S & T CATALOG

SCIENCE AND TECHNOLOGY ACTIVITIES
IN
USAID/PAKISTAN'S PORTFOLIO

Islamabad, Pakistan
December 1988

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LIST OF ABBREVIATIONS AND ACRONYMS

ACE	Agricultural Commodities and Equipmert Program
ADB	Asian Development Bank
ADDR	Applied Diarrheal Disease Research
A.I.D.	Agency for International Development
AZRI	Arid Zone Research Institute
BOSTID	Board on Science and Technology for International Development
CADPAD	Computer-assisted Distributions Planning and Design
CIMMYT	International Wheat and Maize Improvement Center
Coal REAP	Coal Resources Exploration and Assessment Program
DGNRER	Directorate General for New and Renewable Energy Resources
ECE	Energy Commodities and Equipment Program
ENERCON	National Energy Conservation Center
EP&D	Energy Planning and Development Project
FHI	Family Health International Project
FMI/PRI	Farm Machinery Institute/Rice Research Institute
FPD	Forestry Planning and Development Project
FRC	Fuel Research Centre
FSM	Food Security Management Project
GOP	Government of Pakistan
GSP	Geological Survey of Pakistan
HDC	Hydraulic Design Criteria
HDIP	Hydrocarbon Development Institute of Pakistan

LIST OF ABBREVIATIONS AND ACRONYMS (continued)

ICARDA	International Center for Agricultural Research in Dry Areas
IEP	Institutional Excellence Project
IIMI	International Irrigation Management Institute
ISATOP	Institute of Science and Technology
ISM	Irrigation Systems Management Project
ISM-R	Irrigation Systems Management-Research Component
ISPAN	Irrigation Support Project for Asia and Near East
LOP	Life of Project
MART	Management of Agricultural Research and Technology Project
MC-II	Malaria Control II Extension
MOST	Ministry of Science and Technology
NARC	National Agricultural Research Center
NIAB	Nuclear Institute of Agriculture and Biology
NIMRT	National Institute of Malaria Research and Training
NIPS	National Institute of Populations Studies
NRIFC	National Research Institute of Fertility Control (Pakistan)
NRIRP	National Research Institute for Reproductive Physiology
NSF	National Science Foundation
NWFP	Northwest Frontier Province
PARC	Pakistan Agricultural Research Council
PASA	Participating Agency Service Agreement

LIST OF ABBREVIATIONS AND ACRONYMS (continued)

PCRWR	Pakistan Council for Research in Water Resources
PCSIR	Pakistan Council of Scientific and Industrial Research
PHC	Primary Health Care Project
PINSTECH	Pakistan Institute of Nuclear Science and Technology
PSP	Private Sector Power Project
PSTC	Program for Science and Technical Cooperation
PWP	Population Welfare Planning Project
RE	Rural Electrification Project
RESPAK	Reference Energy System Pakistan
R&D	Research and Development
Rs.	Rupee (approximately 18 rupees/U.S. dollar)
SCARP	Salinity Control and Reclamation Project
STDT	Storage Technology and Development Transfer
TA	Technical Assistance
TIPAN	Transformation and Integration of NWFP's Provincial and Agricultural Network Project
USAID	A.I.D. Mission to Pakistan
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VPC	Vertebrate Pest Control
WAPDA	Water and Power Development Authority

INTRODUCTION

PURPOSE OF CATALOG

Recently, the Government of Pakistan (GOP) repeated its strong commitment to strengthen specific science and technology activities and asked USAID to supplement its efforts. Partly in response to this request, USAID undertook a survey of the level and type of S&T activities (existing and planned) in the Mission's portfolio. Projects dating from 1982 to the present were reviewed. Possible future S&T related activities and relevant non-bilateral activities in each sector were also collected. The results are in this S&T catalog.

S&T DEFINED

It can be argued (and was!) that almost all Mission projects involve technology transfer. Therefore, for practical reasons, the survey narrowly focused on activities considered to be on the "cutting edge" of new developments.

Included in the catalog are basic scientific research, the research and development of new technologies in Pakistan using imported state-of-the-art equipment, technologies or equipment which are adapted for conditions unique to Pakistan (as opposed to straight technology transfer), and activities which are innovative rather than merely more efficient.

Excluded from the catalog were economic and social research, training, institution building, systems research, and transfer of "off the shelf" technologies, including most computers.

RESULTS

Even within the confines of a narrow definition, USAID/Pakistan projects support an array of significant S&T activities. For example, since the late 1960's USAID has been a major donor in agricultural development. In irrigation, salinity control and land reclamation projects use state-of-the-art computer modeling to study groundwater and salt transport in soil. An ultra-modern hydraulic design criteria facilitates the rehabilitation of Pakistan's 100-year-old canals which together represent the largest and most sophisticated gravity-fed irrigation system in the world.

Agricultural research support varies from the purchase of laboratory equipment for a genetic research project to pest control measures which save crops from porcupine, wild boar and the rose-ringed parakeet. New and profitable farming methods such as zero tillage planting of wheat in rice stubble have been researched here as well. An unexpected bonus has come from Pakistani scientists in U.S. training programs who have conducted research which benefits America (see pages 15 and 20).

RESULTS (Continued)
Approximately one-third of USAID's budget supports Pakistan's effort to achieve energy self sufficiency. S&T highlights from 1982 to the present include equipment for and partial financing of Pakistan's first (highly successful) combined-cycle power plant in Guddu. Mission projects in the Energy Sector were a link for the use of fluidized bed combustion in thermal plants, initiated a national coal assessment program and also equipped the national Fuel Research Centre with an impressive R&D laboratory. In the Social Sector, the upcoming Institutional Excellence Project will directly support development of research capabilities of Pakistani institutions and scientists.

CONCLUSION
Mission funding for bilateral S&T activities in this catalog is roughly $182 million. In addition, S&T activities outside the regular development program costing about $2 million receive Mission support. S&T activities of the GOP vary widely. However, a common thread which binds together the S&T activities USAID supports is the relevance of each to the objectives of USAID's development program. When addressing constraints to development, A.I.D. must apply a problem-solving approach. At a 1987 symposium, Dr. Nyle Brady noted,

> USAID's experience of the last three decades has shown that the transfer of available technology is a necessary but insufficient condition for development. Increasingly, successes have been achieved by generating specific technologies needed to overcome Third World problems.1/

In Pakistan, the success of combined-cycle power generation at Guddu, the zero tillage research which has led to an increase of wheat yields by one ton per hectare and many other examples bear him out.

The Program Office hopes that readers will find this catalog both interesting and informative. Copies are available upon request.

1/"Science and Technology for Development: Prospects for Entering the Twenty-first Century", a public symposium held in Washington, D.C. in June 1987, to commemorate the twenty-fifth anniversary of the U.S. Agency for International Development.

AGRICULTURE SECTOR

A. AGRICULTURAL COMMODITIES AND EQUIPMENT PROGRAM (ACE)

Funding : $475 million (total project)
Duration: April 1982 to January 1991

The goal of ACE is to increase agricultural productivity in Pakistan through provision of commodities and equipment. Some equipment has direct links to S&T activities.

S&T Highlights Through 1988

1. Research Equipment Supplied Under ACE

Funding : $450,000 grant from ACE

Agency Involved : Center for Advanced Molecular Biology

The Center for Advanced Molecular Biology is affiliated with the University of the Punjab, Lahore. The Center has professional ties with Johns Hopkins, Pakistan Agricultural Research Council, University of Washington, National Science Foundation, USAID, and others.

The $450,000 ACE grant made in 1988 was for equipment and research support. Recently, scientists at the Center have made some important discoveries in genetic engineering by identifying three new restriction enzymes.

B. FOOD SECURITY MANAGEMENT PROJECT (FSM)

Funding : $35 million (total project)
Duration : August 1984 to June 1990

A large and multi-faceted project aimed at improving the analytical and policy formulation network, the managerial capabilities, and the physical capability of GOP agencies to manage the national food security system effectively and efficiently. Although not included in the S&T survey, extensive economic and social science research are sponsored under this project.

S&T Highlights Through 1988

1. Post-Harvest Management: Storage Technology and Development Transfer (STDT)

Funding : $3 million for equipment and research

Agencies Involved
- -Kansas State University, technical assistance (TA) contract
- -Pakistan Agricultural Research Council, (PARC)
- -Grains Storage Research Laboratory, a PARC subsidiary which received USAID equipment
- -Federal Pesticide Laboratories, Karachi, a PARC subsidiary

The STDT component focuses on basic grain storage research in the areas of the no-loss policy, bulk storage handling, storage management, and development and testing of new storage technologies.

Illustrative List of Research Carried Out Under STDT:

- Ecology of Storage Losses. (A follow-up on PARC's 1986 loss assessment survey)
- Pesticide Residues in Grain and Grain Products.
- Monitoring for Insect Resistance to Pesticides.

B. FOOD SECURITY MANAGEMENT PROJECT (Continued)

2. Post-Harvest Management: Vertebrate Pest Control (VPC)

Funding : $1.3 million PASA funds

Agencies Involved:
- Denver Wildlife/U.S. Department of Agriculture (USDA)
- National Agricultural Research Center (NARC)
- Ministry of Food and Agriculture
- University of Agriculture, Faisalabad

The VPC program aims at improving the quality of adaptive research in integrated pest management and strengthening vertebrate pest control programs for stored grains which are implemented by the Provincial Food Departments and the Pakistan Agricultural Storage and Services Corporation.

Vertebrate pest problems are complex, often requiring several years of research before effective management methods are achieved. This is especially so in agriculture which involves a mix of field crops, irrigation, livestock, and other factors.

Some technologies developed in other temperate or tropical climate countries may be adapted to the climatic and agronomic conditions in Pakistan, but this requires pilot field trials, control demonstrations, and extensive field work where damage levels and animal numbers involved are monitored with and without control measures, and over representative large areas.

Early VPC studies of grain storage facilities estimated losses of two to five per cent of total stocks. Project priorities were expanded to include a broader pre-harvest element where losses run from three to eight percent yearly in wheat, maize, rice, and sugarcane. A variety of oilseeds and other crops are damaged by rats, mice, porcupine, pest birds, and wild boar in the pre-harvest period.

Illustrative List of Research in the VPC Component:

- Biology and Behavior of the Wild Boar.
- Toxicant and Repellent Evaluation and Investigation.
- Evaluation of Cultural and Nonchemical Methods of Vertibrate Pest Control.
- Rose-ringed Parakeet Biology and Ecology.
- Porcupine Biology and Ecology in Croplands and Forestry Areas.

C. FORESTRY PLANNING AND DEVELOPMENT PROJECT (FPD)

Funding : $25 million (total project)
Duration : August 1983 to August 1991

Agencies Involved :
-Pakistan Forestry Institute, Peshawar
-Inspector General of Forests
-Provincial Forestry Departments
-Winrock International Institute for Agricultural Development

The project aims at increasing Pakistan's energy supplies, helping the country to move towards energy self-sufficiency, and to reverse the deforestation process. Activities focus on institution development, training and research, and demonstration in the field.

S&T Highlights Through 1988

1. Research Studies at the Pakistan Forest Institute

Funding : $200,000 bilateral for research
$300,000 for research equipment

Pakistan Forest Institute personnel and a provincial committee approve and monitor research projects. A Winrock representative sits on the committee as a technical advisor.

Illustrative List of Research Studies

- "Comparison of intercropping of five tree species with agronomic crops under Barani and irrigated conditions."

- "Establishment of seed orchard of Acacia nilotica var. cupressiformis."

- "Species trials for the xeric, mesic and saline areas of the arid and semi-arid regions."

- "Spacing cum irrigation trial of Ipil Ipil (Leucaena leucocephala) at D.I. Khan."

- "Spacing cum irrigation trial of fodder and fuel producing species namely Acacia nilotica, Leucaena leucocephala and Sesbanea in Sind."

- "The effect of innoculation on the nursery development of three nitrogen fixing species."

D. IRRIGATION SYSTEMS MANAGEMENT PROJECT (ISM)

Funding : $90 million (total project)
Duration : June 1983 to February 1991

The project aims at assisting the GOP and the four provincial irrigation departments to rehabilitate deteriorated surface irrigation and drainage systems, and to improve Pakistan's institutional capacity so reliable and equitable water supplies are available for irrigated agriculture.

S&T Highlights through 1988

1. Competitive Grants Program in ISM-Research Component (ISM-R)

Funding : Rs. equivalent of $750,000 total bilateral grant funds.
Duration : Program will run through June, 1990.

Agency Involved : -Pakistan Council for Research in Water Resources (PCRWR)

Two-year grants for research in irrigation management. Researchers, departments, and institutions already participating in ISM-R are not eligible to compete.

Grants through August, 1988 include:

- "Identification and Relative Contribution of Various Sources Towards Waterlogging and Salinity in Rechna Doab Using Nuclear Techniques." Dr. Ishaq Sajjad, Pakistan Institute of Nuclear Science and Technology (PINSTECH). Rs. 380,000.

- "Water Use for Rice Under Different Planting Techniques." Dr. S. Iqbal Ahmad, Farm Machinery Institute/Rice Research Institute (FMI/RRI). Rs. 380,000.

- "Utilization of Polymer Formulated products as Soil Conditioning and Water Retentive Agents for poor quality soils." Mr. M. Aslam, Pakistan Council of Scientific and Industrial Research (PCSIR), Karachi. Rs. 561,000.

- "Operation and Evaluation of Trickle Irrigation Systems in Pakistani Conditions." Mr. Arshad Aziz, Professor, University of Engineering & Technology, Peshawar. Rs. 443,000.

Five additional grants are almost ready for funding.

D. IRRIGATION SYSTEMS MANAGEMENT PROJECT (Continued)

2. Groundwater Models

Funding : $972,000 under ISM-R

Agencies Involved :
- Water and Power Development Authority (WAPDA)
- Salinity Control and Reclamation Project (SCARP) Monitoring Organization, Lahore
- University of Idaho (long-term TA based in Lahore

The objective is to develop computer models of groundwater and salt transport which are capable of predicting water level and quality trends under various proposed management schemes. State-of-the-art equipment was adapted for use under Pakistani conditions. Progress to date:

a. Mona Groundwater Flow Model

The model of Mona and Shahpur I land reclamation schemes concentrates on investigation of geohydrologic conditions and appropriate methods of modeling.

Status: Data is being collected and processed for calibration of the Mona Groundwater Flow Model. The model was calibrated for a one-year period from June 1985 and subsequently by long term simulation. Water table evaluations are on a computer data base which will ultimately be expanded to incorporate all of Pakistan. Cross-sectional and radial flow groundwater models are being developed to examine model assumptions relative to aquifer thickness and boundary effectiveness.

b. SCARP VI Salt Transport Model

SCARP VI is a groundwater flow and salt transport model.

Status: The modeling unit of SCARP VI has been introduced to the Prickett-Lonnquist finite difference model. The model was modified and used to simulate the effects of drainage and seepage in the Chasma Right Bank Canal Project. Research is ongoing.

D. IRRIGATION SYSTEMS MANAGEMENT PROJECT (Continued)

3. Additional Modeling Activities

Funding :	-$350,000 research grant which includes: $ 50,000 central funds from ISPAN and $300,000 from IIMI (under a $2 million bilateral ISM core grant to IIMI)
Duration :	October 1988 through October 1991
Agencies Involved	-International Irrigation Management Institute (IIMI) -Irrigation Support Project for Asia and Near East (ISPAN), A.I.D./Washington, Asia and Near East Bureau

IIMI headquarters are in Sri Lanka. A branch office exists in Lahore, established in part with USAID support. State-of-the-art modeling activities, similar to SCARP VI and MONA, will be conducted through a research grant awarded by IIMI to Mr. Bob Johnson, a graduate student from Cornell University. Research involves the calibration of groundwater flow and surface water flow models which are combined in one command area. When complete, it will enable conjunctive views of surface and groundwater on a demand basis. Research findings will aid the Punjab Irrigation Department in developing optimal operating procedures.

D. IRRIGATION SYSTEMS MANAGEMENT PROJECT (Continued)

4. Hydraulic Design Criteria (HDC)

Funding : $4 million from USAID for laboratory equipment and research.

Agencies Involved :
-USAID
-PRC/Checchi, long-term TA
-Ministry of Water and Power
-Provincial Irrigation Departments
-DELFT Hydraulics

A state-of-the-art technical assistance activity custom designed in Pakistan to meet the challenge of conditions unique to this country. HDC is an extensive hydraulic data collection and analysis activity which developed a design basis (parameters, or equation) to build canals which meet current field conditions in Pakistan. HDC is also used to re-design sections of canals which have been in existence for over 100 years and are now physically overloaded due to silt deposits and increased user demand. Laboratory equipment was imported from the United States. Research is ongoing.

Note: In addition to being new and original research, this activity has far reaching social implications for Pakistan. Re-design of canals will help deliver water in a more equitable fashion, delivering a more reliable water supply to lenders as well as to farmers at the head of the canal.

E. MANAGEMENT OF AGRICULTURAL RESEARCH AND TECHNOLOGY PROJECT (MART)

Funding : $30 million for total project (plus continuation to the determined)
Duration : August 1984 to September 1991

Agencies Involved : -Provincial Research Institutes and Universities
-Pakistan Agricultural Research Council (PARC)

The Agricultural Research Project (1969 to 1985) focused on the development of the National Agricultural Research Center (NARC). The MART Project follows on with a goal of strengthening Pakistan's capacity to undertake research and apply technology in agriculture. The focus of MART is broader, with 80 percent of its budget going to the provinces.

S&T Highlights Through 1988

1. Arid Zone Research Institute (AZRI)

Funding : $5 million under MART

Agencies Involved : -AZRI
-International Center for Agricultural Research in Dry Areas (ICARDA)

Established by PARC, AZRI has headquarters in Quetta. It operates primarily in Baluchistan but has substations in other provinces aimed at improving agriculture in dry areas. Baluchistan has more than 40 percent of the geographical area of Pakistan and arid lands constitute about 60 percent of the total area.

Laboratory and field equipment have been supplied through MART. The project has also helped initiate a research program at AZRI, including farmer-oriented research in eight communities.

Illustrative List of Publications Indicating Areas of AZRI/ICARDA Research:

- "Range-Livestock Production Constraint Diagnosis and Potential Research Opportunities in Baluchistan: A Farming Systems Perspective." J.G. Nagy. 1988.

- "Proceedings of the International Symposium on Problems and Prospects of Winter Cereals and Food Legumes Production in High Elevation Areas of West and South-East Asia and North Africa." D.J. Rees, J.G. Nagy, S.H. Raza, K.M. Mahmood, B.A. Chowdry and J.D.H. Keatinge. 1987.

E. MANAGEMENT OF AGRICULTURAL RESEARCH AND TECHNOLOGY PROJECT (Continued)

1. Arid Zone Research Institute (Continued)

Illustrative List of Publications Indicating Areas of AZRI/ICARDA Research (Continued)

- "Improvements in Water Use Efficiency in Barani Arable Agriculture in Baluchistan."
D.J. Rees, S.H. Raza, Z. Ali, F. Rehman, M. Islam, A. Samiullah, S.M. Shah, and M.I. Channa. 1988.

2. NARC/CIMMYT Research Collaboration

Funding : $3.5 million, under MART
Duration : 1984 through 1991

Agencies Involved : -NARC
-International Wheat and Maize Improvement Center (CIMMYT)

Professional ties between Pakistani agricultural researchers and CIMMYT date from the 1960's. Research collaboration was strengthened considerably under the Agricultural Research Project and the follow-on project, MART. Some research has been very successful. Highlights are listed below:

a. Zero Tillage Planting of Wheat in Rice Stubble:

During the years 1984-1988, the National Coordinated Wheat Program of NARC and CIMMYT carried out research to test, evaluate, and demonstrate zero tillage in the rice-wheat cropping system of the Punjab and upper and lower Sind. The project developed a system of planting wheat at the time of rice harvest and directly into rice stubble. This time and labor-saving technique has increased grain yields by one tone per hectare and has decreased costs by Rs.500-800 per hectare. This works out to an average yield increase of 20 to 30 percent with a 20 percent reduction over current production costs. It is probably the first successful on farm experiment in the world to combine zero tillage planting with an appropriate technology (Aitchison Seedmatic Linkage Drill) in a rice-wheat cropping system.

E. MANAGEMENT OF AGRICULTURAL RESEARCH AND TECHNOLOGY PROJECT (Continued)

2. NARC/CIMMYT Research Collaboration (Continued)

a. Zero Tillage (Continued)
As a follow-up, USAID is financing the import of twenty Aitchison Drills from New Zealand to demonstrate this technique on a larger scale in 1988 plantings.

b. New Germplasm:

Another collaborative research program between NARC and CIMMYT resulted in provision of new germplasm to enable Pakistani scientists to research high yielding disease resistant plant varieties.

c. Illustrative List of of NARC/CIMMYT Research under MART

- "Population Improvement and the Derivation of National Inbreeds from Local Populations of Akbar and Sultan." T. Izuno, E.J. Stevens. 1987.

- "Maize Improvement in Mountain Land and Maize-based Farming Systems: A Case Study of Upper Swat." E.J. Stevens, et. al. 1986.

- "Effect of Different Tillage Implements on the Yield of Wheat." B.R. Khan, et. al. 1986.

- "Direct Drilling of Wheat Following Rice in the Rice-Wheat Cropping Pattern of the Punjab." Peter Hobbs, et. al. 1986.

- "Primary Tillage as a Way to Increase Wheat Yields in the Barani Tracts of Pakistan." Peter Hobbs, et. al. 1986.

- "Wheat in the Barani Farming Systems of Northern Punjab." Peter Hobbs, 1986.

- "Developing Improved Crop Technologies Within the Context of Pakistan's Multiple Cropping Systems." Derek Byerlee, et. al. 1986.

- "Results from Agronomic On-Farm Trials on Barani Wheat." Peter Hobbs, et. al. 1986.

- "Improving Wheat Production in the Context of South Asia's Cropping Systems." Peter Hobbs, Derek Byerlee, M.I. Hashmi. 1986.

E. MANAGEMENT OF AGRICULTURAL RESEARCH AND TECHNOLOGY PROJECT (Continued)

2. NARC/CIMMYT Research Collaboration (Continued)

c. Illustrative List of of NARC/CIMMYT Research under MART (Continued)

- "Wheat in the Cotton-Wheat Farming Systems of the Punjab." M.R. Akhtar, et. al. 1986.

- "Reconciling Conflicts in Sequential Cropping Patterns through Plant Breeding." Derek Byerlee, et. al. 1986.

- "Response of Wheat to Different Environments and Agronomic Practices in the Context of the Cropping Systems of Pakistan." B.R. Khan, et. al. 1986.

- "Maize Production in NWFP." Derek Byerlee, S.S. Hussain. 1986.

- "Farmer Oriented Research and the Transfer of Maize Technology for NWFP and Islamabad." E.J. Stevens, et. al. 1986.

- "Production of Maize Grain and Fodder in the NWFP and Islamabad." K. Fischer, H.I. Javed. 1986.

- "Maize Marketing and Utilization in Pakistan." P. Amir. 1986.

- "Maize in the Irrigated Farming Systems of Mardan District." S.S. Hussain, et. al. 1986.

- "Selection for Genotypic Stability Using Expected Utility Maximization and Safety First Rules." K.M. Eskridge, et. al. 1986.

- "Maize in the Irrigated Farming Systems of the Punjab." Derek Byerlee, et. al. 1986.

- "Recurrent Selection for Cold and Freeze Tolerance in Maize." C.O. Gardner, E.J. Stevens. 1986.

- "Population Improvement and its Integration with Hybrid Development Activities to Produce Superior Maize Cultivars for Different Maize Growing Areas of Pakistan." C.O. Gardner, E.J. Stevens. 1986.

E. MANAGEMENT OF AGRICULTURAL RESEARCH AND TECHNOLOGY PROJECT (Continued)

2. NARC/CIMMYT Research Collaboration (Continued)

c. Illustrative List of of NARC/CIMMYT Research under MART (Continued)

- "High Altitude Tropical Maize in Temperate Zone Breeding Programs." H. Eagles, E.J. Stevens. 1986.

- "Mountain Land Maize Improvement in Pakistan." H. Eagles, E.J. Stevens. 1986.

- "The Growth and Development of Maize." E.J. Stevens, S.J. Stevens, M.Q. Chatha. 1986.

- "Understanding the Phenology of Maize." E.J. Stevens, et. al. 1986.

- "Farmer Managed Verification of Improved Maize Technology." K. Khan, et. al. 1985.

- "Agronomic Practices and Problems for Wheat following Cotton and Rice in Pakistan." Peter Hobbs. 1985.

- "Wheat in the Irrigated Farming Systems of Mardan District." S.D. Hussain, et. al. 1985.

- "Effect of Mustard Grown as a Mixed or Intercrop on the Yield of Wheat." Peter Hobbs, et. al. 1985.

- "Wheat in the Rice-Based Farming System of the Punjab." Derek Byerlee, A.D. Sheikh, Mohammad Aslam, Peter Hobbs. 1984.

E. MANAGEMENT OF AGRICULTURAL RESEARCH AND TECHNOLOGY PROJECT (Continued)

3. Training Component A MART Success Story

Funding : approximately $85,000 per Ph.D. trained

The MART project has provided short and long-term overseas training for over 170 people. One such trainee was a Pakistani scientist at the University of Colorado. Her research resulted in identification of a new method of treating seed to establish permanent grasses for use in semi-arid regions and rangeland where it is difficult for vegetation to grow.

The technology, which will benefit Pakistan greatly, has also been put to use in the U.S. Our Pakistani scientist is now working with a team in the central Colorado city of Aurora to re-seed permanent grasses on previously irrigated farmland. The new grasses will prevent wind and water erosion on the depleted farmland and enable Aurora safely to transfer water from agricultural to urban and industrial use.

E. MANAGEMENT OF AGRICULTURAL RESEARCH AND TECHNOLOGY PROJECT (Continued)

4. Competitive Grants Research Program (a future activity)

Funding : Initial sum of $3 million, MART project

Agencies Involved : -USAID
-National Academy of Science's, Board on Science and Technology for International Development (BOSTID)
-PARC

Dates : Near future (in 1988)

Under an amendment to MART, USAID is considering a small competitive grants research program. With BOSTID and PARC management, the program would provide for peer review and a link between the U.S. and Pakistani scientific communities. Research would be done in Pakistan. Four areas of priority research have been identified by PARC. The initial focus would be on agriculture in stressed and marginal lands.

Possible areas of concentration are:

- Forestation of Degraded Lands:
Trials of multi-purpose trees; soil fertility studies; erosion abatement; silvicultural studies; propagation of tree species, including tissue culture; symbiotic associations; germplasm collection and evaluation.

- Utilization of Saline Resources:
Use of saline lands; breeding or selection, including use of tissue culture methods, for salt tolerance in conventional crops; development of fodder crops like Kaller grass or salt-tolerant tree crops.

- Farming Systems:
Agro-forestry; systems which exploit biological nitrogen fixation; biological pest management; genetic engineering for crop adaptability or yield; mixed cropping.

TRANSFORMATION AND INTEGRATION OF NWFP'S PROVINCIAL AND AGRICULTURAL NETWORK PROJECT (TIPAN)

Funding : 35.5 million (total project)
Duration : August 1984 to September 1992 (Phase I)

Agencies Involved :
-NWFP Agricultural University
-University Grants Commission
-University of Illinois
-University of Southern Illinois

The project goal is to improve GOP efforts in agriculture through the integration of the provincial research system and the NWFP University. TIPAN also aims to improve the quality of education and research at the University, to strengthen ties with the U.S. scientific community, and to strengthen linkages with agricultural extensions through a problem-solving, farmer-oriented outreach approach.

S&T Highlights Through 1988

1. NWFP Agricultural University Research Projects

Funding :
-$1.3 million. TIPAN has supplied research equipment to the NWFP Agricultural University and will supply field stations in the future.
-Research is funded by the provincial government.

Although training activities are not included in this catalog, a significant ($4 million) amount of project funds are spent on developing research potential through training. For example: Under TIPAN, 114 staff members of the NWFP Agricultural University will be trained for advanced degrees in 35 major agricultural schools in the U.S. Of these, approximately 85 percent are expected to return with Ph.D.'s and 15 percent should return with Masters degrees.

Illustrative List of Applied Research at the NWFP University:

- Under Departments of Agricultural Chemistry and of Human Nutrition:
Local foods are examined for pesticide load, iodine content and other mineral analysis, and fat analysis. These foods have not been studied before.

F. TRANSFORMATION AND INTEGRATION OF NWFP'S PROVINCIAL AND AGRICULTURAL NETWORK PROJECT (TIPAN)

1. NWFP Agricultural University Research Projects

Illustrative List of Applied Research at the NWFP University: (Continued)

- Under the Department of Food Sciences and Technology:
A spectrophotometer is used to identify organic molecules. Researchers experiment with chemicals for post-harvest preservation of food and fodder.

- Under the Department of Animal Sciences:
Research is conducted on the fat, fiber and protein content of local animal feed supplements (boussa). The research is aimed at matching animal food requirements with diet and toward fodder storage techniques.

G. NON-BILATERAL S&T ACTIVITIES IN THE AGRICULTURE SECTOR

1. Program for Science and Technical Cooperation (PSTC)

Funding : $140,000 to $150,000 each grant
Duration : 1987 to 1992

Agencies Involved : -Office of the Science Advisor, AID/Washington
-USAID

Research Grants are awarded to Pakistani scientists under the PSTC program with backstopping by the USAID Mission.

A Sample List of PSTC Grants:

- AID/SCI Proposal No. 5.075:
"Regeneration & Clonal Propagation of Pistachia vera & Phoenix dactylefera plants by Tissue Culture." Dr. Farrukh H. Shah, Pakistan Council of Scientific and Industrial Research, Lahore. Approved June 29, 1987.

- AID/SCI Proposal No. 6.163:
"Bioconversion of Lignocellulosic (LS) Biomass Produced on Saline Land by Cellulomonas." Ibrahim Rajoka, Nuclear Institute of Agriculture and Biology, Faisalabad. Approved July 20, 1988.

- AID/SCI Proposal No. 7.137:
"Evaluation of Wheat, Barley, and Sorghum Germplasm for Resistance to Greenbug." Inayatullah, Pakistan Agricultural Research Council (PARC), Islamabad.

- AID/SCI Proposal No. 8.275:
"Host Range Specificity of Agrobacterium Tumefaciens Strains Isolated from Crown Gall Tumors on Fruit Trees in Pakistan." Riazuddin, University of Punjab, Lahore. Approved July 20, 1988.

- AID/SCI Proposal No. 6.322:
"Studies on Three Plants, Acorus calamus, Annona squamosa, and Curcuma Longa, for possible use as Stored Grain Protectants." Dr. Ghulam Jilani, Grain Storage Research Laboratory, PARC, Karachi. Approved August 15, 1988.

A third category of proposals is under consideration.

G. NON-BILATERAL S&T ACTIVITIES IN THE AGRICULTURE SECTOR (Continued)

2. BOSTID Research Grants

Funding : two grants, @ $140,000 each
Duration : 1987 to present

Agencies Involved :
- Board on Science and Technology for International Development (BOSTID) of the National Academy of Sciences
- Office of the Science Advisor
- Nuclear Institute of Agriculture and Biology (NIAB), Faisalabad

Initial and renewal grants awarded to Dr. Kauser A. Malik of the NIAB. Work is underway in Pakistan in the following subject:

"Associative Biological Nitrogen Fixation in Grasses Which Show Promise for Reclaiming Saline Lands."

Funding is from the Office of the Science Advisor to BOSTID. Grantees receive frequent visits from noted U.S. scientists and the principal investigators attend workshops and meetings in their technical areas. Dr. Malik presented a paper at a symposium on biological nitrogen fixation organized by BOSTID in Indonesia in 1987. He also participated in a BOSTID workshop on application of molecular genetic techniques to field experiments, in Mexico in 1988.

3. Addendum: Technology Transfer Flows Both Ways!

Funding : $250,000
Duration : ongoing

Agencies Involved :
- LAND O'LAKES (a dairy cooperative)
- Bureau for Food and Voluntary Assistance
- Pakistani Dairy Companies

Funding from LAND O'LAKES and AID/Washington's Bureau for Food and Voluntary Assistance supports a project which targets and trains dairy processors.

Pakistani scientists have developed a process to increase the shelf life of some dairy products (like Milk Pac's Long-Life Yogurt). This technology will be further researched in the U.S. and available to Americans through Pakistani trainees in the LAND O'LAKES program.

ENERGY SECTOR

A. ENERGY COMMODITIES AND EQUIPMENT PROGRAM (ECE)

Funding : $100 million
Duration : August 1984 through February 1990

ECE is a commodity support program to provide balance of payments support and to contribute to energy production from indigenous resources and energy conservation in support of Pakistan's sixth five-year plan.

S&T Highlights through 1988

1. Commodity Support to a Variety of Scientific Institutions

Although specific S&T activities are listed under the Energy Planning and Development (EP&D) Project activities to which they relate, the ECE program should be mentioned for equipment support to the following institutions:

- Pakistan Council of Scientific and Industrial Research (PCSIR), $5.45 million. The Council is under the Ministry of Science and Technology (MOST). It administers the Fuel Research Centre (page 27) which received $4.45 million ECE funding, and the Solar Energy Research Center (page 32) which received $1 million ECE funding.

- Geological Survey of Pakistan (GSP) $11.15 million. Under the Ministry of Petroleum and Natural Resources, the GSP has overall responsibility for mineral exploration throughout the country. Equipment supplied to the Petrology and Minerology Lab includes Suspectability meters, and an earth resistivity meter. $3.3 million of the above funding was used to purchase commodities and equipment for the Coal REAP activity (page 25).

- Directorate General For New and Renewable Energy Resources. $1.2 million. (See page 32)

2. Hydrocarbon Development Institute of Pakistan (HDIP)

Funds : $6.2 million from ECE

Agencies Involved : -HDIP
-Ministry of Petroleum and Natural Resources

HDIP has responsibility, under the Ministry of Petroleum and Natural Resources, for assessing the country's hydrocarbon resource base. Activities include the use of computer technology for analysis of exploration data, source rock studies, tectonism, environment of sediments,

A. ENERGY COMMODITIES AND EQUIPMENT PROGRAM (Continued)

2. Hydrocarbon Development Institute of Pakistan (HDIP) (continued)

Commodities have been purchased under ECE for the Basin Studies Division, the Petroleum Oil and Lubricants Laboratory. the Compressed Natural Gas in Automobiles Combustion Engineering Lab, and the Pilot Plant Station for Process Development.

Future USAID funding of research projects at HDIP would be provided under the EP&D project.

B. ENERGY PLANNING AND DEVELOPMENT PROJECT (EP&D)

Funding : $105 million (total project)
Duration : July 1983 to July 1991

EP&D aims to strengthen the GOP's capability to collect and analyze data on energy resources, sectoral demand, and economic and social factors. The multi-faceted project also supports GOP and private sector efforts to develop coal and other energy resources. Energy conservation and renewable technologies are also supported in EP&D.

Due to the complexity of the EP&D project, each activity will be listed on a separate page.

B. ENERGY PLANNING AND DEVELOPMENT PROJECT (Continued)

S&T Highlights through 1988

1. Coal Resources Exploration and Assessment Program (Coal REAP)

Funding : $9.6 million, LOP EP&D funding
$3.3 million, from the ECE Program (commodities)

Agencies Involved : -GSP
-U.S. Geological Survey (USGS), PASA
-Ministry of Petroleum and Natural Resources

The object of Coal REAP is to increase knowledge of Pakistan's coal resources in order to meet the country's energy requirements. Adequate research to understand the geology of areas where coal exists has not been done prior to this project. Both geophysical logging, which involves remote sensing in drilled holes, and direct observation of surface materials, called lithologic logging, have been carried out.

High-tech Equipment Used for Resource Assessment:

- For logging activities, equipment brought it to support the Lakhra Project has been shared.

- Petrographic equipment has been made available to the GSP Laboratory for use in determining the origins and structure of coal samples from around the country.

Initial results of the program include:

- Discovery of Pakistan's thickest coal seam (600 feet deep and up to 2 feet thick) in the Sonda-Thatta area.

- Completion of 8,000 meters of coal drilling. Almost 150 coal samples have been analyzed.

- Estimates of Pakistan's known coal reserve potential increased from under one billion tons to over five billion tons.

Coal REAP is in its fourth year. Training and equipment will remain in Pakistan after the project is finished. For the past year, all research has been managed by Pakistani scientists.

B. ENERGY PLANNING AND DEVELOPMENT PROJECT (Continued)

S&T Highlights through 1988

2. Fluidized Bed Combustion: A Policy Dialogue Lesson

The Lakhra Coal and Mine Power Project evaluated the performance of a large Lakhra coal sample through laboratory tests based on conventional pulverized coal burning technology. The coal, because of its high sulfur content, has an unacceptable potential for air pollution when burned conventionally and conventional pollution control installations are inordinately expensive and poor performers. In the interest of a clean environment and with USAID encouragement, the GOP decided to focus on the use of fluidized bed combustion as the technology for all new coal-based power generation. This is a newly emerging technology which is rapidly becoming commercial because of the existence of large capacity units of commercial size.

In fluidized bed combustion, solid coal is mixed with limestone and burned in a bed of particles suspended by an upward flow of air. The offending sulfur is captured in the bed. Ash particles in the combustion gases are captured in bag filters. The technique burns coal efficiently and with almost no pollution.

Fluidized bed technology to accomplish chemical reactions has been known for about sixty years and has been widely used in the petroleum refining industry. Commercial units for power production have existed for only six to seven years. It is currently being operated in the U.S. in three utilities.

The initial GOP installation will be a plant from sources in the People's Republic of China who are in turn obtaining the design basis and technical guidance from Foster Wheeler Corporation, an American company.

USAID was able to engage in policy dialogue with the GOP on coal because of its major role in coal development through support of the Lakhra feasibility study.

Lesson: Policy dialogue and technical assistance contribute to the choice of technologies which are best for general development.

B. ENERGY PLANNING AND DEVELOPMENT PROJECT (Continued)

S&T Highlights through 1988

3. USAID Support of Research and Development Activities at the Fuel Research Centre (FRC)

Funding : $4.45 million to PCSIR for the FRC under the ECE Program

Agencies Involved :
-PSCIR: supplied the land and buildings.
-USAID: supplied state-of-the-art American equipment for an impressive R&D laboratory.
-Ministry of Science and Technology

The Fuel Research Centre in Karachi was designed to analyze solid fuels, specifically coal. Current activities include:

- Pure scientific research to analyze coal structure and to determine physical and chemical processes which formed it.

- Provides comprehensive analytical and consulting services, making recommendations on how and where to use various kinds of fuels.

- Through its R&D programs, the FRC develops technologies for the potential utilization of indigenous fuel resources in Pakistan and the potential use of alternate fuels.

An assessment of the FRC was conducted in September, 1988 by the U.S. Geological Survey. In its report, Mr. Frederick O. Simon stated,

"The FRC is clearly an asset to the GOP that should be fully utilized in Pakistan's quest for energy independence. I am convinced that coal will be in Pakistan's future, given the projected shortfall in electrical generating capacity of more than 8,000 MW by the year 2000.

"I think the FRC should serve as the focus for technology transfer for coal utilization in Pakistan and [should] develop new technologies and adapt technologies already developed by other countries.... FRC has shown that it has the motivation and is willing to accept new challenges."

B. ENERGY PLANNING AND DEVELOPMENT PROJECT (Continued)

S&T Highlights through 1988

4. Processed Coal Briquettes

Funding : $0.5 million TA, bilateral (EP&D)
$4.45 million funding from ECE purchased coal briquetting equipment in FRC's R&D lab (see item #3)

Agencies Involved : -FRC
-PCSIR

Research and Development at the Fuel Research Centre:

This story illustrates technology transfer and adaptation which produced new a technology in Pakistan. If accepted, it will benefit the country greatly.

At present, firewood and imported kerosene are used extensively for home cooking and space heating by Pakistanis living in rural areas and by low-income city dwellers. Demand for these fuels has resulted in large-scale deforestation and a drain on foreign exchange. The FRC has adapted a new technology developed in Thailand, to produce a low-cost smokeless briquette from Pakistani coal, which is likely to compete, without subsidy, as an alternate fuel with wood and kerosene.

Based on only the general knowledge of a smokeless briquette technology in Thailand, the FRC used empirical techniques to research and develop a new technology in Pakistan. The briquettes are made from indigenous coal blended with an indigenous absorbent clay. While the raw coal is high in impurities, the briquettes are low in noxious sulfur emissions, are practically smokeless, can be store for long periods without danger of spontaneous combustion, and can be transported with minimal breakage. They burn for an average of three hours, allowing time for both cooking food and boiling water for household use.

Current Status:
Scientists are cautiously optimistic. Environmental and safety testing are being carried out. Marketing promotion is being carried out through the Science and Technical Development Corporation of Pakistan, a subsidiary of PCSIR, to demonstrate acceptability. Metropolitan Karachi is the test marketing area.

USAID Involvement:
USAID personnel catalyzed efforts for the development of the briquettes. The production facility, at the FRC, which may reach a capacity of one ton per day, uses American equipment supplied under the ECE Program. The results promise a very successful and useful technology transfer and adaptation.

B. ENERGY PLANNING AND DEVELOPMENT PROJECT (Continued)

S&T Highlights through 1988

5. Possible Future USAID-Related Coal Activities:

- Continuation of Coal REAP for another four to five years to explore all potential coal basins in the country. Emphasis will be on analysis of field data. Adaptation of this knowledge may involve more scientific research.

- Environmentally acceptable coal. Research into developing Pakistani standards for sulfur oxides, nitrogen oxides and particulate emissions. Possible collaboration with the U.S. Department of Energy's "Clean Coal Program".

- Technical research to adapt fluidized bed combustion to Pakistani conditions.

- Beneficiation (scientific and technological investigation on how to wash or prepare coal to required specifications).

- Research and technical development of new forms of coal for commercial sale, i.e. "liquified" coal-water slurry fuels.

- Technical research on coal gasification to anticipate decreasing supplies of natural gas.

B. ENERGY PLANNING AND DEVELOPMENT PROJECT (Continued)

Science & Technology Highlights through 1988 in areas other than coal are listed below.

6. Conservation Component

ENERCON Research

Funding : $15 million total funding under EP&D project
$200,000 to date for R&D

Agencies Involved : -National Energy Conservation Center (ENERCON)
-Hagler, Bailly and Company (American TA consultant)

ENERCON was established by the GOP in December, 1986 with the mandate to establish a national energy conservation program. The bulk of program activity is devoted to the transfer of conservation technology. However, ENERCON, with USAID technical assistance, has carried out a number of research projects related to energy conservation. For example:

Illustrative List of ENERCON Research Projects

- Roof Insulation Studies:
The roof of the ENERCON building was insulated using six different techniques. The temperature of the concrete deck under each type of insulation was monitored using a six-channel temperature recorder. Computer simulations were also run to estimate the energy impacts. Two research papers were prepared on the results.

Additional roof insulation research is going on and demonstration projects have been initiated.

- Energy Surveys and Boiler/Furnace Tune-ups in Industry:
To date, 42 detailed energy surveys and 229 boiler/furnace tune-ups have been conducted in industries all over Pakistan, with a resultant energy saving of $3 million. Instruments and equipment used for the tests and tune-ups have been provided under USAID funding.

- Truck and Bus Body Design: A future activity. A wind tunnel at the University of Engineering and Technology at Lahore will be used to test truck and bus body design from the viewpoint of energy efficiency.

B. ENERGY PLANNING AND DEVELOPMENT PROJECT (Continued)

S&T Highlights through 1988

7. Energy Analysis and Manpower Development Component

RESPAK Model: A New Technology Adapted For Pakistan's Unique Energy Requirements

Funding : $200,000 total cost, USAID bilateral funds (figure includes training)

Agencies Involved : -Energy Wing (GOP)
-IDEA, an American Firm

An energy-planning model called RESPAK, which means Reference Energy System Pakistan, has been developed and successfully transferred to the Energy Wing of the Government of Pakistan.

The model integrates the energy supply and demand of each energy sub-sector, i.e., power, oil and gas, hydro, coal, renewables, conservation, etc., and prepares national energy balances for multiple time periods.

RESPAK first played a key role in the preparation of the seventh five-year plan for the energy sector and now is regularly used for "what iffing" various planning scenarios both for the mid-term (five years) and long-term (20 years).

RESPAK is a computer based model which operates in an econometric as well as an engineering activity level mode for forecasting supply and demand.

In RESPAK, Pakistan has, for the first time, a model of the energy sector for planning purposes which creates an energy balance and shows supply and demand.

Development: This type of model was conceived at the Brookhaven National Laboratories. RESPAK, a model specific to Pakistan, was developed jointly by IDEA and the Energy Wing.

B. ENERGY PLANNING AND DEVELOPMENT PROJECT (Continued)

Future S&T Activities Planned Under EP&D

8. Renewable Energy Technologies Component

a. Directorate General for New and Renewable Energy Resources (DGNRER)

Funding : $1.2 million from ECE

Agency Involved : Ministry of Petroleum and Natural Resources

R&D equipment worth about $1.2 million has been provided for renewable energy development. Additional funding for research may come from the Renewable Energy Technologies Component; dollar amounts are not yet fixed.

Actual research has not yet begun. Planned activities will emphasize commercialization of viable renewable technologies such as solar photovoltaic, solar thermal systems, wind energy, small hydro, and biogas. A data acquisition system will demonstrate and help develop renewable technologies to supply energy in rural areas which are not connected with the power grid and also not likely to be connected for the next decade.

b. Solar Energy Research Center, Hyderabad

Funding : $1 million for equipment from ECE

Agencies Involved : -PCSIR
-Ministry of Science and Technology (MOST)

PCSIR, under MOST, has overall responsibility for research in scientific and technological fields, including conventional and non-conventional energy.

Laboratory equipment has only recently arrived. It includes a gas chromatograph, a thermal analyzer, an infra-red spectrometer and a sulfur analyzer. R&D activities in applied photovoltaics are in the future. Research funding is planned under the Renewable Energy Technologies Component, but no requests have been made to date. It is expected that results of R&D will be made available to other agencies working in the field to help in commercialization.

C. PRIVATE SECTOR POWER PROJECT (PSP)

Funding : $170 million LOP funding from USAID
total $430 million from other donors
Duration : September, 1988 through September 1998

Agencies Involved :
-USAID
-World Bank
-CIDA (Canada)
-Nordic Bank
-ODA (U.K.)
-KFW (West Germany)

Possible S&T Activities in the Private Sector Power Project

This new project is expected to be a vehicle for encouraging private sector involvement in the development of emerging technologies in the area of power generation. USAID and the GOP signed the project on September 22, 1988.

One possible S&T activity under Private Sector Power is in the area of fluidized bed combustion power plant proposals from the private sector. Project sponsors, from the private sector, would provide equity and seek commercial loans for the remaining costs. Estimated cost for one plant is about $100 million. USAID would consider funding up to 30 percent of the cost through a fund administered by the National Development Finance Corporation. Other donor monies will be available to support the fund.

D. RURAL ELECTRIFICATION PROJECT (RE)

Funding : $250 million, Rs.24 million (total project)
Duration : September 1982 through September 1992

Agency
Involved : Water and Power Development Authority (WAPDA)

Pakistan's development depends on meeting a growing demand for energy. The Rural Electrification project seeks to strengthen the organization, staff and management capabilities of WAPDA's distribution function. Another goal is to help the GOP provide reliable and efficient electric service in rural areas, and to reduce voltage fluctuations and loadshedding.

S&T Highlights Through 1988 and in the Future

1. Energy Loss and Rural Distribution System Expansion Components

a. Computer-assisted Distribution Planning and Design (CADPAD)

Funding : $1 million for hardware
$200 thousand for TA

Agency
Involved : WAPDA

Application of imported technology has led to a computer-aided design of WAPDA's power distribution structure based on computerized data. The CADPAD is state-of-the-art technology developed by the American firm, Westinghouse. It has been used in the U.S. for about five years.

Used for design work, CADPAD saves energy planners weeks and months of time. The mapping systems generated by this technique also allow for improved future planning.

b. Distribution Mapping: A Future Activity

Funding : $4.7 million
Date : next few years

Funds will purchase the computer hardware and software and surveying equipment. The computer-based distribution mapping system will use CADPAD and high-level main frames. It will address the primary needs of distribution planning and operations. The system will be of direct benefit in areas of energy loss reduction, efficient planning and resource utilization.

D. RURAL ELECTRIFICATION PROJECT (Continued)

2. Power Generation Component/Guddu

Funding :
- $266 million (total plant cost). Funds came from a variety of sources, the main donor being the Asian Development Bank (ADB)
- $60 million from USAID for TA in design and construction of plant, and for gas turbines which were factory-assembled in the U.S.A.

Agencies Involved :
- WAPDA
- ADB
- USAID

Introduction of Combined-Cycle Power Generation Technology to Pakistan: Rural Electrification's Largest S&T Success Story

USAID, together with WAPDA and the ADB, have built a power plant in the Sui Gas Fields of upper Sind at the Guddu Barrage. It is located where natural gas pipelines cross the Indus River (an excellent site, as water is needed for cooling power plants). Phase One, completed in 1986, provides 400 MW of thermal power to Pakistan's electricity-starved national power grid.

Phase Two, completed in 1988, uses waste heat from the now operative gas-fired turbines to produce an additional 200 MW of power. Phase Three, fully funded by USAID, is expected to generate another 300 MW of combined-cycle power. A combined-cycle plant can provide 50 percent more power than a single-cycle gas turbine from the same quantity of fuel. Though new to Pakistan, the technology has been used commercially in the U.S. for about 10 years.

The highly efficient power plant at Guddu serves as a particularly good example of technology transfer. Success has encouraged WAPDA to upgrade existing power plants by introducing combined-cycle technology. One example is the gas turbine plant at Faisalabad.

HEALTH SECTOR

A. MALARIA CONTROL II EXTENSION (MC-II) Project Amendment

Funding : $25 million for extension, $66 million LOP
Duration: September, 1988 through September, 1992

The amendment continues work begun in the Malaria Control Project. MC-II aims to contain and further reduce the incidence of malaria and to foster national self reliance in Malaria Control.

S&T Highlights Planned under MC-II

1. Operational Research Component

Funding : $300,000 bilateral funds for operational research

Agencies Involved:
-Special Education and Social Welfare Division, Ministry of Health
-National Institute of Malaria Research and Training (NIMRT)
-Directorate of Malaria Control

This component aims to strengthen the capabilities of NIMRT and provincial malaria control programs to conduct operational research and field studies. It provides research supplies and equipment and technical assistance in and training for operational research studies. The design and overall coordination of malaria research will be vested in the newly established NIMRT. Although such a facility may in the future undertake basic research, the immediate need for operational research must take precedence.

a. Operational Research studies planned by NIMRT:

- Protocol NIMRT - 87-1:
"The evaluation of the malaria vectorial status of Anopheles stephensi in rural Pakistan."

- Protocol NIMRT - 87-2:
"The development of Alternative Malaria Control Methods feasible for use through community participation."

- Protocol NIMRT - 87-3:
"An evaluation of the effect of an increased use of primaquine on the transmission of falciparum malaria."

- Protocol NIMRT - 87-4:
"An evaluation of the effectiveness of various primaquine radical treatments against vivax infections in Pakistan."

A. MALARIA CONTROL II EXTENSION (Continued)

1. Operational Research Component (Continued)

b. Additional Proposed Operational Research Topics:

- Country-wide distributional studies delineating the range of primary and incriminated secondary vectors of malaria in Pakistan.

- Bionomic studies of primary and suspected secondary vectors of malaria in Pakistan including feeding and resting habits, breeding habits, seasonal densities, etc.

- Field testing and evaluation of supplementary methods of appropriate vector control. Activities: 1). Reduce mosquito breeding places through environmental management. 2). Introduce biological agents such as fish (which eat mosquito larvae) and Bacillus thurigensis Israelis and others.

- Pilot studies of alternate insecticides.

- Monitor the severity of the problems of insecticide resistance, restricting testing to currently used insecticides and baseline controls.

- Monitoring for drug-resistant parasite strains and their distribution in Pakistan.

Furthermore, the Project Paper strongly urges that the following basic research activities should be addressed in the near future.

c. Illustrative List of Proposed Operational Research Activities:

- Clearly delineate the distribution of each of the primary and secondary anopheline vectors on an ecological and geographical basis.

- Provide seasonal information on prevalence of all vector species as determined by meteorological factors.

- Clearly define larval habitat types and composition for acknowledged vector species where not already known.

A. MALARIA CONTROL EXTENSION II (Continued)

1. Operational Research Component (Continued)

c. Illustrative List of Proposed Operational Research Activities (Continued)

- Identify and test the use of selected permanent control techniques to habitats of vector species illucidated in the study above.

- Review and reaffirm existing knowledge of the vectoral role as well as the vectoral capacity of all suspected vector anophelines.

- Test the response of all target vector species to chemical pesticides to be used in the program.

- Monitor distribution and severity of chloroquine resistance in p. falciparum.

B. PRIMARY HEALTH CARE PROJECT (PHC)

Funding : $30 million
Duration: September 1982 through March 1989

Agencies Involved:
-Pakistan's Federal Ministry of Health
-Provincial Departments of Health
-National Institute of Health

The goal of Primary Health Care is to improve the quality and expand the coverage of primary health care services in rural areas of Pakistan. The project supports the national immunization program, public education in areas such as oral rehydration therapy, training of health technicians, institution building, and operational research.

Possible Future S&T Activities

1. Field Testing of a Solar-powered Digital Scale

Funding :
- Estimated 30 x $100/scale from PHC project funds.
- S&T Bureau (central) funding is also expected. Amount to be determined.

Agencies Involved:
- Teaching Hospitals
- Rural Health Centers

Field testing of a portable, solar-powered, digital read-out scale which is practical for accurate weighing of young children. If the scale is successful, it may be used in a small follow-up to the National Nutrition Survey and for growth monitoring programs in rural health facilities.

C. NON-BILATERAL S&T ACTIVITIES IN THE HEALTH SECTOR

1. Applied Diarrheal Disease Research (ADDR)

Funding : $47,000 for each study from the S&T Bureau, Washington, and the ADDR, Pakistan.

Agencies Involved: -Aga Khan University
-Harvard University

The research projects look at cereal-based oral rehydration therapy.

- "A Study on the Dietary Management of Persistent Diarrhea." Dr. Zulfiqar Ahmed Bhutta, and Professor A. Majid Molla of the Aga Khan University Hospital. Dr.'s John Snyder and Kristy Hendricks of Harvard School of Medicine. August, 1987.

- "The Role of Food in the Management of Acute Diarrhea in Children." Dr. Salahuddin A. Shaikh of Aga Khan University Hospital and Dr. A. G. Billoo of Dow Medical College. Dr.'s Allan Walker, John Snyder and Kristy Hendricks of Children's Hospital, Harvard School of Medicine. August, 1987.

Note: In the future, USAID may buy into this type of research under the Child Survival Project.

2. BOSTID Research Grants

Funding : $140,000 for each project from the Office of the Science Advisor

Agency Involved: Board on Science and Technology for International Development (BOSTID)

Program is administered by BOSTID. All grantees receive frequent visits from noted U.S. scientists. Principal investigators attend workshops and meetings in their technical areas.

Research Projects

- "Etiology of Acute Respiratory Diseases in Children." Dr. Abdul Ghafoor leads a multi-disciplinary team at the National Institutes of Health, Islamabad. He and an assistant attended a workshop on data management and a coordination meeting on acute respiratory disease research in Washington, D.C. in June, 1987.

C. NON-BILATERAL S&T ACTIVITIES IN THE HEALTH SECTOR (Continued)

2. BOSTID Research Grants (Continued)

Research Projects (Continued)

- "Rapid Epidemiologic Techniques for Assessment of Childhood Disability."
A three-nation study led by Dr. Z. Meher Hasan of the Jinnah Postgraduate Medical Center, Karachi. Dr. Hasan also participated in a meeting on rapid epidemiologic techniques in Peru in April, 1987.

3. Field Testing of a Disposable Syringe and Needle

Funding : $40,000 central funding from S&T Bureau, Washington, in coordination with the World Health Organization.

Agencies Involved:
-USAID
-S&T Bureau (REACH)
-World Health Organization

Field testing of a single-use, self-destructing, disposable syringe and needle. Testing would be under the "Expanded Program for Immunization" of the National Institute of Health.

Note: The Primary Health Care project may be involved in this project.

POPULATION SECTOR

A. POPULATION WELFARE PLANNING PROJECT (PWP)

Funding : $74 million
Duration: August 1982 through September 1989

Project goals are to strengthen the Government of Pakistan's population planning, evaluation, operations research, motivational and logistic capabilities, and performance.

S&T Highlights Under PWP:

1. Demographic and Health Survey

Funding: To be determined
-$140,000 estimated bilateral funding from PWP for local costs
-$220,000 estimated central funding from U.S. firms
Duration: Will begin in early 1989

Agencies Involved: -GOP
-Westinghouse,
-USAID
-National Institute of Population Studies (NIPS)

NIPS will conduct the Demographic and Health Survey. Basic demographic research is the foundation of Pakistan's future Health and Population Programs. This survey is the Population Sector's equivalent of Coal REAP in the Energy Sector. Research will focus on levels and trends of contraceptive knowledge, and availability and use of contraceptives.

2. State of Population in Pakistan Survey

Funding : Bilateral funding of $15,000.
Duration: May-July 1986.

Agency Involved: NIPS

The survey was conducted by NIPS. It involved collection and analysis of demographic data.

A. POPULATION WELFARE PLANNING PROJECT (Continued)

3. National Research Institute For Reproductive Physiology (NRIRP)

Funding: -$266 thousand bilateral funds earmarked to date
-$2 million LOP funds budgeted.

USAID funding has provided technical assistance, training, and laboratory equipment and supplies. The Institute plans R&D activities to develop contraceptives based on eastern medicine and indigenous materials. The lab is now set up and research plans are being developed.

Note: Research funding, if requested, might come from PWP.

B. NON-BILATERAL S&T ACTIVITIES IN THE POPULATION SECTOR

1. Clinical Trials of Contraceptives

Items Tested : -Norplant Subdermal Contraceptive Implant
-Copper-T 380A IUD

Funding : -$83,000 bilateral funds
-$213,000 non-bilateral funds from Family Health International, an American research firm in reproductive health.

Duration: -1988 to 1991, Norplant Subdermal Implant trials
-____ to 1989, Copper-T 380A IUD trials

Agencies Involved: -Family Health International (FHI)
-Pakistan's National Research Institute of Fertility Control (NRIFC)

The Family Health International project is state-of-the-art research and technology transfer. The purpose of the trials is to test, assess and improve fertility regulation technologies and disseminate information. Both Copper-T and Norplant are new technologies world-wide. USAID input includes physician training and supply of the Norplants. FHI supplies TA and the IUD's.

2. Family Planning Enterprise Program

The project approach in Pakistan is to integrate the provision of family planning information and services into the health services being provided by an existing profit-making company. The experiment in motivating private companies to provide family planning services to their employees and pick up the cost is new world-wide. The U.S. contractors show how it is profitable for private enterprises to provide family planning for employees and help set up delivery programs.

a. Multan Road Family Welfare Project

Funding : $213,000, S&T Bureau, Washington
Duration: May, 1988 through October, 1990

Agencies Involved: -John Snow, Inc.
-Family Planning Association of Pakistan
-Mumtaz Bakhtawar Memorial Trust Hospital/Guard Group of Industries

B. NON BILATERAL S&T ACTIVITIES IN THE POPULATION SECTOR (Continued)

2. Family Planning Enterprise Program (Continued)

a. Multan Road Family Welfare Project (Continued)

This program is a model for other industrial plants in the area. Over a three-year period, it envisions mobile delivery of maternal/child health and family planning serivces to over 60,000 people. Surgery and medical follow-up are provided at the Mumtaz Bakhtawar Memorial Trust Hospital. The project provides TA for training doctors and setting up a family planning program for employees. The Norplant subdermal Contraceptive Implant will be offered.

b. Survey of Industries in Pakistan

Funding: $11,000 from S&T Bureau, Washington
Duration: 2 year contract. Dates to be decided.

Agencies Involved: -Domestic Research Bureau, a Pakistani firm
-John Snow, Inc., an American TA firm

The survey will determine the possibility for additional industry-run family planning programs similar to the Multan Road Family Welfare Project listed above.

SOCIAL SECTOR

A. INSTITUTIONAL EXCELLENCE PROJECT (IEP)

Funding : To Be Determined
Duration: Project is in design stage (12/88)

Agencies Involved:
-Ministry of Education
-University Grants Commission
-USAID

The GOP has shown a strong commitment to strengthen S&T activities in Pakistan. For example, the Ministry of Science and Technology has provided funding for Ph.D. level training of several hundred scientists at U.S. universities. (USAID provides administrative and logistic support for this activity.) Another example is the establishment of a National Scientific Research and Development Fund by the GOP. The Fund received an initial allocation of $5.5 million to support research and development activities of the private and public sectors in Pakistan.

In September, 1988, USAID received a letter from the Ministry of Education which detailed GOP plans to establish a highly qualified Institute of Science and Technology (ISATOP). The letter indicated a desire to work through HRD projects to compliment or supplement its efforts. USAID response is detailed below.

Planned S&T Activities

The proposed Institutional Excellence Project will be used to address a number of areas in which USAID can support science and technology in Pakistan.

1. Institutional Development

Funding : Approximately 80 per cent of project funds

Agencies Involved: To Be Determined

This component will concentrate on the long-term development plans of a few graduate level institutions in basic and applied sciences. It will provide technical assistance, training, commodities, professional exchanges, joint research, workshops, and seminars with appropriate U.S. universities.

A. INSTITUTIONAL EXCELLENCE PROJECT (Continued)

2. Competitive Research Grants

Funding : Approximately 20 per cent of project funds

Agencies Involved: To Be Determined

This component will support a competitive, small grants award process which will strengthen science and technology in Pakistan. Support will be available for specific research studies and limited resource needs of individuals outside the institutional development funding scheme. A possible collaboration with an already established and experienced U.S. research granting agency is being considered. The goal is to set up a process which will rationalize USAID's response to immediate assistance needs of the public and private sectors in this area.

I N D E X

I N D E X (Continued)

I N D E X (Continued)