, please see Appendix E, page 74.

— The 211(d) grant project purpose is to maintain and sustain an institutional response capability in water delivery and removal practices and systems with special emphasis on improving the quality of life of the small farmer in the LDCs. During the terminal year two studies made in different LDC countries are very much in line with the grant purpose stated above. The first was An Appraisal of Technical Aspects of

the Rambukkan Oya Irrigation Scheme--Sri Lanka by Dr. E. V. Richardson of CSU and Dr. G. L. Corey of AID/W. The project purpose is to restore and enlarge an old dam and reservoir in the dry zone of Sri Lanka to irrigate about 6,000 acres of land on which it is planned to settle 2,400 landless families. For further information, see Appendix E, page 74.

— The second study, referred to in the preceding paragraph, is a feasibility report on an On-Farm Water Management Project for Egypt. This feasibility study was conducted by Drs. E. V. Richardson, W. Clyma, W. R. Schmehl, and W. W. Shaner all from CSU. Also participating was Mr. R. S. McCandliss representing AID/Washington. The report assessed and verified the feasibility of increasing agriculture production by changes to either water management or agronomic practices on the farm or both. Please see Appendix E, page 74 for additional information.

— In February 1977 Dr. W. W. Shaner published a draft for review report on Project Planning for Developing Economics. This has resulted from his long-standing interest in and involvement with project planning for the less developed countries (LDCs) and lectures given at Colorado State University over the past four years. The objective of the text is to give the reader a technical capability in project planning that: 1) fits in with the broad goals of a country's economic, social, and political development, 2) takes account of characteristics commonly encountered in the LDCs, 3) is based on the cash flow technique of analysis, and 4) is illustrated with examples of typical investments, while many of the examples refer to water resources, the engineering approach to cash flow analysis is sufficiently general that it can be reliably applied to other forms of investment. A case study of an investment in small-scale irrigated farming is presented. Here many of

the report's conceptions are applied in a practical way making it easier for the student to successfully apply the knowledge gained to situations in his own country. During the past several years Dr. Shaner has been doing some economic analysis of small scale irrigation projects in Peru using a computer program for evaluation. See Appendix E, page 74.

— Professor Robert Longenbaugh conducted a workshop on irrigation pumping costs December 1, 1976 at Fort Morgan, Colorado. The workshop was designed to discuss in detail the importance of pump efficiencies in reducing total costs and conserving energy.

b. Accumulative

The CSU policy of concentrating on the requirements of, and benefits of, the poor farmer in LDCs in regard to irrigation and drainage has taken real effect over the past several years.

c. Total Expenditures

See Appendix D, page 73 for breakdown.

D. Advisory Capacity, Objective/Output no. 4

1. Narrative Description

See Appendix B, page 62 for description and definition.

During the past several years, the grant funded a small amount of consultation time for emergency situations when individuals are needed on short notice and when other means could not be found or utilized without causing unacceptable delay for advisory and consultation work in LDCs. In addition grant funds were used for short-term consulting, for release time of faculty members for staff training; and for development, improvement and organization of the talent bank. Now that this type of funding has ended, it will be more difficult to provide the quick services that AID/W often wants.

Colorado State University worked very closely with CID during the terminal year in an advisory capacity and in helping to develop and provide expertise in problem identification and analysis, and in project design and evaluation. While grant funds were still attainable, over thirty-six (36) faculty members in such fields as civil engineering, agricultural engineering, watershed sciences, agronomy, and sociology, including specialists in dryland farming and on-farm water management were available for consulting work involving optimum water management for improved crop production in the LDCs.

2. Targets for the Terminal Year

a. Maintain advisory and consulting capability by responding to numerous requests from AID, CID, LDCs, World Bank, consulting firms, etc., as quickly as possible.

b. Provide release time making it possible for any professor to get away for a short period of time.

In the future, Colorado State University's ability to provide advisory and consultant capacity quickly may become increasingly restricted due to the lack of funds to replace 211(d) grant funding for this project.

3. Accomplishments

a. Terminal Year

— In March of 1976, Dr. E. V. Richardson, Civil Engineering Department, Director of the 211(d) grant project at CSU, led a team of scientists to Egypt to determine the feasibility of initiating an On-Farm Water Management Program. A project proposal (PP) was prepared and submitted to AID/W. The proposal was accepted and now scientists are being recruited. The other team members were: Drs. W. Clyma, W. R. Schmehl, and W. W. Shaner--all from CSU. Mr. R. S. McCandless also accompanied the team as a representative of AID/W. Like the very successful water management project in Pakistan, this project too may be considered typical of the many beneficial off-shoots of the CSU/211(d) grant program. For more details, please refer to Appendix E, page 72, stating the projects conclusions and recommendations.

— Dr. E. V. Richardson was asked to comment on the Varongay Water Project in the Philippines by AID/TAB. The PP originated in USAID/Manila. Dr. Richardson pointed out that CSU's main effort has been in developing a community effort to improve the utilization of irrigation water for increased agricultural production and has not been directed specifically at the development of cooperative domestic water systems to improve rural health. Dr. Richardson mailed a dozen or more water management reports and offered to help in any way possible in the project.

— Professor Robert Longenbaugh participated in an Energy Research and Development Administration workshop on energy conservation in agricultural production. The workshop was held in Washington, D.C., July 15-16, 1976. The workshop was divided into six (6) areas of expertise. Professor Longenbaugh was chairman of the Water Resources (irrigation) section. His group came up with twenty-six (26) recommendations for research topics but these boiled down to two areas of practical consideration: (1) improvement of water management and applications efficiency including use of irrigation scheduling, and (2) improvement of pumping plant efficiencies.

— In addition to the above, Professor Longenbaugh submitted a proposal to ERDA and FEA for funding on a study for "Evaluation of Energy Conservation from Irrigation Pumping Plants."

— During the reporting year, the professional personnel from CSU actively involved in the following AID/CID contracts are:

Dr. Kenneth Ellis	}	Agricultural Development in Bolivia
Mr. James Walker		
Dr. Anthony Hatch		Short-term consultant, Agricultural Development in Bolivia
Dr. Vearl Smith	}	Increased Productivity of Dryland Crops and Improvement of Livestock
Dr. Kenneth Brengle		
Dr. P. L. Crane		Kenya Food Crops Research Project
Dr. Herbert Mann (Chief of Party)		Niger Improved Crops Project

— The following CSU personnel developed the On-Farm Water Management proposal for Egypt--now accepted for funding by AID and being implemented through CID which has designated Dr. Richardson as the project coordinator:

Dr. E. V. Richardson

Dr. W. Clyma

Dr. W. R. Schmehl

Dr. W. W. Shaner

— A proposal by Dr. Charles Bonham and Everet Byington on "Planning Analysis Study for the Development of Range Livestock Projects" was mailed to AID/W January 7, 1977.

— Dr. George E. Radosevich, Associate Professor of Water Law, CSU, presented a paper "Legal Considerations and Alternatives to Organizing Water Users," at a workshop on implementing public irrigation programs held at the East-West Food Institute, Honolulu from 18-31 August 1976. The prime objective of the paper was to show how water users, individually and collectively, could improve themselves by providing a governing body with appropriate feedback so that realistic policies and programs could be formulated and implemented.

— Dr. George E. Radosevich spent thirty (30) days in Pakistan conferring with Pakistan officials and CSU personnel on agricultural and water organizations as well as to evaluate formal and informal arrangements for organizing farmers into water-user associations. He also spent a few days in Spain to obtain current information on the activities of water user associations and, in particular, the important rules and regulations adopted and employed by the associations for effective allocation and distribution of water. Dr. Radosevich is currently working on a SOTA report he is preparing for the 211(d) grant on water delivery rules and regulations.

— While not yet funded by the 211(d) grant, a paper on "Optimal On-Farm Allocation of Irrigation Water" by Jose Trava, Agricultural Engineer, Colegio de Post Graduados, Chapingo, Mexico; Dale F. Heermann, Agricultural Engineer, USDA-ARS, Fort Collins, and Dr. John W. Labadie, Assistant Professor of Civil Engineering, CSU, is of interest because of its potential for development. The paper points out that an irrigator must make many decisions in determining the date and volume of water to apply to each field. Scheduling programs that recommend the date and volume have been developed and used for assisting management through optimization of the on-farm allocation of water within the limits of available water and labor as indicated on one farm with forty (40) fields.

b. Accumulative

In a relatively short span of time, many CSU professors have gone from a rather reluctant stage of leaving the confines of the campus for even short periods of LDC consulting to one of genuine interest in serving the needs of developing countries in specialized capacities.

c. Total Expenditures

See Appendix D, page 73 for breakdown.

E. Linkages and Networks, Objective/Output no. 5

1. Narrative Description

See Appendix B, page 62 for description and definition.

Excellent relationships during the reporting year were maintained and strengthened with the networks of existing domestic and foreign organizations for the purpose of collaborating on problems of mutual concerns and joint problem solving through cooperative research and exchange and dissemination of information. During the early years of the grant, CSU was quite aware that its personnel were making most of the advances in establishing linkages with little or no response from the other party. Looking back over the past eight (8) years, it is almost incredible the progress made in this respect. Firm linkages are in evidence at the highest levels of LDC governments and strong efforts are now being made by many LDCs to maintain or strengthen linkages with CSU. Every effort will be made to maintain this level of relationships by whatever means may be available in future years.

2. Targets for the Terminal Year

a. Maintain a close, collaborative, and professional relationship with AID Missions, the Regional and Technical Assistance Bureau of AID/Washington in achieving the final purposes of the grant by the end of the year.

b. Cement the mutually helpful linkages already established with CID and the Tropical Soils Consortium to provide continuous coordination among the universities for the support of water research, development, and management on a worldwide basis.

c. Through "On-campus Coordinators" or LDC programs such as for the Water Management Project in Pakistan and for the newly approved

On-Farm Water Management project in Egypt, every effort, after the terminal grant year will be made to continue meaningful linkages with such institutions as FAO, OECD, CENTO, and AID working in water for increased food production in Africa, Near East, Middle East and Latin America or in other areas of the world if called upon for technical assistance. Attendance by CSU personnel at International Conferences and participation of CSU faculty in LDC projects have placed CSU scientists in the same field of activity with other scientists from other areas of the world thus strengthening linkages and broadening the network system. Lack of future funding by the 211(d) grant may make it more difficult for CSU personnel to participate fully in future International Conferences.

d. Linkages with institutions in LDCs will continuously be sought to be sure that CSU SOTA studies on water delivery and removal systems are relevant to LDC problems, particularly to food production and helping the small farmer.

3. Accomplishments

a. Terminal Year

— Completed integration of computerized index system with the MUSAT index of the University of California now known as CIDNET. The computerized index listing at CSU has grown to nearly 4000 listings. A complete set, at present, consists of six (6) volumes broken down by author, subject, and geographical area. A preliminary publication of the index listing WASAR was published and distributed to the CID universities, AID/W, and other institutions.

— The International School for Water Resources and Associated Programs is a continuing source of contacts and linkage building. Since its inception ninety six (96) highly placed engineers representing over

40 countries have participated in the School's educational program with a high degree of success.

— Dr. Warren Hall and Dr. William Shaner, at the request of the Direccion General de Aguas (DGA), Lima, Peru, gave a short course on Water Resources Engineering to their engineering personnel.

— Dr. Shaner attended the Organization for Economic Cooperation and Development (OECD) workshop on small scale energy sources for rural communities in developing countries, held in Paris, October 20, 1976. There he made a number of important contacts resulting in requests for CSU studies not only in water resources and development but also on solar, biomass, and wind-power energy.

— Dr. E. V. Richardson, who was originally scheduled to attend the OECD meeting in Paris, instead was asked to help make an appraisal of the technical aspects of the Rambukkan Oya irrigation scheme in Sri Lanka. He accompanied Dr. G. Corey from AID/W on this task. A number of new and important linkages were developed during the study period October 18 to November 5, 1976.

— During the past several years, Dr. Richardson has made a number of trips to Egypt. Last year a feasibility study entitled "On-farm Water Management Project for Egypt" was completed. Co-workers on the study included Drs. W. Clyma, W. R. Schmehl, and W. W. Shaner, all from CSU. During the reporting year AID/W approved and funded the project. Dr. Richardson, as of June 1977, was in Egypt conferring with high government officials concerning implementation of the project. Obviously many important linkages were developed both in Egypt and on-campus at CSU before the Egyptian government extended the invitation to participate.

— The highly successful efforts of the CSU team in Pakistan working on Water Management Research problems, particularly as related to the small farms and to increased farm crop production, has promoted the capabilities of CSU in this specialized field among important officials in the LDCs. The SOTA studies and handbooks underway will, when completed, serve to help quicken the pace of accomplishment in the future technical assistance projects undertaken by this and other CID universities.

— Dr. George E. Radosevich, associate professor of Water Law, Department of Economics, has developed important linkages around the world for CSU among specialists interested in water laws in an international aspect and how such laws affect agricultural production in various countries. He is presently working on a SOTA report on water delivery rules and regulations.

Other CSU international technical assistance activities and events occurring during the reporting year which have contributed to the building of a strong network of linkages, would include the following:

— In October of 1976 President A. R. Chamberlain visited National Taiwan University at the invitation of President C. H. Yen. While there Chamberlain met with Dr. Y. H. Tsiang, Minister of Education for the Republic of China to discuss the status of education in that country. President Chamberlain was accompanied by Dr. Grant S. Lee, assistant professor of Philosophy at CSU. Among the other universities visited were Tokyo and Kyoto Universities in Japan, Seoul National, Yonsei, and Ewha Women's Universities in Korea and Singapore University in Singapore.

— Lowell H. Watts, CSU Extension Service Director, was recently appointed to a key international committee on agricultural development by the U.S. Agency for International Development (AID) and the Board for International Food and Agricultural Development (BIFAD). The purpose of the Joint Committee is to extend the role of U.S. agricultural colleges and universities in helping developing countries solve critical food and nutritional problems. Watts has also served as assistant administrator of the federal Extension Service, USDA and as chief of party for two agricultural survey teams from CSU, one in northeast Brazil and the other in eastern Nigeria.

— Dr. Thomas M. Sutherland, professor of animal science, was selected to head the International Livestock Center for Africa (ILCA) at Addis Ababa. This is one of ten (10) research centers worldwide, all dedicated to solving world food problems by first filling local and area needs. These centers have been established by the Consultative Group on International Agricultural Research (CGIAR) sponsored by many developed nations, a number of U.S. Foundations, the UN, World Bank and other international groups.

— Dr. Cleon V. Kimberling, Associate Professor of Clinical Sciences, is the principle investigator and coordinator of the Kenya Veterinary Program which started in 1963 and continues today.

— Dr. Harold K. Hagen, Associate Professor of Fishery and Wildlife Biology, established an inland fishing project designed to develop a trout farming industry in Peru.

— Dr. Jack Altman, Professor of Plant Pathology was recently granted the Alexander vonHumboldt Foundation's Senior U.S. Scientist Award for his accomplishments in research and teaching. He

will spend one year at the Hannover Technical University in the Federal Republic of Germany lecturing and doing research. Dr. Altman has served previously in a technical assistance capacity in a number of middle-east countries.

— Sixty-five (65) foreign agricultural officials and educators from 19 countries participated in a program to provide a concentrated advanced level study in rangeland planning, grazing and forage management and improved practices.

— The following comments made in a GAO report last year would appear to support the basic reasons why CSU has also been successful in the international aspects of research and development in the LDC.

CSU is one of four universities reviewed in the federal government's General Accounting Office (GAO) investigation into some of the federal programs established in the 1960s to strengthen academic science.

That investigation, which was completed recently, also inquired into various factors accounting for progress by some of the universities competing for federal research and development funds.

CSU was reviewed because of strong administrative philosophy and operations relating to outstanding achievement in the receipt of federal research and development funding. It is one of 20 institutions that had experienced a more than 200 percent growth in this area during the 1964-1974 period. The other three institutions selected for review had schools of medicine which normally receive high funding for research work.

The GAO report cited the following factors accounting for growth in research and development at CSU:

"The administration is dedicated to research. The faculty feels no limitation from the school when pursuing research efforts. The administration is willing to gamble on hiring young researchers.

"CSU hired some top-quality researchers in a few areas, which enabled CSU to have a national impact in these areas.

"Some CSU researchers were able to obtain funds in areas of federal government interest. Many projects are weighted toward applied research.

"Federal institutional development grants enabled the recipient departments to build up their research capabilities.

"In one college a major effort was made to replace faculty members who had discouraged research with persons dedicated to excellence in research and education.

"Most CSU researchers are relatively young, and barriers between departments are low; it is therefore easier to develop interdisciplinary research."

b. Accumulative

Much of the credit for expanding the boundaries of educational outreach at CSU in the field of water research, development, and management--as well as in other fields--must be given to the Federal Government, which in the Foreign Assistance Act, and other Acts, has laid the groundwork and provided seed funding over the past several decades to stimulate universities to take part in helping the world to help itself through technical assistance. However, since most state governments are having an increasingly difficult time funding their own institutions, and universities are looking more and more to federal funding to carry on an ever expanding program of investigation and

research, the present supporting structure of university technical assistance to foreign countries could easily diminish if funding for international activities is not available.

Present day activities related to international education have grown to the extent that they are underway in practically every department and college of the CSU institution. This is an important factor in the growing ability of the University to make the kind and type of domestic and foreign linkages desired by the college or department involved. For further information on CSU's total international activity on and off campus, please see Appendix H, page 104.

c. Total Expenditures

See Appendix D, page 73 for breakdown.

IV. IMPACT OF GRANT SUPPORTED ACTIVITIES IN ACHIEVING GRANT PURPOSE

The various water resources programs of research and education at Colorado State University constitute one of the largest such graduate programs in the world, and of this a significantly large number of specific programs were committed to foreign research activities and were widely spread not only through the engineering sciences but also through such disciplines as economics and sociology resulting in increased competency, teaching capability, and better utilization of research findings. Past and present utilization of 211(d) grant funds played an important part in the development of capabilities in technical assistance to foreign countries in water research and management. For example, utilization of such funding brought opportunities for CSU faculty to visit foreign countries and participate directly with host country individuals on specific problems. As a result, there developed a great increase in the interest of faculty on world affairs as well as greater competence on the part of individual faculty members in directing advance degree programs of foreign students based on solving an aspect of water resources development or management problems in their own countries. The influx of foreign students during the past decade, attracted by the excellent water resources programs in research and education, produced many beneficial results such as: improvement of the libraries by the addition of water resources literature from other countries of the world; establishment of CIDNET making it possible to quickly obtain information from any of the CID universities; successful operation of the International School for Water Resources for a number of years; improvement of language instruction at the University through the teaching of English as a second language, and;

had a beneficial effect on recruiting and holding internationally known scientists available for teaching, directing research, and responding to LDC requests for technical assistance.

The prime purpose of the overall 211(d) grant program was to increase the competence of selected universities in water research, management, and development for the transfer of such knowledge to LDCs seeking technical assistance. Without a doubt the apex of the results of the 211(d) grant program at CSU lies in the present ability of the University to provide the kind and type of talent to support such a large and successful project as the Water Management Research Program in Pakistan; and now through CID, to help supply talent for the recently approved large national on-farm water management program in Egypt. This ability is the most significant impact the grant has made on the University.

Many of the following professors, now members of the water management research team in Pakistan, or who were former members, were originally brought to CSU and supported wholly or in part by 211(d) grant funding until assigned to Pakistan. Illustrative of the grant impact encouraging university participation in LDC technical assistance projects, is the water project in Pakistan. Dr. W. Doral Kemper, professor agricultural engineering and currently field party chief of the CSU/AID Water Management Research Program in Pakistan recently stated on the CSU campus, "Our mission is to help Pakistan develop a program of research and information for its farmers which will identify real constraints in their water management and food production, to develop and test means for eliminating those constraints, and to adapt methods for increasing food production to the resources available to

the farmers." Others of the CSU field party presently consists of Drs. Sidney A. Bowers, associate professor of agricultural engineering; Alan C. Early, assistant professor in the same department; Sam H. Johnson, assistant professor economics; John O. Reuss, professor of agronomy; and Tom Trout and Larry J. Nelson, Ph.D candidates. In addition to the above, the following men have served on the CSU field team for several years and have now returned to continue teaching responsibilities at CSU. They are: Dr. C. Jack DeMooy, professor of agricultural engineering; Dr. Wayne Clyme, associate professor of agricultural engineering; Dr. Jerry Eckert, assistant professor of economics, and Dr. Max Lowdermilk, assistant professor of sociology. Short-term personnel from CSU assisting the program both from the campus and on-site from time to time are: Dr. George Radosevich, specialist in Water Law and assistant professor in economics, Dr. David Freeman, assistant professor of sociology, and professor Gaylord Skogerboe, professor of agricultural engineering. Dr. Gilbert Corey, also from CSU, was the first chief-of-party for this project. However, he is now with AID in the Washington, D.C. office.

There is little doubt but that the 211(d) grant funds have had a major effect on turning some of the attention of a large university to assisting foreign countries in solving technical problems. Hopefully, this broadening of the University's horizons may be continued and the momentum gained so far may be maintained. Ways and means should be found for the CID universities to meet the present and future technical assistance needs of developing countries. While state and private funding are continually being sought, experience indicates such would fall far short of the required amount. If this should occur, hopefully

there would not be any lessening of the interest in applying the University's capabilities and competence in the International aspects of water resources development, management and research or willingness to respond promptly to AID/W requests for technically competent scientists for specific LDC tasks.

V. OTHER RESOURCES FOR GRANT-RELATED ACTIVITIES

Some of the other resources for carrying out grant-related activities would include many of the departments and units of the University, including the Engineering Research Center, Colorado Experiment Station, and other units such as the following:

1. One of CSU's educational facilities is the International School for Water Resources and Associated Programs, in existence since 1967.

This school is administered by the College of Engineering and the Department of Civil Engineering. It provides training in other phases of engineering and applied sciences, although an emphasis is still maintained on water resources. The School can adapt its educational program to fit the needs of the individual, though to begin with, a first degree is a requirement. A diploma is usually granted to those who successfully complete one or more years and a certificate to those studying less than a year. The School does not award degrees. A few qualified individuals sometimes transfer from the School to a regular degree program. About 50 percent of the school's participants to date have been supported through one of several UN agencies.

2. Another CSU educational facility is offered by the College of Agricultural Sciences known as the International Agricultural Program. AID/W is familiar with this facility through an agreement with the training division of USDA and AID. The agricultural program is designed to assist in coordinating and supporting programs involving foreign students, trainees, and visitors sponsored by AID/W, USAID/Missions, UN agencies such as FAO, UNDP, and other organizations in accordance with formal or informal agreements on a case by case basis. Most of the foreign students enrolled in the International Agriculture

Program are seeking degrees. Occasionally, a short summer course such as in Range Management, is offered permitting both degree and non-degree enrollment.

3. Another educational facility at CSU, not used before by foreign students, but which might be useful in the future to help meet the needs of foreign students, is the University Center for Continuing Education. The Center offers a wide range of educational opportunities both on and off campus to those continuing their education on a part-time or interruptable basis. The Center's flexible program is designed to meet specifications of individuals, groups, or industries as well as to provide traditional academic, degree-oriented courses.

4. Yet another educational facility is CSU's SURGE (Colorado State University Resources in Graduate Education). Here, videotape brings CSU's educational resources to business, industry, and research organizations.

5. The University also has an Office of International Education (OIE). Though this office is primarily concerned in teaching the American student in the general areas of international and intercultural relations, the size and scope of teaching and research activities greatly strengthens the growing educational program for the foreign student. Among the approximately 1,600 faculty members at CSU, more than 55 foreign universities in 26 countries are represented. In addition, numerous faculty members are very familiar with foreign countries and many return to foreign countries for continued study and research. Also, a number of CSU faculty members whose specialized training has been in areas of international concern, have distinguished themselves nationally and internationally. In addition, the Office of

International Education of CSU supports a Foreign Student Advisor who provides very valuable services to the foreign student. While the OIE is not primarily concerned with the foreign student, the program has had a favorable impact in making the campus a genial and helpful host to foreign students as well as to fulfill an important education and cultural attainment at Colorado State University. For more detail, please see Appendix H, page 104.

6. Colorado State University is the recipient of many contracts and grants from private sources, the State, and from the federal government. During the reporting year, sponsored research was the highest ever with about 700 projects. Many of these are water related, i.e., having elements of investigation into water development, water management, and various aspects of water research.

7. The Board of the Colorado Association for International Education (CAIE) is made up of participants from eighteen (18) universities, colleges, and institutions, seventeen (17) of which are in Colorado. The association is organized for the purpose of enabling the institutions of higher education to develop cooperative programs in the field of international education. At the present time CAIE is developing a computerized information retrieval system for the purpose of compiling an information bank of the international experiences, talents and interests of faculty members in the member institutions. This will identify those faculty members who are interested in activities and assignments of an international nature. It also identifies the competence and expertise available for international activities.

8. Major water related projects undertaken by Colorado State University sponsored by the State Experiment Station are as follows:

Water Resource Optimization

Experimental Practices, Return Flow, Salinity and Crop Yields

Systems of Management for Optimum Water Utilization

Drainage Design Criteria

Salinity Control Irrigation

VI. UTILIZATION OF INSTITUTIONAL RESPONSE CAPABILITIES IN
DEVELOPMENT PROGRAMS

A. Requests for Assistance (Tables III-A and III-B)

The utilization of institutional response capabilities as shown in Table III-A and III-B includes mainly AID-supported activities and the technical services of individuals supported in part by 211(d) grant funds. All AID-CID requests for assistance in LDC development programs are reported. See following pages.

TABLE III-A

Request for Assistance Received During Reporting Period July 1, 1976 to June 30, 1976					
A. Requests Attended					
Description of Request for Assistance	Whom Did You Assist?	Who Requested Assistance?	Who Founded Assistance?	Size of Effort Dollars Man/days	Results of Assistance
On-Farm Water Management-Egypt	Governments Farmers	Egypt	AID	\$ 5000 42	Arrangements to implement project with Egyptian Government
An Appraisal of Technical Aspects of the Rambukkan Oya Irrigation Scheme-Sri Lanka	Governments Engineers Farmers	Sri-Lanka	AID	\$ 4000 30	Preliminary steps taken to help settle 2,400 landless families
Short Course in Water Resources Engineering	Governments Farmers	Peru	AID	\$ 4000 30	Enlightenment of Government officials
Moslem & Spanish Water Laws	Governments Technicians Farmers	Ecuador	AID	\$ 1000 30	Better understanding of Water Laws and need for revision
Agricultural Development in Bolivia	Governments Farmers	Bolivia (AID-CID)	GOB/AID	\$1,382,800 7-year (Two men from CSU)	Increase production & improve marketing of food crops
Short-term Consultants Agr. Dev. in Bolivia	Governments Farmers	Bolivia (AID-CID)	GOB/AID	\$ 362,930 (One man from CSU)	Help to solve agricultural problems
Dry Land Crops Increase Cattle Improvement Farm Manager Training	Government Farmers	Iran (AID-CID)	GOI	\$ 280,000 (Two men from CSU)	On-going project.
Kenya Food Crops Research	Governments Farmers	Kenya (AID-CID)	AID	\$ 76,967 (One man from CSU)	Evaluation Report

TABLE III-A

Request for Assistance Received During Reporting Period July 1, 1976 to June 30, 1976					
Description of Request for Assistance	Whom Did You Assist?	Who Requested Assistance?	Who Founded Assistance?	Size of Effort Dollars Man/days	Results of Assistance
Niger Improved Crops	Governments Farmers	Niger (AID-CID)	AID	\$ 67,098 (Chief of Party-CSU)	Increased quality of life for farmer
Legal Considerations to Organizing Water Users	Governments Lawyers Farmers	Water users in various countries	AID	\$ 1000 7	Requests for additional information
Organizing Farmers to Improve Watercourses in Pakistan	Governments Farmers	Pakistan	AID	\$ 2000 30	Step forward towards realization of such activity (Social factors in irrigation improvement)

TABLE III-B

Request for Assistance Received During Reporting Period July 1, 1976 to June 30, 1976					
A. Requests Not Fulfilled					
Description of Request for Assistance	Whom Did You Assist?	Who Requested Assistance?	Who Founded Assistance?	Size of Effort Dollars Man/days	Results of Assistance
Improved Water and Land Use in the Sierra of Peru	--	Lower Level Echelon of Peruvian Gov't.	--	-- --	Under consideration by AID
Development of Range Livestock	--	--	--	-- --	Proposal under consideration by AID
Procedures and Methods in Irrigation Agronomy for Foreign Researchers	--	--	--	-- --	No response from AID/W
Evaluation of Energy Conservation-Irrigation Pumping Plants	--	--	--	-- --	No response from ERDA
Computer Program for Sierra Irrigation Project in Peru	--	--	--	-- --	Under consideration by AID
Optimal On-Farm Allocation of Irrigation Water	--	--	--	-- --	No response from AID
Identification of Water-logging & Salinity Problems in Irrigation Systems of LDCs.	--	--	--	-- --	Under consideration.
Training Materials for Pakistan Water Management Project Including Handbook & Water Management Seminar	--	Pakistan	--	-- --	Under consideration by AID.
Technical Services to Dryland Applied Research Team in Morocco	--	--	--	-- --	Under consideration by AID.

B. Specific Information

1. Following are several classifications of full-time foreign students registered at CSU as of the Spring Semester of 1976:

a. Alphabetical listing and number of foreign students.

Country	Number of Students	Country	Number of Students	Total By Categories Indicated Below	
Alphabetical listing of Foreign Students					
Afghanistan	5	Jordan	3	Total number of students	443
Algeria	2	Kenya	1	Total number of countries	69
Argentina	1	Korea	5	Total number of new students	173
Australia	5	Kuwait	7		
Austria	1	Lebanon	1		
Bangladesh	1	Lesotho	2		
Bolivia	1	Libya	34	PhD Candidates	145
Botswana	1	Malaysia	3	Master Candidates	221
Brazil	16	Mexico	14	Non-Degree	27
Canada	14	Micronesia	1	Undergraduates	49
China, Republic of	43	Morocco	1		
Colombia	5	The Netherlands	3		
Costa Rica	1	New Zealand	1		
Denmark	2	Nicaragua	4	Post-doctoral, Researchers, Visiting Faculty & Practical Trainees	56
Dominican Republic	1	Nigeria	7		
Ecuador	2	Norway	1		
Egypt	6	Peru	2		
Ethiopia	9	Philippines	3		
Finland	1	Poland	1		
Germany, Fed. Rep. of	1	Pakistan	18		
Ghana	2	Puerto Rico	2		
Greece	1	Saudi Arabia	29	Intensive English Students	25
Guatemala	1	South Africa	1		
Guyana	1	Spain	5		
Hong Kong	7	Sri Lanka	3		
Hungary	1	Sudan	9		
Iceland	1	Tanzania	3		
India	16	Thailand	15		
Iran	38	Turkey	2		
Iraq	16	Uganda	1		
Ireland	1	United Kingdom	4		
Israel	6	Vietnam, South	4		
Italy	1	Yemen	1		
Ivory Coast	1	Venezuela	28		
Japan	12				

2. Number of On-Campus Visitors or Consultations

No accurate statistics are available regarding on-campus visitors or consultations specifically related to water research, development or management. In many cases of individuals or groups visiting the campus or attending conferences sponsored by CSU, water is a vital component of topics discussed. For example, The Second International Conference on the Transfer of Water Resources Knowledge was held on the Campus June 30 through July 2, 1977. Approximately two hundred (200) people attended. The Third Fort Collins International Hydrology Symposium was held June 27-29 on Campus. About one hundred twenty (120) scientists participated. Another meeting, Institute on River Mechanics-Modeling of Rivers was held July 5-15, 1977. One hundred forty (140) people participated. For the three (3) conferences indicated above, it is estimated ten percent (10%) came from foreign countries. Other small conferences on campus sometimes are attended by a few foreign visitors interested in some phase of water management. A smaller number of foreign individuals or groups (less than 6) from such countries as Russia, Italy, Japan, Korea, India, Pakistan and from various countries in Central and South America visiting the campus primarily for water information might amount to one hundred (100) or thereabouts. Some of the above foreign visitors were directed to the University by CSU contacts or linkages with foreign personnel interested in water research or development or by U.S. federal agencies having water management responsibilities.

3. Known Use of Research Developed Under Grant

a. Training of librarians in computer indexing and listing of nearly 4000 entries, mainly in the field of hydrology and irrigation and published under the title, "Water and Soil in Arid Regions (WASAR)". The computerized listing is immediately available to all CIDNET universities.

b. Training of students in irrigation and drainage systems showing how they can be adapted to similar world-wide conditions.

c. For about five (5) years, Dr. Willis W. Shaner has been giving lectures at the University and in LDC on the economics of project planning. As a mechanical engineer and an economist he was particularly well qualified to integrate the practical aspects of engineering and economics in LDC. During the reporting year Dr. Shaner published a report on "Project Planning for the Developing Economies".

d. Dr. Shaner also was directing the Ph.D. program of three (3) Ph.D. candidates from foreign countries on project planning for developing economies at the time he accepted the position as Assistant Director of CID with headquarters at Logan, Utah.

e. It is assumed that the following SOTA studies have added something to the store of knowledge, and hence its utilization, in both domestic and foreign countries. These studies are:

- * "Investigating Agricultural Waterlogging and Salinity Problems"

- * "Some Aspects of Irrigation Technology in Afghanistan"

- * "Moslem Water Law and Its Influence on Spanish Water Law and the Irrigation System of Valencia"
 - * "Legal Considerations and Alternatives to Organizing Water Users"
 - * "Discharge Through Inclined Gates"
 - * "Reclamation and Water Management Studies on Coarse-Textured Saline-Sodic Soils in the San Luis Valley of Colorado"
- f. Known use of research findings have resulted in:
- * AID funding of the project, On-Farm Water Development Project for Egypt
 - * Possible restoration and enlargement of an old dam and reservoir in Sri Lanka.

4. Significant Graduate Roles

a. Following is a brief list of recent graduates supported at least partially by 211(d) grant funds who have assumed positions of leadership and responsibility in government, the educational field, or in the private sector:

Herbert G. Blank, Ph.D.--Engineer in charge of village and municipal water supply projects, USAID Mission to the Yemen Arab Republic.

Lee Ann Ross, M.S.--International Development Intern, now serving USAID in Yemen Arab Republic.

Lemme Wendim-Agegnehu, Ph.D.-- Bechlel, Inc., San Francisco.

Catherine E. Kroeger Rovey, Ph.D.--Private Consulting Firm, St. Louis, Missouri.

Della Lara Bennett, Ph.D.--Plans Teaching Career.

Darrel M. Temple, M.S.--USDA-ARS

Alan D. Wood, M.S.--SCS

A.M. Melone, M.S.-- Western Canada Hydraulic Laboratory, British Columbia.

b. Following is a brief list of master degree graduates who were partially supported by grant funds and who have decided to go on for Ph.D. degrees at the institutions mentioned:

Chia-Shyun Chen, College Station, Texas A & M.

James A. Riley, CSU.

Stephen W. Smith, Research Associate, Agricultural Engineering, CSU.

Janakiram Subramanian, IBRD/W, will return soon to CSU.

Mark T. Svendsen, Cornell University.

5. Professors Working on Development Programs

a. Terminal Year

Dr. Everett V. Richardson, Dir.

Dr. Warren A. Hall

Dr. John W. Labadie

Prof. Robert A. Longenbaugh

Dr. George E. Radosevich

Dr. James F. Ruff

Dr. Willis W. Shaner

Prof. George L. Smith

The above and other faculty members eligible for advisory or consulting service are listed in Appendix G, page 100, including for each a brief statement of field of expertise.

b. Utilization of Colorado State University's
Competence

Much of this aspect has already been discussed in Chapters III, IV., and V as well as in this Chapter (VI) item 3 (Known Use of Research).

6. Progress in Establishing and Maintaining Linkages

Please see Chapter III, section E, Linkages and Networks, page 25.

7. Utilization of Institutional Response Capacities
during and after Grant Expiration

This subject has been discussed a number of times in the text and may be summarized briefly as: excellent CSU response capacity during the grant years, but there exists some doubts about future response capacity after termination of the grant.

VII. NEXT YEAR'S PLAN OF WORK AND EXPENDITURES ANTICIPATED

This section is not applicable as this report covers the terminal year in the CSU/211(d) grant period. A request for a NO COST extension of the grant was not approved by AID/W.

VIII. INVOLVEMENT OF MINORITY PERSONNEL AND WOMEN

For many years CSU has made a conscientious effort to add minorities and women to faculty and graduate students to the University. CSU has had more success with students than faculty because there are very few technically trained minorities and women. However, the numbers of both categories are gradually increasing under CSU policy and in time there should be a far better distribution within the staff and faculty.

Several approaches are being used by CSU in regard to this problem. One approach is the cooperative venture between Colorado State University and Colorado High Schools in a science motivation program. Selected students are brought to the campus for a four (4) week period (fully paid) during which time they are taught by professors and exposed to university life. The colleges participating are: College of Engineering, College of Forestry and Natural Resources, College of Natural Sciences, College of Agriculture, and the College of Home Economics. The long range goal of the program is to expand science educational opportunities by increasing admission and enrollment of talented minority students into science programs at CSU as well as other institutions of higher learning.

Another University approach is through Project GO which became a part of the CSU program in 1968. This is a special needs program for minority and low-income students who otherwise may not attend college. It provides counseling, tutoring, referral services and disseminates information of interest to these students.

There has been a significant increase in the past five (5) years in the number of women enrolled in engineering. For example several

years ago two (2) women engineers received their Ph.D degrees in Water Management and now there are a greater number than ever taking advanced degrees. By transfer from Utah State University, the College of Engineering has enrolled Nancy L. Adams, a graduate in Agricultural Engineering under the 211(d) grant program. She is scheduled to serve in Egypt under the On-Farm Water Management project recently approved.

Within the last few years, the following U.S. minorities have been involved in the program:

	Faculty	Graduate Students	Undergraduates
Women	5	4	4
Blacks			
Spanish Americans	2		
American Orientals	6	3	

IX. TABLES I, II-A and II-B

Table I shows the distribution of 211(d) grant funds and contributions from other sources of funding for the reporting period July 1, 1976 to June 30, 1977.

Table II-A shows the 211(d) actual and projected expenditure for the reporting year (Terminal Year).

Table II-B shows the detail expenditures for the reporting year.

TABLE I

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

Reporting Period 1 July 1976 to 30 June 1977 Terminal Year.

Grant Objectives/Outputs	221(d) Expenditures		Non 211(d) Funding** Amount
	Period Under Review Terminal Year	Cumulative Total End of Grant	
1. Information Capacity	10,380	127,055	101,000
2. Education and Training	24,494	183,608	50,500
3. Expanded Knowledge Base	55,524	320,361	1,010,000
4. Advisory Capacity	14,198	312,281	20,200
5. Linkage and Networks	23,090	103,459	30,300
Total	127,686	1,046,764***	1,212,000

TOTAL

* These figures are best estimates

** Other AID projects are included

*** Includes Support to CID.

TABLE II-A
211(d) Expenditure Report
Actual and Projected Summary
Under Institutional Grant AID/csd-2460
Reporting Period 1 July 1976 to 30 June 1977

	Expenditures to date		Projected Expenditures						
	Reporting Period	Cumulative Total			Year				
			1	2	3	4	5	6	7
	1976-77		1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
Salaries	79,522	497,066	55,460	53,587	84,594	79,566	66,506	48,413	29,418
GRA	10,194	255,377	21,977	37,044	59,695	52,426	29,374	18,850	25,817
Travel	3,799	73,021	4,351	19,470	13,188	16,232	3,334	6,916	5,731
Equipment	7,565	12,543	213	3,118	--	96	--	826	725
Office Expense and Computer	3,727	129,055	13,132	19,291	28,082	33,465	30,292	--	1,066
Library and Publications	10,198	48,786	6,077	1,188	9,515	3,604	5,518	1,487	11,199
Subcontracts	12,681	30,916	--	--	--	--	--	8,235	10,000
Totals	127,686	1,046,764 ^{1/}	101,210	133,698	195,074	185,389	135,024	84,727	83,956

^{1/} This amount does not include \$6833 obligated by the project's first director and carried over to his successor's budget of \$300,000. The overencumbrance at the end of the project's terminal year is \$3,597.

TABLE II-B
211(d) Expenditure Report
Reporting Year Detail
Under Institutional Grant AID/csd-2460
Reporting Period 1 July 1976 to 30 June 1977

I.	A.	<u>Professional</u>	<u>% of Time</u>	<u>Salaries</u>
		M. E. Becker	12	1,909.09
		W. A. Hall	22	11,655.85
		J. W. Labadie	8	1,889.25
		R. A. Longenbaugh	17	4,556.14
		G. E. Radosevich	32	9,633.00
		E. V. Richardson	40	15,655.35
		J. F. Ruff	9	2,400.14
		W. W. Shaner	49	14,487.33
		G. L. Smith	12	3,183.33
				<u>65,369.48</u>
	B.	Clerical		1,582.21
		Library		4,960.50
		Other nonprofessional		-0-
	C.	Fringe Benefits - Retirement only		7,610.21
		10.64% of Gross Salary		
II.	<u>Student Support</u>	<u>Country</u>	<u>Amount</u>	
		S. R. Abt	U.S.A.	393.75
		C. S. Chen	Taiwan	1,800.00
		J. V. Domenick	U.S.A.	3,900.00
		C. A. Craig	U.S.A.	300.00
		T. St. Sheng	Taiwan	3,500.00
		M. Svendsen	U.S.A.	300.13
				<u>10,193.88</u>
Grand Total: Professional and Student Support				89,716.20

TABLE II-B (continued)

III. A.	Consultants	-0-
B.	Guest Lecturers	-0-
IV.	Travel	
A.	Domestic (7).	3,799
B.	Foreign (4)	-0-
	Total	3,799
V.	Equipment.	7,565
VI.	Library Acquisitions, Training & Publications, i.e., Thesis & Dissertations, Reports, Papers, etc.	10,198
VII.	Other	3,727
	Telephone 195.44	
	Postage 743.34	
	Computer 2,688.87	
	Miscellaneous 99.53	
	Subcontracts	12,681
	Grant Total	127,686

APPENDIX A

Original Grant Objectives

OBJECTIVES AS STATED IN THE ORIGINAL GRANT DOCUMENT

The initial grant program had as its main objective a broad scale plan to increase and expand the existing competence of Colorado State University in the science and technology concerned with water delivery and drainage systems. Increased competence in teaching and in research activities were to be developed as follows:

Specific objectives

- a. Expand its professional staff in the various departments of the University which are now involved, or which would like to be involved, in water resources activities related to the needs of the less developed countries.
- b. Expand its number of graduate students in these departments from or interested in, the less developed countries.
- c. Expand its departmental research programs and activities related to the needs of the less developed countries.
- d. Expand its course offerings in these departments--including interdisciplinary courses--which are related to the less developed countries.
- e. Expand special activities, and initiate new ones, in the United States and abroad which are related to research, teaching, and service--e.g., seminars, exchange programs, institutes, conferences, and publications which are concerned with the less developed countries.
- f. Help to alleviate the critical shortage of qualified personnel with international interests, experience, and expertise, and with cross-cultural insights.
- g. Expand its capability to serve in advisory and consulting capacity to various individuals, government agencies, industries,

business, and other organizations who have an interest in activities abroad. It would be understood, however, that substantial specific services in this area will be funded by AID and any other sponsoring agencies under separate contractual arrangements.

h. Improve its understanding of the nature of less developed societies, and find ways and means of assisting them to resolve crucial problems relating to water resources development and management.

i. Develop an exchange of personnel and publications, and other programs of interaction, which will help to establish steady and effective lines of communication between Colorado State University and the less developed countries.

APPENDIX B

Description of the Five (5) Objective/Outputs Specified
for the CSU/211(d) Grant

Description of the Five Objective/Outputs Specified for the CSU/211(d) Grant
Project Purpose

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Project Purpose			
To maintain and sustain an institutional response capability in water delivery and removal practices and systems with special emphasis on improving the quality of life of the small farmer in the LDCs. In cooperation with CID to focus on problems of watershed management and on-farm water management.	<p>a) Colorado State University is recognized as a center of excellence for information, personnel, adaptive research and knowledge on water delivery and removal systems, watershed management and</p> <p>b) Continuous and significant involvement and linkages with LDC institutions.</p> <p>c) Linkages and networks with other significant institutions working on food production problems in the LDCs.</p>	<p>a) Peer evaluation</p> <p>b) Record of utilization</p> <p>c) Annual report</p>	<p>a) That additional capabilities by staff increases or improvements will result in a gradual increase in utilization.</p> <p>b) Utilization will increase available funding and staff capabilities. These in turn will increase utilization.</p> <p>c) That meaningful problems will be identified in the LDCs and adequate adaptive research will be performed.</p>

Information Capacity, Objective/Output #1

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Output 1			
Information Capacity. Collection evaluation and dissemination of information related to water resource utilization.	a) Distribution of reports documenting research results. b) Expand printing and publication capabilities of CSU. c) Increase the size of the library collection on water delivery and removal systems. d) A developed information storage and retrieval system.	a) Annual report and on site visitation. b) Receipt of publications c) Documentation of data storage and retrieval programs.	a) LDCs, CID and donor agencies will provide inputs and utilize the information system.

Education and Training, Objective/Output #2

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
<p>Output 2</p> <p>Education and Training.</p> <p>Design, develop and strengthen education and training programs in the field of drainage and delivery of water to the small farmer. The primary purpose is to help meet the need and demand in the LDCs for such training.</p>	<p>a) Development and revision of courses</p> <p>b) Increase of students from LDCs in both conventional graduate training and International School for Water Resources.</p> <p>c) Development and presentation of short courses and training sessions on drainage and delivery of water to the small farmer.</p> <p>d) Development of contracts to improve training in LDCs research institutions and universities.</p> <p>e) Seminar in an LDC on soil and water management for erosion control.</p> <p>f) Development of legal and administrative constraints on water delivery and removal practices.</p>	<p>a) Annual report with specific numbers and examples of accomplishments.</p> <p>b) Number of students and countries using International School.</p> <p>c) Final reports on seminars or conferences.</p> <p>d) Symposium proceedings.</p> <p>e) Manuals developed for short courses.</p>	<p>a) There is a need and demand in the LDCs for the training and education so that funds will be provided for students to participate in the training.</p> <p>b) Cooperation by LDC institutions for training and education programs.</p>

Expanded Knowledge Base, Objective/Output #3

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
<p>Output 3</p> <p>Expanded Knowledge Base.</p> <p>Emphasis will be placed on state-of-the-art and problem identification relating to small farms in LDCs.</p>	<p>a) Identification and evaluation of practices utilized by LDCs in water removal and delivery systems.</p> <p>b) Design and adapting new techniques for water removal that have low energy demand, can be utilized by small farmers and existing irrigation projects.</p> <p>c) Adaptive research on water delivery to small farmers that decrease water loss and improve crop production.</p> <p>d) State-of-the-art reports on water delivery and removal systems and relevant institutional development.</p> <p>e) Studies on salinity control to increase crop production and decrease loss of land from production.</p> <p>f) Low cost and energy demand pumping methods for both drainage and water supply. State-of-the-art reports on pumping systems.</p> <p>g) Handbooks on the design of drainage systems, salinity control, sediment handling methods, operation of irrigation systems, etc.</p> <p>h) State-of-the-art report on sediment problems at lower end of the irrigation system.</p>	<p>a) State-of-the-art reports.</p> <p>b) Annual report.</p> <p>c) On site observations.</p> <p>d) Utilization of both research results and staff doing the research.</p> <p>e) Requests for reports.</p> <p>f) Increase in food production.</p> <p>g) Peer review.</p>	<p>a) Effective help from AID, Research projects, and LDCs in identifying problems or needs and conducting the research, etc.</p> <p>b) Continue interaction by 211(d) directors with AID, LDCs and CID to identify research priorities.</p>

Advisory Capacity, Objective/Output #4

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
<p>Output 4</p> <p>Advisory Capacity</p> <p>Advisory and consultant capability for AID, LDCs, consulting firms, World Bank and other donors. Provide release time, allow faculty to respond quickly to a consulting request.</p>	<p>a) Over 36 faculty are available for consulting an optimum water management for improved crop production. These are in the fields of civil engineering, irrigation engineering, watershed sciences, on-farm water management, agronomy and dryland farming.</p>	<p>a) Annual report documenting requests for consultants.</p> <p>b) Trip reports.</p> <p>c) Final project reports.</p> <p>d) Peer evaluation.</p> <p>e) Donor recommendations.</p>	<p>a) There is a need for these consulting services.</p> <p>b) That the availability and talent at Colorado State University is known by the potential user.</p>

Linkages and Networks, Objective/Output #5

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
<p>Output 5</p> <p>Linkages and Networks</p> <p>Linkages and networks with institutions concerned with water resource utilization for food production. Emphasis on water removal and delivery.</p>	<p>a) Establish or strengthen our linkages with institutions working in water for food production in Africa, Near East, Pakistan and Latin America.</p> <p>b) Strengthen our linkage with the other members of CID.</p> <p>c) Establish very close relations with the other 211(d) directors in the water chain.</p> <p>d) Establish a network of institutions working on water and water related problems for food production in the LDCs.</p> <p>e) Establish linkages with the centers and consortiums working to increase food production to help the small farmer.</p>	<p>a) Annual report</p> <p>b) Number of joint programs, seminars and training programs that have been developed with other institutions.</p>	<p>a) AID assistance and support.</p> <p>b) The cooperation of the other institutions.</p> <p>c) Linkages and networks provide an effective basis for utilization of institutional capacity.</p>

APPENDIX C

Report Distribution

Sample of Distribution of Reports Documenting
Water Delivery and Drainage Research Results

July 15, 1976	Eight textbooks sent to Ghana Water and Sewerage Technical School, Accra, Ghana.
July 20, 1976	Letter from Office of Program Planning, TAB/AID requesting continued views and collaboration.
July 20, 1976	Copy of "Small Water Storage and Erosion Control Dams," mailed to Dr. J. M. Kramer, Department of Watershed Management, University of Arizona.
August 20, 1976	Copy of Wood's thesis on pumps mailed to Dr. Garg, Allahabad, India.
August 24, 1976	Mailed copy of Wood's report to Mme. M. Tanzer, Special Counsellor for Scientific and Technical Cooperation, Paris, France.
September 3, 1976	Two copies of Optimal Irrigation Decisions by Herb Blank sent to Government offices in Romania and Mexico.
September 7, 1976	Purchase of text, "Fertilizers, Crop Quality and Economy," by Elsevier for CSU library.
September 9, 1976	Circular from E. V. Richardson's office to Engineering Research Center Faculty, CSU, for share textbooks for Ghana students.
September 13, 1976	Fifteen CSU water publications sent to the Indonesian Moslem Library, Bogor, Indonesia.
September 17, 1976	Mailed to the USDA National Agricultural Library, Beltsville, Maryland, Water Management Technical Reports Nos. 1 through 41, 43, 45. All future publications will be mailed.
September 23, 1976	Four copies of Water Management reports mailed to Institute for Agricultural Research, Zaria, Nigeria.
September 27, 1976	Six textbooks sent to a student in Ghana.
September 27, 1976	Two copies of a water report mailed to VITA volunteers in Technical Assistance, Mt. Rainier, Maryland.
October 22, 1976	Letter by E. V. Richardson to Ghana Water and Sewage Tech. School offering to send four or five textbooks upon official request from the school's library

November 2, 1976	Mailed one copy of a water report to Monsieur Yves Lambert, Ministère de la Coopération et Groupe de Recherche sur les Techniques Rurales, Paris, as result of Dr. Shaner's attendance at the October 20 meeting of OECD in Paris.
November 2, 1976	Copies of Pumping Report and other material given to Dr. Shaner for forwarding to president, International Development Research Center, Ottawa, Canada.
November 2, 1976	Copies of several reports given to Dr. Clyma for Classroom use, CSU.
November 10, 1976	Letter by E. V. Richardson expressing willingness to a Ghana student to sent textbook to the Ghana Technical Library.
November 17, 1976	Mailed two sets of available 211(d) reports and two sets of Water Management reports to the U.S. AID Representative, c/o U.S. Embassy, Colombo. The 211(d) reports were mailed in 12 numbered packages and the Water Management reports in 10 numbered packages.
January 6, 1977	Sent two (2) boxes of Science magazines to Dr. K. A. de Alivis, Land Use Division, Dept. of Irrigation, Colombo, Sri Lanka.
January 10, 1977	Textbook "Problems in Applied Hydrology," delivered to Rudolpho Ramos of the Divisao de Ciencias Atmosfericas, Brazil.
January 17, 1977	Mailed copy of WASAR to H. Hocde, G.R.E.T., Paris.
January 17, 1977	Copy of WASAR sent to Consortium on Soils of the Tropics.
January 26, 1977	Sent a training manual to a student in Ghana. Again E. V. Richardson requested the student to ask the technical school to send him an official request for specific textbook or water report material.
February 14, 1977	Mailed two Water Management reports to Department of Soil and Water Engineering, Punjab Agricultural University, Ludhiana, India.
February 25, 1977	E. V. Richardson answers request from a Ghana student for EE books.
March 3, 1977	A copy of the CSU Water and Soil in Arid Regions (WASAR) Index (3000 entries) sent to USAID/ Nairobi, Kenya.

APPENDIX D

Total Expenditures by Objective/Outputs

TOTAL EXPENDITURES BY OBJECTIVE/OUTPUTS

Chapter III, Paragraph C, items i, ii, & iii

Objective/Outputs, #1, 2, 3, 4, 5

	Information Capacity, #1	Education & Training, #2	Expanded Knowledge Basis, #3	Advisory Capacity, #4	Linkages & Networks, #5	TOTAL
Terminal Year	10,380	24,494	55,524	14,198	23,090	127,686
Accumulative	127,055	183,608	320,361	312,281	103,459	1,046,764
University and Other Sources	101,000 The total expenditure for this item was for staff salary, book and periodical purchases and printing costs.	50,500 The University now completely supports such activities as the 1) International School of Water Resources, 2) open seminars, and 3) new courses originally developed to carry out the objectives of the 211(d) grant objectives.	1,010,000 The above estimate of university expenditure in the field of water for agriculture is probably conservative.	20,200 Federal funding a major entity in this category	30,300 This could shrink noticeably if not for federally funded programs.	1,212,000
GRAND TOTAL						<u>2,386,450</u>

APPENDIX E

Abstracts, Summaries, Introductions

<u>211(d) Terminal Year Publications</u>	<u>Page</u>
Feasibility Report: On-Farm Water Management Project for Egypt. . by E. V. Richardson W. R. Schmeh W. Clyma W. W. Shaner R. S. McCandliss Cairo, ARE, April 1976	76
An Appraisal of Technical Aspects of the Rambukkan Oya Irrigation Scheme--Sri Lanka by E. V. Richardson G. L. Corey CSU, November 1976	79
Water and Soil in Arid Regions (WASAR) (An Index to Selected Materials in CSU Libraries) by Marjorie Rhoades Barbara Burke Barbara Fraley CSU, October 1976	81
Project Planning for Developing Economies. by W. W. Shaner CSU, February 1977	82
Investigating Agricultural Waterlogging and Salinity Problems. . . by Mark T. Svendsen CSU, July 1976	86
Some Aspects of Irrigation Technology in Afghanistan by Mark Svendsen CSU, January 1977	87
Discharge through Inclined Gates by Chia-Shyun Chen CSU, Spring 1977	89
Reclamation and Water Management Studies on Coarse-Textured Saline-Sodic Soils in the San Luis Valley of Colorado. by W. T. Franklin Robert S. Whitney CSU, October 1976	90
Moslem Water Law and Its Influence on Spanish Water Law and the Irrigation System of Valencia. by George Radosevich CSU, July 1976	92
Annual Technical Report 1975-1976 (Summary of Principal Accomplishments) Improving Capacity of CID Universities for Water Management for Agriculture Report No. VII CSU, July 1976	94

Feasibility Report
ON-FARM WATER MANAGEMENT PROJECT
for
EGYPT

E. V. Richardson, W. Clyma, W. R. Schmehl, W. W. Shaner
R. S. McCandliss

INTRODUCTION

To assess and verify the feasibility of increasing agriculture production by changes to either water management or agronomic practices on the farm or both a team of specialists (Agronomist, Agricultural Engineer, Water System Engineer, Engineering Economist) and AID Coordinator visited various areas in Egypt; interviewed various in-country experts (GOE officials, Ford Foundation scientists, FAO scientists, etc.) and studied various reports. The following is the feasibility report on this study. The report gives 1. team conclusions, 2. team members, 3. areas visited, 4. people interviewed, 5. reports studied, and 6. observations. The report is in summary form because major report effort was in drafting a Project Paper for a project titled "On-Farm Water Management."

CONCLUSIONS AND RECOMMENDATIONS

1. The team concludes that existing on-farm water and agronomic technologies are available for farm application in Egypt.
2. That some of these technologies are presently being applied on the farm (i.e., fertilizers, crop rotation) but that many are not. The amount of water applied to a crop is not managed by either the farmer or by the government. The government tries to control the amount applied but neither the farmer nor the government apply the correct

water amount for maximum crop yields or for control of drainage requirements. Neither know how much water is being applied, lost or wasted.

3. That on-farm management project should be implemented in Egypt.
4. Irrigation methods, on-farm problems, agronomic practices, soil types, cropping systems, etc. are different in various sections of the country. Thus, an on-farm water management project should have programs in more than one area.
5. The project should have the following major components:
 - A. Soil, water, crop, farmer on-farm interaction. This component is to determine, by measurement, interviews, and observations, what is going on at the farmer level in the agriculture system in selected areas by trained people.
 - B. Improvement of on-farm water-management practice. This component will be in adaptive research and demonstration program of known technologies in selected areas.
 - C. Irrigation district delivery and removal system water budget. This component is to determine the quality and quantity of water entering and leaving an irrigation district and several of its distributaries.
6. With one slight exception, the three areas (Mallawi, in Minya Governorate, Mansouria, in Giza Governorate and Sakha in Kafr El Sheikh Governorate) selected by the Government of Egypt and AID/ Cairo are excellent sites for the project. The one exception is Mallawi District. Because tile drains are scheduled to be installed in this district in 1979 the team suggests the project area be moved to the Abu Korkas District which is the next district north of Mallawi in Minya Governorate.

TEAM MEMBERS

Dr. E. V. Richardson	Professor of Civil Engineering Colorado State University
Dr. W. R. Schmehl	Professor of Agronomy Colorado State University
Dr. W. W. Shaner	Associate Professor of Mechanical Engineering Colorado State University
Dr. W. Clyma	Associate Professor of Agricultural Engineering Colorado State University
Mr. R. S. McCandliss	AID/Washington

AN APPRAISAL OF TECHNICAL ASPECTS OF THE RAMBUKKAN OYA
IRRIGATION SCHEME - SRI LANKA

E. V. Richardson and G. L. Corey

The Rambukkan Oya irrigation scheme will restore and enlarge an old dam and reservoir in the dry zone of Sri Lanka to irrigate about 6,000 acres of land. The scheme is located on the Rambukkan Oya (Stream) between Palaturuella and Pulaveli in the northern part of Monaragala District. The area is presently sparsely settled, depends on slash and burn rainfed agriculture, and lacks roads, schools, health services and other civic amenities. Presently less than 1 percent of the land area is used. About 2,400 families, presently landless, will be settled on the 6,000 acres to be irrigated.

Elements of the scheme consist of (1) physical infrastructure, (2) social infrastructure, and (3) resettlement. The physical infrastructure includes restoration of the dam, construction of irrigation canals and a diversion dam (anicut) construction of roads and land clearing and leveling. Some of the social infrastructure and resettlement aspects of the project include training of farmers in irrigation agriculture, development of proper water management, development of communities, health services, and schools.

The proposed reservoir will have a catchment area of 50 square miles, and will inundate 1,700 acres and have the storage volume of 40,000 acre feet at full supply level (FSL) of 244.0 MSL of which 2,500 is dead storage dedicated to sediment. The weighted average rainfall in the catchment area for 27 years is 84.7 inches of which about 60 percent falls in the months of October through February. Monthly average evapotranspiration exceeds monthly average rainfall 7 months of the year.

And even during the monsoon season (October to February) there are years with some months where average monthly evapotranspiration exceeds the average monthly rainfall.

The average annual yield at Rambukkan Oya dam site is 117,874 acre feet with a maximum of 200,528 acre feet and minimum of 33,000 acre feet.^{1/} These figures were obtained by adjusting the records at the gauging station 5 miles downstream. The drainage area at the gauging station is 62.0 square miles vs 50 square miles at the dam site. The period of record is 27 years from September 1947 to October 1974.

The Government of Sri Lanka (GSL) has conducted extensive field, laboratory and office investigations of the project, approved the project after preparing a feasibility study, and is now in the process of final design and economic analysis. These will be completed by the end of the year. The Government of Sri Lanka (GSL) has requested AID to finance the foreign exchange costs of the scheme. This report is an appraisal of the technical aspects of the irrigation works, water management, land utilization, construction methods, costs and environmental factors. The report is based on a two-week visit to Sri Lanka where the site was visited and extensive discussions were held with the Director of Irrigation, Deputy Director for Planning and the specialist involved in the design and implementation of the project. For further details not covered in the report the PID should be referred to.

^{1/}Revised from PID totals

INTRODUCTION

Water and Soil in Arid Regions (WASAR) is an index and guide to books, conference papers, journal articles, government documents and technical reports within the appropriate subject areas and held by Colorado State University Libraries. The index is comprised of bibliographical citations of selected items dealing with soils, water, arid lands, crops, foods and nutrition and deemed to be of interest in developing countries. Certain economic, political, ecological and historical parameters have also been included.

The information needs of developing countries and of those who serve them, as we perceive those needs, are the prime criteria for inclusion.

Use of the Index

WASAR is divided into four separate indexes, any one of which gives the complete citation with the CSU library location noted. You may search by (1) Subject, (2) Author, (3) Title or (4) Geographical Location. Call numbers have been included for convenience. Those readers having access to The Colorado State University Libraries can find the books, journals, conferences, technical reports and government documents on the library shelves by using the call number as given.

Those who use this index and are at a distance from the Colorado State University Campus may be able to find the indexed materials in a library more easily accessible to them. They are also available from this and other locations by normal Interlibrary Loan channels through your local library.

Requests may be addressed to:

Engineering Sciences Branch Library
Interlibrary Loan Department
Engineering Research Center
CSU - Foothills Campus
Fort Collins, Colorado 80523 U.S.A.

Response to requests will necessarily vary depending on the bibliographical nature of the material needed. Library copies, when loaned, must be returned at the end of the loan period. Xerox copies, to be kept by the user, may be supplied for a fee.

D R A F T

PROJECT PLANNING FOR DEVELOPING ECONOMIES

by

W. W. Shaner

(First four (4) pages of Preface Only)

The subject of economic development, when taken in its pure form, is extremely complex. Cause and effect relationships are still largely speculative, despite the flood of literature on the subject. The breadth of factors to be taken into account is great, encompassing disciplines such as anthropology, sociology, political science, economics, agriculture, engineering, and so forth. Any attempt to reach a fully satisfactory approach to the many development issues is bound for failure, at least in the near term. At the same time the urgency to do something concrete and on a broad scale, and to do it quickly, is becoming more and more apparent. One of the principal categories of development is that of project planning, which forms the basis for much of the aid programs supported by the United Nations, World Bank, regional development banks, and bilateral donors.

The nature of project planning is such that it requires interdisciplinary input from a number of contributors for even relatively modest-sized investments. This present text was prepared with the desire to provide a means of instruction for those with diverse backgrounds who are likely to become involved in this type of work. The material that follows is the result of my long-standing interest in and involvement with project planning for the less developed countries (LDCs). The chapters follow my lectures on a course entitled Project Planning for the Developing Countries that has been given at Colorado State University over the past four years. Much of the emphasis in methodology reflects

my experiences with this type of work while I was with the projects wing of the Imperial Ethiopian Government's Central Planning Commission.

In teaching this subject, I have found the need for a text that introduces the beginning student briefly and yet incisively to key areas of development planning. These areas, to my way of thinking, include the characteristics of LDCs, elements of macroeconomic and project planning, basic cash flow analysis, shadow pricing, indirect consequences, means for handling welfare objectives, and financial analysis. While other topics might be included, such as manpower training and organization theory, the above topics form a reasonably cohesive package that can serve as the basis for further study and analysis by those interested. In fact, experience in teaching follow-on courses reveals the need for good grounding in these basics before attempting to learn the procedures of more complex texts such as the Organization for Economic Cooperation and Development (OECD) manual by Little and Mirrlees, the United Nations Industrial Development Organization (UNIDO) manual, or the more recent work of the World Bank by Squire and van der Tak.

The material presented herein, when supplemented by selections from the references, problems, and questions at the end of the chapters and by case studies of the type developed by the Economic Development Institute of the World Bank, is sufficient for a three-credit semester course at the graduate level. The graduate level is suggested, not because individual portions of the material are particularly difficult, but because a certain level of academic maturity is needed when combining the many diverse subjects of the course into a meaningful whole. The material is also suitable for instructions at the middle and upper management levels for those who are responsible for project planning in the LDCs. The bulk of the students who have taken the course have been

either from the developing countries or plan to work there on behalf of one of the aid-giving organizations.

The objective of this text is to give the reader a technical capability in project planning that:

- fits in with the broad goals of a country's economic, social, and political development,
- takes account of characteristics commonly encountered in the LDCs,
- is based on the cash flow technique of analysis, and
- is illustrated with examples of typical investments.

The engineering economy approach to cash flow analysis, with suitable adjustments, is extensively relied upon because of its high degree of refinement and ability to handle most investment-type decisions. Many of the examples refer to water resources, but the approach is sufficiently general that it can readily be applied to other forms of investment.

The approach of the text takes the following form:

- while many of the concepts are derived from economic theory, little time is spent with abstract theory; instead, emphasis is given to the application of economic concepts to investment decisions often confronting engineers, managers, and technicians with formal training in economics; economists will recognize the underlying theory, but will probably find the tools of analysis somewhat new,
- analysis procedures are derived from compound interest formulas that are not mathematically complex,
- little is formally done with optimization, although the concepts lend themselves to such possibilities as will be illustrated in a few cases,

- the techniques of analysis are those generally being employed in the Western World by the United States, English, Swedish, German, French, and other governments, and by international organizations such as the World Bank and the Interamerican Development Bank, and
- the approach is considered politically neutral and can be applied to decision-making in countries with vastly different political philosophies; the end product of applying the approach is improved decisions concerning investments over which the government has authority or influence.

ABSTRACT OF THESIS

INVESTIGATING AGRICULTURAL WATERLOGGING AND SALINITY PROBLEMS

The world's agricultural systems will be called upon to double their production of food and fiber during the next thirty years. A primary impediment to achieving this goal is the twin problem of waterlogging and salinization of agricultural land. Removing this impediment requires a methodology for the systematic study of the nature, seriousness, extent, and sources of the problem. This paper attempts to develop such a methodology by drawing on existing knowledge and incorporating it into a logical investigative framework.

Background information on the agricultural water use model is presented and the nature of the problems caused by waterlogging and salinity is described. An investigative approach is described whereby an agricultural system is delimited and then broken down into water delivery, water use, and removal and drainage subsystems. The general concept of water and salt budgeting is used to define data needs and to identify linkages among system components.

Appropriate techniques for measuring the quantity and quality of relevant surface and ground water flows are then presented, with special attention being paid to the farm water-use subsystem which is the heart of the irrigated agricultural enterprise. Finally, water and salt budgets for each subsystem and for the system as a whole are developed and presented as a means of integrating the data collected.

Mark T. Svendsen
Civil Engineering Department
Colorado State University
Fort Collins, Colorado 80523
July, 1976

SOME ASPECTS OF
IRRIGATION TECHNOLOGY IN AFGHANISTAN

by

Mark Svendsen

Afghanistan is a variegated, landlocked country of high mountains, narrow fertile valleys, broad steppes, and deserts located at the heart of Central Asia (figs. 1,2). It is a harsh and austere land, the home of 12 million people¹ 80 to 90 percent of whom depend directly upon its soil for their livelihood. Still, in the words of an Afghan proverb, "Each man's country is his own Kashmir", and Afghanistan remains one of the few countries in Asia never to have been a European colony.

As a partial result of this distinction, it has no railroads, no heavy industry, and only rudiments of a banking and credit system. What it does have is a fiercely independent population and a highly specialized system of agricultural technology and social, political, and religious institutions evolved over centuries in response to relatively static conditions. This steady-state situation, however, no longer holds. One indication of this is the fact that Afghanistan has become a net importer of wheat, the staple food grain, and after centuries of rough balance between birth and death rates, now has a population that is increasing at about 2.3% per year.

This paper is an examination of the state-of-the-art of irrigation in Afghanistan and its effect in constraining increased national agricultural production.

¹Official government figures give a population of 17.6 million. A demographic survey currently being conducted by a State University of New York (SUNY) team, however, will probably show a figure of 11 or 12 million to be more realistic when it is released.

Water, of course, is not the only constraint operating to restrict increased production, but it is one of the more important ones. That the farmers themselves realize this is indicated by the fact that land prices for adjacent plots of irrigated and unirrigated land may be 100 times greater in the case of the former.

In the remainder of the paper, I will sketch briefly the context of the irrigation problem in Afghanistan and describe the three types of irrigation systems being used at the present time. I will also suggest modifications in some cases, based on experimental results and on my own experiences and observations. It should be noted at the outset, that data on all of the topics covered below are extremely sketchy and in many cases, simply rough approximations. It should also be emphasized that conditions and irrigation practices differ greatly throughout the country. I have not attempted to draw regional distinctions, as the basic data for this are simply non-existent. I have attempted to discuss practices and problems which are fairly widespread and have drawn examples to illustrate these points from different parts of the country.

ABSTRACT OF THESIS
DISCHARGE THROUGH INCLINED GATES

Four gates, one rectangular and three circular, installed at 45 degrees to the channel bottom, were investigated. The rectangular gate performed as a submerged weir only. The circular gates performed as submerged weirs when the upstream water depth was below the top of the circular opening, and performed as orifices when the upstream water depth was above the top of the circular opening. Two kinds of nappes, surface nappe and plunging nappe, were observed in the submerged weir flow conditions. Weir discharges under plunging nappe flow were independent of downstream water depth, so these data were used to calibrate the free flow discharge equations. The free flow discharge coefficient for the rectangular gate was constant, and for the circular gates was a function of the ratio of upstream head to the crest height. Data for the surface nappe condition were used to calibrate the submerged flow discharge equations. The submerged flow discharge coefficients for all gates were functions of submergence ratio and opening configurations, and different by multiplicative constant from reported coefficient for vertical sharp-crested weirs. The discharge equations for orifice flow were functions of opening configurations.

Chia-Shyun Chen
Agricultural Engineering Department
Colorado State University
Fort Collins, Colorado 80523
Spring, 1977

RECLAMATION AND WATER MANAGEMENT
STUDIES ON COARSE-TEXTURED SALINE-SODIC
SOILS IN THE SAN LUIS VALLEY OF COLORADO

by

W. T. Franklin and Robert S. Whitney

SUMMARY AND CONCLUSIONS

A field experiment was conducted to study methods of reclaiming and managing the coarse-textured saline-sodic soils in the Mosca-Hooper area of the San Luis Valley. The objectives of the experiment were to determine the effects of pre-leaching, amendments, and irrigation on soluble salt and exchangeable sodium removal and on subsequent crop growth at various water table levels. The experimental variables on the 96 plots in the investigation included: two water table levels; the application of 0.1 percent kribium, one and four tons per acre of gypsum, and 0.8 and 3.2 tons per acre of calcium chloride; two rates of leaching; various rates of surface irrigation; nitrogen fertilizer rates with and without phosphorus fertilizer; and, subsoil tillage. Water table differences were achieved by pumping water from one area to lower the water table level and using the pumped water to raise the water table level in a second area. A water table difference was maintained but the levels in both areas fluctuated considerably from year to year.

Crops grown on the plots to test the effects of the various treatments were: barley (1952), sweetclover (1953), potatoes (1954), barley (1955), alfalfa (1956-1960), barley (1961-1962), and oats (1963-1964).

Removal and Control of Soluble Salts and Exchangeable Sodium

In the low water table or pump-drained area where the water table was maintained below five feet, the application of either four tons per acre of gypsum or 3.2 tons per acre of calcium chloride combined with

30 acre-inches per acre of pre-crop leaching water plus additional irrigation with high calcium-magnesium water reduced salts and exchangeable sodium to non-saline and non-sodic levels to a three foot depth during the first cropping season. Raising the water table level, smaller rates of amendments, or lower leaching rates retarded salt and sodium removal. Complete reclamation was achieved with the high calcium-magnesium groundwater used for irrigation but it required a longer period of time.

Salts and sodium reaccumulated rapidly in the soil surface whenever the water table raised to three feet or higher in the high water table area. These reaccumulated salts and sodium were reduced again by irrigation when the water table level lowered.

MOSLEM WATER LAW AND ITS INFLUENCE ON SPANISH WATER LAW
AND THE IRRIGATION SYSTEM OF VALENCIA

by

George E. Radosevich

It is a real pleasure and honor to be here in Quito and participate in this important seminar.

This meeting is a further illustration of worldwide concern over proper and coordinated development, control, and management of natural resources. During the past year, I have been working for the United Nations, New York, in the field of water resources economics and legislation, and have observed a global trend in the water legislation and administration field. This trend is to modernize and streamline the national water law systems consistent with social, technological, and economic changes. Since the 1960's, major revisions or adoptions have taken place in over a dozen countries or states. In addition to the countries in South and Central America that are in the process of changing their water legislation and means of implementation, at least six African countries are in the process of enacting or revising water codes. In Asia, the countries of Afghanistan, Pakistan, Nepal, and several countries of the Mekong Delta are re-examining their water laws.

Perhaps the most significant current trend is the emphasis placed upon the formulation of sound national and regional water policies. From a general review of national water laws, the one single element most frequently absent is the water policy. It is interesting to note that many countries experiencing water resources development and control problems are the same nations without comprehensive and well-defined guidelines to be applied in the development of their water resources.

Those countries having the greatest success in the efficient use of their water have defined their goals and objectives and have translated them into policies. In addition to the efforts of this group and its sponsors, the United Nations has been concerned with the problems and has brought together groups of experts and held conferences to deal with the subject. One such group of experts held meetings in Vienna and New York in 1969-1971, respectively, to prepare a report on water resources policies, and a United Nations conference in New Delhi, India, last January, 1973, concentrated on the administrative aspects of water resources management. Both reports will be available in a few months.

SUMMARY OF PRINCIPAL ACCOMPLISHMENTS

Reporting Year 1975-1976

The primary focus of the Colorado State University grant during the reporting year has been on delivery and removal components of the water chain with emphasis on practices applicable to the small farmer and on drain-systems. A secondary focus was also maintained on other elements of the water chain in cooperation with the CID universities. Response capabilities have been augmented which has resulted in notable increases in the utilization aspects of water resource information, education and training, expanded knowledge base, advisory capacity, and linkages and networks. More specifically, the utilization activities included 1) training at lower levels, i.e., on-site in LDCs, distribution of publications on practices applicable in LDCs, faculty and student exchange, joint advisory and research teams, building and maintaining a nationwide talent banking function for water delivery and removal, and maintaining meaningful linkages with selected international agricultural institutes and LDCs. This year major progress was made in state-of-the-art studies in water delivery and removal systems and practices concentrating on identification of simple systems easy to operate and maintain and best adapted to the varied conditions of LDCs. With regard to the above, special attention was given to cost/benefit analyses and social and political constraints as well as energy saving practices.

Life of Grant

A brief summary of the life of the grant might be contained in the statement that the first five (5) years of the grant was spent in improving the competence of the University in water delivery and removal systems while the last two (2) years has been spent in utilizing this

competence. During the period of competence development, Colorado State University increased its faculty by twenty-two (22) new professional personnel working in the area of water resources development. Thirteen (12) of these positions were fully or partially supported by university funds. A characteristic of the first five (5) year period was the development of a strong interdisciplinary team approach to research in the full dimension of water resources problems as it pertained to the economic, sociological, and engineering fields.

The comprehensive review of July 1974, drastically changed the former thrust of the grant program at CSU resulting in the elimination of generalized studies and activities in the field of water resources development, management and research. Instead, activities were concentrated on specific problems of water delivery and removal systems - particularly on the latter - as they affected the small farmer in developing countries. Research on water delivery and removal systems was expanded by a wide variety of new funding generated by the faculty as a result of the extended grant funds and joint research programs were established between CSU and with the other CID universities. During the reporting year several new courses were developed but no additions to the faculty membership were made.

APPENDIX F

International School Students

Students in International School
for Water Resources & Associated Programs
January 14, 1977

Abdel-Bary, Mohamed Rafeek, Engineer, Hydraulic & Sediment Research
Institute, Delta Barrage, Egypt.
Sponsored by: United Nations.
Dates here: 6/76-6/77

Bhorntus, Chavalit, Highway Department, Material Testing & Research
Division, Bangkok, Thailand.
Sponsored by: Royal Thai Embassy
Dates here: 3/75-5/77

Chinnamani, Strinivasan, Plant Scientist & Head, Soil Conservation
Research Centres, Indian Council of Agricultural Research,
Ootacamund, Tamil Nadu, India
Sponsored by: Ford Foundation.
Dates here: 8/25/76-5/24/77

El-Kasabgy, Adel Ahmed, Hydrologist, Hydraulic & Sediment Research
Institute, Delta Barrage, Egypt.
Sponsored by: United Nations.
Dates here: 1/77-5/77

Jayakumar, Nair M., Junior Research Engineer, Indian Council of
Agricultural Research, Amberpet, Hyderabad, India.
Sponsored by: Ford Foundation.
Dates here: 8/25/76-5/24/77

Shanmugam, Sankaralinga Doss, Superintending Engineer, Goundwater Circle,
Public Works Department, Government of Tamil Nadu, Madurai, India.
Sponsored by FAO.
Dates here: 1/14/77-5/13/77

Students in International School
for Water Resources & Associated Programs
September 17, 1976

Abdel-Bary, Mohamed Rafeek, Engineer, Hydraulic & Sediment Research
Institute, Delta Barrage, Egypt.
Sponsored by: United Nations.
Dates here: 6/76-6/77

Bhorntus, Chavalit, Highway Department, Material Testing & Research
Division, Bangkok, Thailand.
Sponsored by: Royal Thai Embassy
Dates here: 3/75-5/77

Beyene, Atnafe, Sociologist, Planning & Programming Office, Ethiopian
Water Resources Authority, Addis Ababa, Ethiopia.
Sponsored by: United Nations.
Dates here: 8/18/76-8/10/77

Chinnamani, Strinivasan, Plant Scientist & Head, Soil Conservation
Research Centres, Indian Council of Agricultural Research,
Ootacamund, Tamil Nadu, India.
Sponsored by: Ford Foundation.
Dates here: 8/25/76-5/24/77

Ellafi, Omran, General Commissioner, General Company for Agricultural
Projects, Tripoli, Libya.
Sponsored by: Ford Foundation.
Dates here: 8/76-

Jayakumar, Nair M., Junior Research Engineer, Indian Council of
Agricultural Research, Amberpet, Hyderabad, India.
Sponsored by: Ford Foundation.
Dates here: 8/25/76-5/24/77

Kwerepe, Moemedi Raymond, Animal Production Officer, Government of
Botswana, Ministry of Agriculture, Maun, Botswana, Southern Africa.
Sponsored by AID
Dates here: 8/76-

Anjanayalu, Bandaru, Assistant Professor, Indian Institute of Technology,
Kharagpur, W. Bengal, India.
Sponsored by: Ford Foundation.
Dates here: 9/76-12/76

Mishra, Akhilesh Prasad, Lecturer, Agricultural Engineering, Indian
Institute of Technology, Kharagpur, W. Bengal, India.
Sponsored by: Ford Foundation.
Dates here: 9/76-12/76

Rao, K. Annaji, Lecturer, Indian Institute of Technology, Kharagpur,
W. Bengal, India.
Sponsored by: Ford Foundation.
Dates here: 9/76-12/76

Students in International School
for Water Resources & Associated Programs
June 14, 1976

Abdel-Bary, Mohamed Rafeek, Engineer, Hydraulic & Sediment Research
Institute, Delta Barrage, Egypt.
Sponsored by: United Nations.
Dates here: 6/76-6/77

Azizi, Abdul Hamid, General Director & Project Manager of Water
Management and Planning Department, Kabul, Afghanistan.
Sponsored by: United Nations.
Dates here: 6/75-5/77

Gebeto, Petros, Acting Head, Planning & Programming Office, National
Water Resources Commission, Addis Ababa, Ethiopia.
Sponsored by: United Nations.
Dates here: 8/17/75-12/24/76

Simo, Joseph, No Work Experience, Foumban, West Province Cameroon.
Sponsored by: WMO.
Dates here: 1/76-7/16/76

Tucci, Carlos Eduardo Morelli, Professor, IPH, P. Alegre, Brazil.
Sponsored by: UNESCO.
Dates here: 9/75-8/76

Wrege, Mario Luis, Assistant Professor, Center for Applied Hydrology,
Institute of Hydraulic Research, Federal University of Rio Grande
do Sul, Porto Alegre.
Sponsored by: UNESCO.
Dates here: 9/75-10/76

APPENDIX G

CSU Staff Consultants

Colorado State University Staff Consultants

<u>Name</u>	<u>Field of Interest</u>	<u>Function</u> *
Henry Caulfield	Water resources development, former director of U.S. Water Resources Council, political economics, political theory, constitutional law, industrial organization and control.	1,2,3,5,6,7
Wayne Clyma	Water delivery and removal. Irrigation systems.	1,2,3,4,5,6
Cornelis deMooy	Soil-water relations.	1,2,3,4,5,6
Jerry Erkert	Agricultural economics, economics of water resources development and management.	1,2,3,4,5,6
William T. Franklin	Diagnosis and reclamation of salt-affected soils; water management related to water quality and soil fertility; soil mineralogy.	1,2,3,4,5,6
David Freeman	Social science factors in relationship to water development, management and research problems in LDCs.	1,2,3,5,6
Warren Hall	Water resources systems with emphasis on delivery, irrigation, dry land agriculture, water logging, salinity, and related fields, Former Director Office of Water Resources Research, Washington, D.C.	1,2,3,5,6,7
Judson M. Harper	Food technology, irrigation, drainage, salinity control, and solid waste management. Department Head, Agricultural Engineering.	1,2,3,5,6,7
William E. Hart	Irrigation systems, drainage, waterlogging, field machinery.	1,2,3,5,6
Robert A. Longenbaugh	Groundwater hydrology, hydrology, water resources, operations research or systems engineering.	1,2,3,5,6

Max K. Lowdermilk	Extension work, irrigation systems planning, water management, adaptive crop research.	1,2,3,4,5,6
David B. McWhorter	Theoretical and practical aspects of flow in porous media and groundwater hydraulics and hydrology.	1,2,3,5,6
H. J. Morel-Seytoux	Hydrology, water resources planning.	1,2,3,5,6
G. E. Radosevich	Water law and administration, agricultural law, environmental law, economics of natural resources.	1,3,5,6
E. V. Richardson	Experimental fluid mechanics, turbulence and diffusion, open channel flow, fluvial hydraulics, fluid measurement, stream morphology and water management, Administrative Head, CSU Engineering Research Laboratory, Principal Investigator of On-Farm Water Management Project in Egypt.	1,2,3,5,6,7
James F. Ruff	Hydraulics, hydrodynamics, hydraulic structures, remote sensing, open channel flow, closed conduit flow.	1,2,3,5,6
Willard R. Schmehl	Soil fertility, clay mineralogy, soil management.	1,2,3,4,5,6,7
Edmund F. Schulz	Hydrology, flood runoff, small watershed hydrology, water resources, and flood plain planning.	1,2,3,5,6
Willis Shaner	Water resource planning, engineering economics	1,2,3,5,6,7
Gaylord V. Skogerboe	Waterlogging, salinity, irrigation systems, water measurement, drainage.	1,2,3,5,6

Daryl B. Simons	Erosion and sedimentation, river mechanics, hydraulics, stable channel design, open channel flow, flood control and navigation, water resources development, stream gaging, hydraulic structures.	1,2,3,5,6,7
Ronald L. Tinnermeier	Economics of water management as related to farm management and production.	1,2,3,4,5,6
Evan C. Vlachos	Interdisciplinary education and training between social sciences and engineering sciences (particularly in field of water resources development, management and research); methodology, demography, urban studies, comparative social structure.	1,2,3,5,6

*Numbers under the heading Function refer to the following:

- 1) Problem identification and analysis
- 2) Program or project design
- 3) Education and training
- 4) Extension
- 5) Advisory capacity and professional backstopping
- 6) Research
- 7) Evaluation of mission program

Colorado State University International Education Activities

The Colorado State University educational activities now are so extensive as to touch many of the major activities of the institution. These are very important in the growing ability of departments and colleges to make the kinds and types of linkages that are meaningful and desireable.

Library Resources

With its extensive interdisciplinary resources, CSU has working library collections for all areas of undergraduate and graduate study related to foreign topics. The library subscribes to the Universal Reference Service, it is a depository for U.S. Government documents, and receives selected United Nations publications as well as fifty six (56) foreign newspapers. There are approximately 900,000 volumes in the William E. Morgan Library. The University is also widely known for its technical collections, including both foreign and domestic sources, in irrigation and hydraulics engineering, water resources, agriculture, nutrition, veterinary medicine, and botany. CSU is also a member of CIDNET, a computerized index system covering in the main the fields of hydrology and irrigation including items on food, agriculture and other resources deemed useful to developing countries.

Extracurricular Activities

CSU provides rich opportunities for activities outside the regular course curricula. For example the Fine Arts Series sponsors performing art groups from foreign countries. A popular activity is the International Relations Club which organizes informal symposia, lectures, and other programs on contemporary foreign relations. Another activity,

is the arrangement of visits from dozens of international guests from around the world in a program of intercultural exchanges on the CSU campus.

Special Programs

The University offers several opportunities for both undergraduate and graduate students to develop their special interests in foreign studies. Concentrations permit students to build an interdisciplinary program around a major public concern or a geographic area. For those interested in international development, CSU has several unique programs which permit students to prepare themselves for technical careers in foreign countries, particularly in the field of agriculture. Briefly, the University concentrations are in the following studies: Asian, Latin American, Ethnic, and General Environmental. In addition, CSU offers specialized options in the technical aspects of international development. Three examples are: World Agriculture option, Foreign Service in Agronomy option, and International Interdisciplinary Seminar on Water Resource Management, and World Forestry.

Institutional Membership

Colorado State University is a member of a large number of regional or national organizations which are useful to faculty members to keep abreast of new ideas and developments in foreign studies. Three examples are: Colorado Association for International Education, Inter-University Consortium for Political Research, and the Society for International Development.

Foreign Study and Off-Campus Program

An opportunity exists for students interested in foreign studies to supplement their CSU course work and extracurricular activities with actual residence and study in foreign countries.