

- PN-AMM-026

REPORT

FINAL REPORT

CONTRACT NO. AID/ta-C-1337

1967-70

LDC INDUSTRIAL RESEARCH INSTITUTE EFFECTIVENESS

UNIVERSITY OF DENVER • DENVER RESEARCH INSTITUTE

FINAL REPORT

CONTRACT NO. AID/ta-C-1377

LDC INDUSTRIAL RESEARCH INSTITUTE EFFECTIVENESS

Submitted to

Office of Science and Technology
Bureau for Technical Assistance
Agency for International Development
U.S. Department of State
Washington, D.C. 20523

Submitted by

Office of International Programs
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Denver, Colorado 80208

April 1980

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INTRODUCTION

This is the final report under contract AID/ta-C-1337. It is in essence the conclusion of a ~~six-and-one-half-year experiment~~ aimed at finding improved approaches that might strengthen applied research institutions (ARIs) in developing countries. The program was sponsored by USAID's Office of Science and Technology and included the ~~present contract as well as two preceding ones--AID/CM-ta-C-73-20 and AID/CM-ta-C-73-21.~~ The experiment was conducted by the Denver Research Institute (DRI) with the assistance of interested international organizations as well as scientific and technological institutions in both industrialized and developing countries.

Following World War II, a strong, if now discredited, belief emerged that science and technology (S&T) could solve the world's problems--problems of "unemployment and underemployment, large population and galloping rate of its increase, low income, undernourishment and malnutrition, poor agricultural practices and production, unsanitary villages without healthy drinking water or disposal arrangements for refuse, poor and inadequate housing, inadequate communication facilities by way of roads, lack of electricity in the villages, lack of school buildings and educational facilities for children, and every other demonstrable evidence of poverty."¹

To pursue this S&T panacea, developing countries, often with the assistance of international organizations or industrialized nations, began establishing institutions to conduct research and development (R&D) in areas of industrialization, agriculture, and health and nutrition. Often these were multipurpose organizations.

By the late 1960s and early 1970s, however, many were questioning not whether these newly established institutions had solved the problems of development--clearly they had not--but whether they were even contributing to the solution of their countries' problems in any significant way. It was within this environment that the present experiment was initiated.

During the late 1960s and early 1970s, a number of analyses of S&T organizations, their problems, potentials, and opportunities were undertaken. One of the most exhaustive was James P. Blackledge's comparative analysis of approximately ~~eighty institutions in about forty developing countries.~~² These analyses pointed to two problem areas: (1) the institutions too often focused on R&D projects with little potential for payoff in their

1. B.H. Singh, Remarks at seminar on "Generation and Diffusion of Adaptive Technologies to LDCs," East-West Center, Honolulu, Hawaii, 4-6 October 1972.
2. James P. Blackledge, The Industrial Research Institute in a Developing Country: A Comparative Analysis, 31 August 1975, Washington, D.C.: AID.

nation's economic and social environment; and (2) a weakness in management (as opposed to technical) capabilities tended to permeate these organizations.

Moving from the problems to their solutions, an often heard technique that held major promise for strengthening institutions of the developing nations was to link them with successful institutions of industrialized countries. With these problems and opportunities in mind, USAID initiated the experiment that this report concludes.

The experiment had three major elements:

- a grants program that focused R&D in developing countries on projects that had a high payoff potential in their own environment;
- an R&D management program that experimented with various forms of management development workshops and follow-up programs; and
- a linkage program that experimented with this technique as a means of strengthening S&T organizations in developing countries.

Each element had its successes and failures, as would be expected in an experiment. Those occurring under contract AID/ta-C-1337 are described in this report.

The report is organized into four sections. Following this introductory section are:

- section II--focuses on the linkage as a mechanism for strengthening S&T organizations;
- section III--examines the experimental R&D management development program element; and
- section IV--discusses the use of research grants as a means of increasing the relevance of research at ARIs to national development.

Conclusions and recommendations follow each section.

LINKAGES

The strategy of DRI was to explore the effectiveness of the linkage mechanism with different types of organization. As a result, DRI selected four institutions for experimentation. In each case, a memorandum of understanding was developed with the linked institute. Each memorandum was slightly different depending on the nature and needs of the institute.

When the present contract was initiated, ~~only two of the original linkages were considered active;~~ these were with the Pakistan Council of Scientific and Industrial Research (PCSIR) and the Instituto de Investigaciones Tecnológicas (IIT) in Colombia. Under the current contract, a further linkage subsequently was formed with the ~~Thailand Institute of Scientific and Technological Research (TISTR).~~³ These three linkages were quite successful, and their importance as mechanisms for strengthening the linked institutions continued to grow during the duration of this contract.

THE LINKED INSTITUTES

IIT was the first of the three institutes to be successfully linked with DRI. When the linkage was formed in 1973, IIT was very much a contract research institute that derived less than 30 percent of its income from governmental subsidy. In 1974, PCSIR, at that time a network of four separate institutes, became the second successful linkage. TISTR, a large multipurpose research institute that received virtually all of its income from governmental subsidy, became the third institute to be successfully linked with DRI. The formal linkage occurred in 1976.

The IIT Linkage

The Instituto de Investigaciones Tecnológicas was established in 1958 through the patronage of the Banco de la Republica, the Caja de Crédito Agrario, and the Federación Nacional de Cafeteros. Its purpose is to undertake applied research directed toward the industrial and economic development of Colombia. The Armour Research Foundation (now the Illinois Institute of Technology Research Institute) provided initial organizational guidance and assistance, and UNIDO furnished equipment and experts on a counterpart basis. The subsidy received by IIT has increased only slightly since its founding, and today that subsidy amounts to approximately 25 percent of IIT's operational budget requirements. The balance is derived from contracts (mostly short-term) from the private sector or governmental enterprise.

3. At the time the linkage was formed, TISTR was the Applied Scientific Research Corporation of Thailand (ASRCT). During 1979, its name was changed to the Thailand Institute of Scientific and Technological Research.

IIT's activities are conducted through four operating divisions: Applied Research, Consultation, Industrial Services, and Administration. Major areas of involvement include applied research in chemistry, food technology, industrial microbiology, mineral products, and raw materials; and technical assistance and consultation in food production, metal-mechanical industries, natural resources, construction, and related fields. Activities carried out by the institute include: techno-economic analyses; collection of technological information; quality control, standards, and performance testing; chemical, biological, and physical properties testing; industrial troubleshooting; and pilot plant operations. Specific areas of study have included food processing and dehydration; protein enrichment of bread and pasta flours and milk substitutes; the concentration of fruit juices; and quality control of agricultural chemicals, coal, brick, clays, metal products, and other materials.

IIT is attempting to establish an aggressive promotional campaign, which includes frequent staff visits to industry, topical seminars for industrial sectors, training of industrial staff, publication of informational brochures and reports, technical demonstrations, and similar activities. The establishment of an Industrial Coordination Department is planned. The institute provides technical assistance on a full cost-recovery basis, but very small industries are assisted to the extent possible on a no-fee basis.

IIT staff members have studied at various centers in the United States and elsewhere and have received specialized training that is helping to establish an IIT capability and expertise in problems of foods quality control and standards, tariffs and trade barriers, technological information and technology transfer, environmental pollution monitoring and control, coal briquetting, alternative energy development, contract research support, and research institute management--all directed toward assisting IIT to better serve the Colombian government and industrial clients in general, and specifically to assist Colombian industries in increasing their exports.

In order to participate in linkage activities, IIT was required to obtain financial support to pay the salaries of IIT staff members who were removed from contracted research projects. IIT was largely unsuccessful in obtaining such financial support from the Colombian government, which constrained the utilization of some of the services that DRI was prepared to provide under the linkage agreement. Therefore, linkage activities with IIT consisted primarily of providing technical information, arranging for the training of IIT staff members in various U.S. organizations (to enable IIT to provide more assistance to industry), and conducting technical seminars jointly with IIT and ANDI (National Association of Industrial Development). The seminars were particularly productive, resulting in requests to IIT for like activities. Thus, IIT has provided training to private company and research institute staff from Colombia, Mexico, Argentina,

Venezuela, Ecuador, Peru, Costa Rica, Panama, and elsewhere. Training has encompassed areas such as chemical and biological quality control, precooking technology and methods, composite and specialty flours, soy cake texturizing, pasta making, and other projects. It appears that Colombian governmental funds to support such seminars and training programs also will be forthcoming.

Recent changes have been made in Colombian governmental policy that will affect the future of IIT. The government is now willing to subsidize up to 50 percent of the costs of providing technical services to small-scale industry. This should stimulate an increasing use of IIT by industry, particularly the food-processing industry. A National Food and Nutrition Plan (PAN) has also been established to emphasize the significance of protein-enriched foods for the poor. In the plan, small industries that desire to produce low-cost, protein-enriched foods will be subsidized for the utilization of IIT expertise in this field. Finally, the government has recently announced a 4 percent tax on the sale of all sugar produced in Colombia. Sixty percent of this tax will be used to support R&D in all phases of sugar production and processing.

At the suggestion of DRI, IIT established an industrial advisory panel--Friends of IIT. Two committees of the panel are currently active: a Committee for Development of IIT and a Committee for Improvement of Relations between IIT and Industry. Industry leaders and ANDI have been enthusiastic about this relationship, and IIT is beginning to feel the benefits from a wider range of contacts within the industrial sector. As a result, proposals have been prepared in the areas of food and chemicals. Industry awareness of IIT's capabilities to provide considerably more than the usual consulting services has also increased. Consequently, IIT top management has been asked to participate in industry committees and on association panels when technological questions are involved.

The PCSIR Linkage

The Pakistan Council of Scientific and Industrial Research (PCSIR) is the largest technological organization in Pakistan. The need for an industrial R&D capability in Pakistan was first felt in 1951, when the Department of Scientific and Industrial Research was established within the Ministry of Industries to pursue R&D aimed at greater utilization of indigenous raw materials. In 1953, the department was converted to semiautonomous status and was renamed PCSIR. Controlled and financed by the Pakistani government, PCSIR derived its present status and increased autonomy from the PCSIR Act of 1973.

The PCSIR Directorate is located in Karachi and controls planning, development, training, budgeting, accounting, auditing, patent coverage, publications, press information, and personnel management. R&D operations are carried out through three subsidiary laboratories located in Karachi, Lahore, and Peshawar.

PCSIR also operates a diploma-granting, Pakistan-Swiss Training Center in Karachi for precision mechanics and instrumentation and a Fuels and Leather Research Center, also in Karachi.

The PCSIR laboratories conduct pure and applied R&D, with emphasis on industrial science and technology for national development. Laboratory staff undertake a variety of activities, including chemical analyses, chemical and biological testing, mechanical testing, technical information dissemination, techno-economic studies, industrial troubleshooting, and pilot plant studies and research. Research programs have included food and fruit technology, sugar and rice bran processing technology, leather technology, glass and ceramics, biological fermentation, edible and nonedible oils and fats, derivation of natural drugs from medicinal plants, ore dressing and metallurgy, mineralogy, wool technology, pesticides, polymers, coatings, building materials, and chemical engineering process design.

PCSIR performs an advisory function for both provincial and federal governments. Recently, the laboratories began to develop better relationships with industry through their efforts to promote utilization of research results. During its formative years, PCSIR was organized, staffed, and managed primarily by basic researchers and enjoyed considerable freedom in selection of research projects. Applied R&D was carried out on only a few projects stressed by the government. In 1965, however, the government demanded more applied R&D along with increased technical services to the industrial sector.

Working relationships with PCSIR have been excellent. It appears that PCSIR materially benefited from its linkage with DRI. The linkage involved the Karachi, Lahore, and Peshawar Laboratories, and the Fuels and Leather Research Center (FLRC). Interaction with the Lahore laboratories was primarily in the areas of small-scale industry assistance and small-scale sugar and edible oil production technology. Work in Peshawar focused on natural resources, specifically minerals development. Several staff training programs and two techno-economic feasibility studies, conducted jointly with PCSIR staff and supported by contract AID/CM-ta-C-73-20, led to the strengthening of an Industrial Liaison Unit in the Karachi laboratories. While funds from contractual sources are not large by some standards, they do represent a trend on the part of the Karachi laboratories toward increased interaction with the private sector. Staff of the FLRC participated in several management development workshops.

As a partial result of two techno-economic feasibility studies (by-product chemicals from solar salt residues and soluble fish protein concentrates), PCSIR received funds from the Pakistani government to build pilot plants and demonstrate to industry the commercial feasibility of these two processes. Under this contract, DRI provided technical assistance, as required, in the design and operation of the pilot plants aimed at producing test results for use by industry.

PCSIR laboratory directors from Karachi, Lahore, and Peshawar participated in management development workshops for research directors conducted by DRI under contract AID/CM-ta-C-73-21 in Bangkok, Ankara, and Tunis. DRI staff members made frequent visits to PCSIR in connection with staff training, technical assistance, and other linkage activities. The rapport between PCSIR and DRI staff was excellent throughout the contract period.

Two events in Pakistan caused delays in pursuing the activities proposed under the revised linkage agreement with PCSIR. These were: (1) the promotion of the director of the Karachi laboratories to the position of Member-Technology of the PCSIR Governing Board; and (2) the civil disturbances following the March 1977 national elections. These two events delayed scheduled workshops, provision of technical assistance, and follow-up on small-scale industry outreach programs.

The TISTR Linkage

The Thailand Institute of Scientific and Technological Research (TISTR) is the main center for governmental and industrial research in Thailand. It was established in 1963 to undertake applied scientific research and to coordinate research programs involving governmental departments and organizations. It is responsible for promoting the application of its findings in order to contribute to national development and the utilization of natural resources. TISTR provides scientific services and technical assistance and participates in a number of activities, including technical information collection and dissemination, standards and performance testing, industrial troubleshooting, and research projects. Areas of capability include biotechnology, chemical technology, metallurgy, and agricultural products.

Examples of projects undertaken are: (1) utilizing and upgrading local raw materials; (2) identifying problems of existing industries; (3) adapting known technology to local conditions; and (4) researching the feasibility of new industries. Past activities have dealt with preinvestment studies, utilization of agricultural products, pulping studies, industrial wastes, solar technology experiments, minerals and metals studies, exploitation of natural products, the chemical industry, the building industry, physics and engineering, socioeconomic studies, environmental and ecological studies, water pollution, and sewage treatment.

Today, research at TISTR is devoted primarily to short-term applied research, although recently its charter was expanded to allow for more fundamental explorations that have significant potential for the development of the country. Some projects originate from governmental requests and others through surveys and contacts with government and industry. Although only about 5 percent of the budget derives from governmental and industrial contracts, the Thai government and industrial firms are increasingly requesting support and assistance from TISTR. Since

DRI has been working with TISTR, the volume of income acquired from contracted projects has increased more than sixfold.

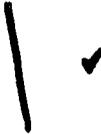
The DRI-TISTR linkage is relatively new and was originated after two of the first four linkage attempts with other institutes had proven ineffectual. The linkage was first formally proposed when the governor of TISTR visited Denver in February 1976. The linkage agreement was formally approved by the government of Thailand in December 1976. In the interim, several activities were initiated with the assurance of the governor that the agreement would be approved. The linkage was built around a program largely aimed at assisting rural development in Thailand. The program specifically focused on agricultural and rural-based industrial problems and on upgrading TISTR's management capabilities and procedures. The general goals of the program were:

- to create useful and productive employment in rural areas;
- to increase the level of income in rural areas; and
- to increase skill levels in rural areas.

Although the DRI-TISTR linkage is relatively new, TISTR responded quickly and aggressively to DRI's offers of assistance and, indeed, initiated task requests on a frequent basis.

TASK ACTIVITIES WITH LINKED INSTITUTES

It was believed that a multifaceted approach was needed to strengthen the linked institutes. Therefore, DRI concentrated on four areas that covered most of the conceived needs of the linked institutes. These areas were:

- staff development;
 - technical assistance;
 - information services; and
 - women in development.
- 

Considerable flexibility was employed in providing assistance, thus allowing DRI to respond to the varying needs of the different institutes. The directors of the linked institutes have repeatedly affirmed that this flexibility is one of the major reasons why the linkages have been successful.

Another important factor noted by management of the linked institutes was the speed with which DRI responded to the changing needs of the institutes. In 1978, TISTR believed that it was going to receive a contract from the Office of Land Reform to conduct an integrated rural land use study. The institute perceived a need for technical assistance from DRI, and DRI subsequently identified a person who could provide this support. As often happens in the business of ARIs, various factors within the government kept delaying the contract. In the meantime, a TISTR proposal won the competition to conduct a multifaceted land reclamation feasibility study that was to start immediately. TISTR therefore suggested that DRI provide technical assistance in this area rather than in land use planning. Within one month of the request, DRI had a person in Thailand working with TISTR. The project proved so successful and so enhanced TISTR's prestige that the institute has subsequently received contracts for several similar projects that it has, or is, successfully completing on its own. Without the flexibility and power to act with the speed provided under the contract, DRI would have never been able to respond as it did.

During the project, a major change occurred in DRI's internal management of the linkage activities. Originally, a task manager was assigned to each of the major areas in which assistance was being provided. Each task manager worked with all three linked institutes. Occasionally, situations arose in which task managers duplicated discussions with the management of the linked institutes. This sometimes caused confusion on the part of their management and that of DRI. Also, different areas of assistance were not as mutually supportive as they might have been. The management system caused a certain rigidity in DRI's ability to respond to linked institute needs in that DRI's internal accounting procedures allocated funds to program areas rather than to the linked institutes.

These problems did not seem as severe at TISTR as at the other two linked institutes, despite the fact that TISTR was the newest linkage. This was assessed to be a result of frequent visits to TISTR by a task leader who was managing other projects in Southeast Asia. This person consequently became a de facto coordinator of the TISTR-DRI linkage. At the January 1978 AID project review, it was suggested that DRI shift to a management system that employed linkage coordinators rather than task area leaders. This was done, and it is believed that the change contributed to the success of this program element.

The following subsections provide a summary of DRI's activities with its linked institutes in the four major areas of concentration.

Staff Development

The goals of the management training and staff development activities for personnel of linked institutes were aimed at increasing the effectiveness of administrative and technical performance within their respective institutions. Included in this task were DRI "in-residence" training programs for the directors of the linked institutes; ARI staff training (either at DRI or in some other appropriate U.S. or Third-World country institution); workshops and seminars that related to institute and project management conducted by DRI in the linked institutes; project cost controls; industrial liaison and client promotion; and the use of technical information services. DRI regarded assistance provided to linked ARIs in the preparation and selling of proposals as an overlapping activity between staff development and technical assistance.

IIT

In September 1976, an IIT staff member received three weeks of training in pharmaceutical industries quality control in the laboratories of the Squibb Pharmaceutical Company (jointly supported by the USAID Mission/Bogotá). The purpose of this training was to prepare IIT to provide appropriate quality control services to Colombian pharmaceutical industries. The trainee already has established a quality control service project with a Colombian pharmaceutical company and has been sent to Europe by that company for observation of quality control procedures there. (It should be noted that seven other IIT staff members brought to the United States for training with USAID Mission/Bogotá support in fiscal year 1976 also have active industry-supported projects underway.)

The company in question has since expressed to IIT an interest in performing a prefeasibility study and market analysis for production of antibiotics in Colombia. As ANDEAN companies are all viewed as potential markets, however, the process has been delayed by the political considerations of site selection, foreign

exchange, and other factors. Other companies engaged or interested in the manufacture of antibiotics for human and animal consumption have informed IIT of their interest in such a study, indicating a high probability of commercialization with the perception of a growing market.

Dr. Norton L. Young, director of IIT, was in residence at DRI during September 1976 to review progress of the DRI-IIT linkage and to plan program activities for the future. Dr. Young was advised that, in DRI's opinion, activities under the linkage, except for staff training, had been limited in nature and fell below DRI projections of what was required to make the linkage effective.

In the revised linkage agreement prepared jointly with Dr. Young, requests were made for information relating to sugar extraction from cane (small industry producers), the extrusion of alimentary pasta, and the briquetting of coal. The information was a precursor to follow-on technical assistance programs to be provided by DRI at a later date. Dr. Young also suggested staff development assistance and assistance in establishing a packaging laboratory similar to the laboratory that DRI created in Brazil in cooperation with the Instituto de Pesquisas Tecnológicas (IPT) of São Paulo.

Shortly after his return to Bogotá, Dr. Young decided to accept early retirement. His successor took office in January 1977 and felt it necessary to reevaluate the linkage priorities. These were confirmed by the new director, Dr. Jaime Ayala, in March 1977, with some change in priorities.

As a result of two DRI-IIT-ANDI industry-oriented seminars conducted in Medellín in May 1976 (topics were foundry and packaging; 265 industrialists attended), ANDI asked DRI and IIT to conduct nine additional industry-oriented seminars on the following subjects:

- food for the poor;
- industrial research/processing;
- extraction and exploitation of nonferrous/nonmetallic minerals;
- chemical industry (paints and pigments; sulphuric acid production; new agrochemical products such as pesticides, herbicides, and fertilizers, particularly for the cattle industry);
- reduction of iron with natural gas;
- naval construction;
- reforestation with conifers;
- transportation, both land and water; and
- domestic utilization of electric power.

DRI stipulated that while such industry-oriented seminars are useful to improving IIT's interaction with industry, these projects must be cost-shared with IIT and ANDI. During discussions

with Dr. Teresa de Buckle and Dr. Jaime Cardenosa, deputy director of IIT, priorities were established for the early conduct of seminars with the assistance of COLCIENCIAS and ANDI in:

- quality control of high-nutrition, low-cost foods;
- marketing of foods for low-income groups; and
- appropriate technology to meet Colombian food industry needs.

The first of these seminars, conducted in Medellín in March 1978, focused on "Quality Control in Food Production with High Nutritional Value and Low Cost." Financial support was provided by COLCIENCIAS and ANDI, in addition to USAID funds furnished through DRI. Four DRI representatives participated in the seminar, along with 150 participants from 80 public and private organizations in Colombia.

The seminar covered topics such as standards and quality control systems, implementation, and comparison of such systems in various countries; mechanisms for assistance in quality control; and the processed foods industry. The workshop served to formulate IIT's concepts of quality control for industry and provided an opportunity for IIT to promote its solution to specific Colombian problems. It proved to be a valuable experience and a confidence builder for Colombian industrialists to see IIT and foreign experts taking the same stand on issues, thus reinforcing the perception that IIT can be relied upon for up-to-date and practical solutions to Colombian food quality control and standards problems.

On the occasion of the twentieth anniversary of IIT, three DRI staff members presented a five-day, middle-management workshop in Bogotá in May 1978. Twenty-two section leaders from IIT participated. Topics included in the workshop were project conception, project cycle, project organization and controls, leadership and motivation, and client liaison.

During the post-evaluation of the workshop by the IIT participants, the following recommendations were made to IIT senior management:

- prepare in a planned and efficient manner the staff of IIT, which has obtained or will obtain administrative functions (of research projects), to train and develop professionally for administration and project management;
- arrange conferences and periodic meetings relative to administrative techniques for projects that would maintain continuing interest in these subjects by the institute staff; and
- maintain an exchange of administrative and project management experience with national and foreign institutes having similar characteristics.

These expressions of interest on the part of IIT staff reflect, in DRI's opinion, a realization by IIT middle management of the need for increased emphasis on project management training in order to improve the efficiency of operations.

Dr. de Buckle and Dr. Cardeñosa of IIT were in residence at DRI during June 1977 to discuss implementation of staff development and technical assistance from DRI in the areas of food extrusion, briquetting of coal, and extraction of panela (brown sugar) from sugarcane. As a result, and in cooperation with the U.S. Department of Agriculture, Dr. de Buckle attended the Annual Meeting of the Institute for Food Technologists (IFT), followed by visits to several organizations involved in food processing, which were sponsored by the U.S. Department of Agriculture.

According to Dr. de Buckle, the work that she was able to do with experts in extrusion at the Winger Company was the most important part of her trip. Dr. de Buckle produced samples in unifying cooking and pasta-making stages within a few days (equipment for this is unavailable in Colombia). The samples were shipped to Colombia for analysis and testing, and good results were obtained for both pasta and arepas, proving that good arepas can be made from flours cooked in an extrusive cooker with even better properties than from the process used in Colombia with precooked flours. Two papers were produced. Also, Dr. de Buckle reproduced results locally at the Sambeli Company, which is seriously considering marketing the product. The project in composite flours for pasta making is ongoing and successful. The companies involved are now looking into rice as a wheat substitute because rice is less expensive. IIT decided that no market survey would be necessary because the pasta makers state that the product is not different in any way from that being produced currently.

At the IFT meeting, Dr. de Buckle received state-of-the-art information regarding evaluation of wheat-based products using the amino tetraemina, which is currently used at IIT. She also feels that she gained considerable confidence by learning that her studies at IIT were advanced and deserving of publication. She visited Colorado State University (CSU) and saw the work being done with quick-cooking beans in the Brady cooker. This knowledge is now being applied to soybeans with good results in a program sponsored by the Colombian and Dutch governments. The techno-economic feasibility has been established--one-third to one-half the cooking time at one-half to two-thirds the price of the current process, with higher nutritive values, whole fat content, and good quality protein. The product imitates locally popular white beans quite well.

On the same trip, Dr. de Buckle checked with the USDA for liquid cyclone process (LCP) state-of-the-art information for cottonseed. She received a report stating that this was not a profitable process as established at Lubbock, Texas, and thereby saved considerable time in learning what to expect. She sent the information to ANDI in Lima, and this was taken into account in

ANDI's decisions regarding the product and its appropriateness in South America. As a further consequence of the visit by Dr. de Buckle, a proposal was written and approved for grant support from DRI to do design work in appropriate technology for extrusion of composite flours for pasta making.

Dr. Francisco Galiano of IIT is currently involved in environmental control studies of the Magdalena River and the Cartagena Bay, with special attention being devoted to gas chromatography of petrochemicals and pesticides. Dr. Galiano was brought to the United States in August 1977 for two weeks of intensive training at the National Enforcement Investigation Center, EPA, Denver; the U.S. Geological Survey, Water Resources Division, Denver; and the Battelle Northwest Laboratories, Ecosystems Department, Environmental Chemistry Section, Seattle. This training enhanced Dr. Galiano's capability to continue his research into water pollution measurement and control under a contract to IIT from the government of Colombia.

One phase of the IIT linkage, as revised in September 1976, involved development of a low-cost briquetting process for coal, which could provide an alternative source of cooking fuel for low-income families in Colombia who now use gasoline for such purposes. Camilio Olivera of IIT was invited to attend the Fifteenth Biennial Conference of the Institute for Briquetting and Agglomeration in Montreal during August 1977. Since that time, the government of Colombia has contracted with IIT to undertake the development of a process for briquetting coal, and the training is expected to have a direct impact on the contract activities. Mr. Olivera has gained background in:

- knowledge of general techniques of briquetting of solids;
- criteria for utilization of diverse binders; and
- information from other countries where actual briquetting technology is being practiced.

Another phase of the IIT linkage involved improvement in the production of panela by small industry producers in rural areas. COLCIENCIAS funded IIT to conduct the study, and it is anticipated that funding support will be obtained from the government of Colombia. Short-term training in this area was provided to Arnulfo Jiménez of IIT during the period of 26 September to 19 October 1977. The objectives of the training program were:

- to accomplish additional specialized training in sugar technology; and
- to obtain advice for establishing the steps to be taken by IIT in studying the present situation and to carry out applied research that would improve existing techniques for production of panela in Colombia.

The training was provided by F.C. Shaffer and Associates, Baton Rouge, Louisiana; USDA-ARS Crops Utilization Research Laboratory,

Weslaco, Texas; and the Plantaciones Azucar y Derivados, Tegucigalpa, Honduras.

In June 1978, Dr. Jaime Ayala, director of IIT, devoted one week at DRI to future planning and coordination of the DRI-IIT linkage and to the scheduling of activities for the final year of the program. Discussions were also held concerning the possibility of transferring to IIT the explosive forming of metals and packaging technologies that during the past five years DRI transferred to IPT in São Paulo, Brazil.

Following his stay at DRI, Dr. Ayala, accompanied by DRI staff, visited the Colorado School of Mines Research Foundation, the Solar Energy Research Institute in Colorado, USAID/OST, ATI, DOE, EPA, OAS, IDB, the World Bank, NSF and the National Academy of Sciences in Washington, D.C., and UNDP in New York. The purpose of these visits was to explore the potential for various sources of funding to continue and expand IIT projects in alternative energy sources, pollution, and similar areas.

Prior to his return to Colombia, Dr. Ayala participated in the Regional Management Development Workshop for Latin American ARI Directors in Guatemala (19-23 June 1978).

PCSIR

The director of the Karachi laboratories, Dr. Mohammed Aslam, visited DRI in August 1976 for a three-week period of consultation and work. While at DRI, the PCSIR-DRI linkage was reviewed, and plans were made for the following year. Consultations were held with personnel from DRI's Electronics Division, the Metallurgy and Materials Science Division, and the Laboratory for Applied Mechanics to determine ways that would strengthen PCSIR's capabilities in these areas and to examine new initiatives that PCSIR might pursue. Consultations also took place with the head of DRI's Patent Committee to assist PCSIR with the development of its own patent policy. While the director of the Karachi laboratories was at DRI, drafts of four proposals to the EPA were prepared in areas in which the EPA is interested in supporting Pakistan with PL-480 monies.

A joint PCSIR-DRI proposal to "Identify, Develop, Test, Produce, and Disseminate Intermediate Technology Suited for Village-Level Operations in Pakistan for Processing of Sugarcane, Oilseeds, and Rice Bran" was prepared in competitive bidding with several Pakistani and U.S. organizations and submitted to the government of Pakistan. The PCSIR-DRI proposal was subsequently selected for implementation, and the contract was negotiated (funds were to be provided by a technical assistance grant to the government of Pakistan from USAID). This joint effort clearly enhanced the DRI-PCSIR linkage and brought PCSIR into more intimate contact with small-scale rural industrial problems.

Also while at DRI, Dr. Aslam outlined the information needs of PCSIR. Visits were made to Colorado State University (CSU) to examine the potential of CSU-developed food-processing technology for use in Pakistan. Additionally, Dr. Aslam held discussions in Washington, D.C., and in Cincinnati, Ohio, with officials of EPA and USAID.

A PCSIR senior staff member completed a two-year graduate internship at DRI and studied toward a Master's Degree in Business Administration (MBA) at the University of Denver. On-the-job training at DRI (one-half-time basis) included assignments in research accounting, project cost controls and project management, techno-economic studies, institute operations, industrial liaison, and client promotion. His thesis--"Industrial Research Project Feasibility Study Handbook"--is expected to be completed in 1980. The handbook is intended to assist developing country ARI project managers in the appraisal of the commercial viability of industrial research projects prior to and during laboratory phases. DRI's experience has shown that ARIs often tend to undertake laboratory research and pilot plant operations without such appraisals, only to learn later that there is, in reality, either no market or the process is not economically feasible.

Two middle-management-level workshops were originally planned for one week each (September 1976) in Karachi and Lahore on the subject of institute-industry relations. Scheduled topics included: project evaluation and performance measurement, feasibility studies, leadership and management development, industrialization of research results strategies for industrial liaison, industrial cooperative action, and two DRI-developed case studies on TISTR and KIST. However, the Karachi director was promoted to a higher post, and no replacement was made immediately; therefore, PCSIR requested that these workshops be postponed until March 1977. These were delayed again due to civil disturbances in Pakistan and were finally completed in September and October 1977. During each workshop, several industries were visited as part of the training exercise in industrial liaison and institute-industry interaction. Thirty-four participants were involved in the Karachi workshops and thirty-eight in the Lahore workshop.

In November 1977, discussions were held in Karachi with Dr. Mohammed Aslam, Member for Technology of the PCSIR and principal intermediary for the PCSIR/DRI linkage, concerning possible new directions and enhanced activities that might be initiated with regard to DRI's assistance program. In addition to the continuation of ongoing programs, it was concluded that a thematic approach to the linkage be sought by identifying a specific area of technical emphasis and that linkage support activities be concentrated in that particular area. It was decided that it would be easier to determine and apply some direct measures of the linkage arrangement effectiveness and thus better enable program reviewers to assess the efficacy of the linkage concept--at least insofar as it applied to the PCSIR situation.

Because the number-one priority in the new Pakistani national development plan is the development of natural resources, and because the PCSIR is formally mandated to perform R&D and other activities for the minerals industry sector, concentration was to focus on this subject area. As a consequence, several specific activities were postulated:

- a planning and technology review tour in the United States by the director of the Peshawar laboratories, which is at the focus of PCSIR minerals industry-related programs;
- the presentation of a staff development workshop for upper- and middle-level PCSIR management; the workshop would concern the preparation of feasibility studies and the development and presentation of proposals especially directed toward the minerals industry;
- the organization and presentation of a symposium, the theme of which would be small- and medium-scale minerals industry development for Pakistan; and
- the development of a concept for a multiclient, minerals industry-based research project that PCSIR would carry out with the involvement of other Pakistani minerals-related organizations, both in the private and public sectors.

This general concept was presented for consideration in January 1978 during the annual review of the DRI programs by the AID Office of Science and Technology and was approved. The activity was initiated during a six-week visit to the United States by Dr. Riaz Ali Shah, director of the Peshawar laboratories. Dr. Shah was involved in an intensive tour of public and private minerals research and production organizations, such as the U.S. Bureau of Mines; the Colorado School of Mines; Hazen Research, Inc., of Golden, Colorado; Monsanto, Inc.; AMAX; Battelle Institute; the National Bureau of Standards; and others. In addition to technical updating, Dr. Shah developed detailed plans for the Minerals Industry Symposium, conducted in March 1979 in Peshawar.

A workshop was conducted in Peshawar in December 1978 that presented an integrated series of discussions and exercises based on the development of proposals and feasibility studies for the natural resources development industry. It emphasized report writing, feasibility studies, statistical analytic methods, linear programming, economic forecasting, and other applied mathematical tools. The detailed rationale and procedure for the preparation of complete feasibility studies involving sample cases, especially for consideration by financial institutions, was presented. Group analysis and discussion of actual proposals was a feature of the preparation phase and included proposal development and presentation by teams of the participants.

The small- and medium-scale extractive industry development symposium at Peshawar in March 1979 included presentations and discussions of the following principal subjects:

- contemporary minerals exploration technology;
- small- and medium-scale mining techniques;
- beneficiation and extraction technology suitable to Pakistani mineral resources; and
- a review of present and potential domestic and foreign markets for Pakistani mineral resources.

The government of Pakistan's prime emphasis within this industrial sector development activity was on improvement in employment and other economic benefits that may accrue to underdeveloped rural areas in the country. DRI's support of this symposium comprised identification of and arrangements for participation by appropriate U.S. experts in four of the specific subject areas. The experts presented papers and led discussions relevant to their particular backgrounds. Attendance at the symposium consisted primarily of representatives of Pakistani private and public sector minerals industry interests, but also included a few representatives from Turkey, the People's Republic of China, and Iran--which share common mineral provinces with Pakistan--as well as representatives from Indonesia and from various international minerals industry firms. AID funding through the DRI contract was limited to payment of transportation and per diem for invited U.S. symposium contributors (four individuals), plus funds directly related to DRI staff-time costs and travel and living expenses.

The minerals industry development symposium is expected to have such long-range effects as:

- a more effective relationship between PCSIR and the minerals industry sector in Pakistan;
- increased input for the next Pakistani six-year national development plan as it relates to natural resource use;
- a research project to be conducted by PCSIR concerning some significant aspect of small- and medium-scale minerals industry; and
- broader exposure of PCSIR to the private sector in Pakistan, plus to selected minerals industry representatives from Turkey, Iran, China, and multinational concerns.

While it was not possible to evaluate the Lahore workshop, an evaluation was made of the Karachi workshop. Figure 1 shows that the participants believed that more time was needed for project evaluation, while the usefulness and detail of the industrial liaison presentations required more thorough development of inputs. Overall, however, the evaluation indicates that the Karachi workshop was moderately successful.

In another instance, DRI assisted PCSIR in the search for U.S. engineering organizations to participate in joint ventures for making feasibility studies of minerals projects in Pakistan. This program resulted from an industrial development loan by AID

Figure 1. Quantitative Evaluation of the Karachi Workshop
26 September to 1 October 1977

Rating Scale: 3 = very good
to
0 = not good

Number of voters (participants): 24

Evaluation Criteria ↓	Workshop Topics →					
	Industrial Liaison	Commercialization	Feasibility Studies	Leadership and Management Development	Project Evaluation	Quantitative Methods
I. Content						
1. Applicability/usefulness	1.88	2.42	2.23	2.26	2.25	2.40
2. Adequacy of depth/detail	1.83	2.17	2.06	2.13	2.11	2.19
II. Presentation						
1. Clarity	2.21	2.35	2.50	2.33	2.18	2.29
2. Conciseness	2.21	2.90	2.29	2.20	2.09	2.29
3. Organization	2.27	2.19	2.38	2.28	2.14	2.29
Average	2.23	2.48	2.39	2.27	2.14	2.29
III. Time Allocation	2.35	2.29	2.37	2.11	1.75	2.28

to Pakistan and required significant participation by U.S. entities in the studies. Although unsuccessful in identifying an adequate range of U.S. interest and capability regarding a study of Pakistani gypsum industry development and expansion, DRI was able to enlist the participation of an outstanding technology source for a study of bauxite industry potentials in the country. This assistance, in the context of the linkage theme of minerals-related research, resulted in a joint PCSIR/DRI/Hazen Research, Inc. proposal (prepared during Dr. Shah's visit), which achieved second place in international competition.

All tasks of the PCSIR linkage suffered and were constrained appreciably by the political situation in Pakistan and by the uncertain relationship between the governments of Pakistan and the United States. Both difficulties resulted in delays and other operational problems.

TISTR

In February 1977, a DRI staff member spent three weeks at TISTR planning for several technical assistance activities to be initiated in 1977 and working with selected TISTR staff members in a "proposal writing" training effort. This consisted of conducting individual consulting sessions with TISTR staff and leading a team in the preparation of an actual proposal in response to a request by the Thai government. This request, open to international competition, was for the conduct of surveys and new commercial feasibility studies in six agricultural areas of importance to Thailand. Approximately twenty proposals were submitted, many from U.S. organizations. TISTR's proposal got into the "runoff" for the contract. This was encouraging inasmuch as this was TISTR's first attempt to compete in the international bidding process, and TISTR was the only Thai firm to get into the runoff.

In April 1977, a DRI staff member visited TISTR to initiate and promote two additional proposals:

- A proposal to the Thai Department of Technical and Economic Cooperation (DTEC) for developing an agricultural products packaging technology laboratory and extension capability in Thailand. This would consist of a joint Thai institutional capability with the laboratory activities residing within TISTR and the extension activities within the Thai Industrial Services Institute. TISTR developed the first draft of this proposal, to which DRI reacted. The proposal was accepted in concept, and the Belgian government approved TISTR as the institute to perform the activities. A first phase training activity is currently taking place.
- A proposal to further develop the R&D management capability of Thailand and to establish an indigenous capability for continuing the R&D management training function. This was envisioned as a two-task project,

with DRI staff initially providing a series of management development short courses to R&D project and institutional management and subsequently working with selected TISTR staff and the National Institute of Development Administration (NIDA) to develop a cadre of Thai R&D trainers who could continue the instructional function beyond the life of the linkage. DRI developed the first draft of this proposal, to which TISTR reacted. The proposal currently is pending.

In June 1977, DRI provided an opportunity for the deputy director of TISTR's Industrial Research Department to attend "A Seminar for Women Managers and Administrators in Agriculture, Rural Development, Home Economics, and Nutrition," conducted by the U.S. Department of Agriculture. The deputy director spent five days at DRI to plan the women managers' development program to be conducted by TISTR-DRI in Thailand. (It should be pointed out that prior to DRI's commitment to support the TISTR staff member's participation in the USDA workshop, DRI attempted to find support for her from other sources in order to stretch OST funds. Support was sought from USDA, Asia Foundation, Pathfinder, and AID's Women in Development Office. While all of these groups found the DRI goal admirable, for various reasons all except USDA, which waived tuition, were unable to provide assistance.)

A TISTR staff member, scheduled to be in charge of institutional planning and evaluation upon his return to TISTR, began a two-year training program leading to an MBA in management in September 1977 and finished in June 1979. During his stay in Denver, the TISTR staff member was involved one-half time in academic pursuits and one-half time in a variety of DRI management and planning activities. He has since returned to TISTR and been placed in the planning office. Subsequent to the first staff member's arrival, a second member of the TISTR staff has initiated a similar program.

Part of the DRI linkage with TISTR involved assistance in integrated rural development projects undertaken by TISTR with the support of the Thai government and the USAID Mission to Thailand. This task involved staff development, training in proposal preparation, and, at a later stage, DRI on-site technical assistance (October and December 1978).

In November 1977, a representative of TISTR, accompanied by a DRI staff member, spent two weeks in Indonesia and the Philippines studying integrated development activities. The study tour was beneficial to TISTR in that it provided background experience and guidance in:

- improving the ongoing TISTR integrated rural development project to make it more practical and realistic;
- assisting TISTR in the preparation of a proposal on "Prefeasibility Studies Related to Flood Control, River Pollution Problems, and Urban Development Projects in

Chonburi" (submitted to the government of Thailand in December 1977, part of which was contracted with TISTR; DRI provided technical assistance in October and November 1978);

- assisting TISTR in preparation of a concept paper based on cashew nut plantations and industries; and
- assisting TISTR in preparation of a research proposal on integrated slum development in collaboration with the Building Research Department, to be submitted to the government of Germany.

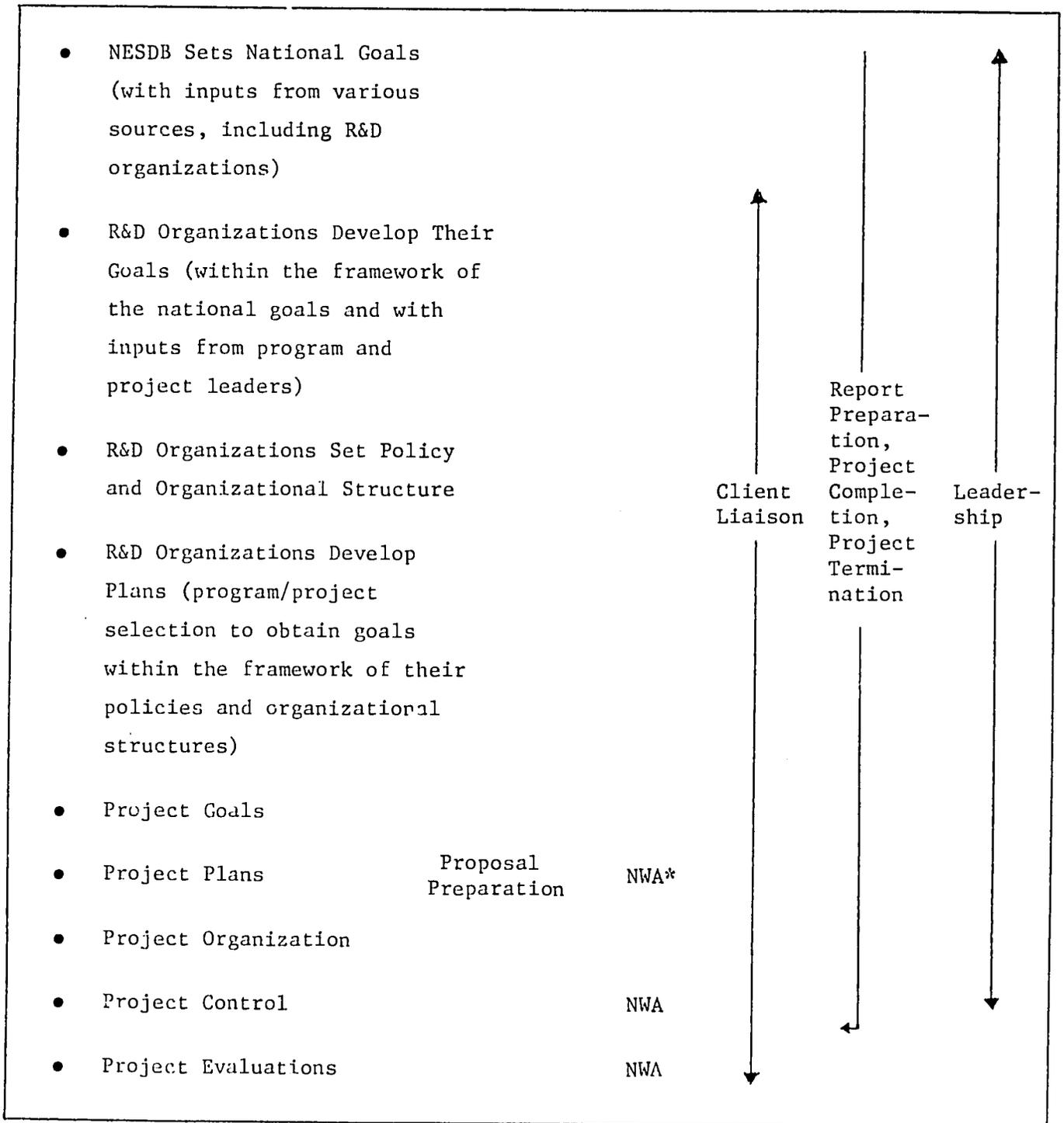
The experiences gained from this study tour are expected to further influence TISTR's ability to increase its activities in integrated development, an area in which both the government of Thailand and the USAID Mission to Thailand are placing considerable emphasis.

At the request of TISTR, DRI presented a ten-day R&D project management workshop in Thailand in December 1977. The workshop received financial support from the Thai government in addition to USAID support through DRI. The objective of the workshop was to increase the effectiveness of Thai management of R&D. The workshop focused on issues confronting the R&D project manager. Participants examined questions on project management from the inception of an idea to the commercialization of the project results. In addition to workshop leaders from TISTR and from DRI, twenty participants were involved representing TISTR, the Department of Science and the Department of Industrial Promotion of the Ministry of Industry, the Office of the National Economic and Social Development Board, the Military Research and Development Center, Mahidol University, the Office of Land Reform, and the Preserved Food Organization. The hierarchy of workshop activities is shown in Figure 2.

A wide representation of agencies and fields of research attended the workshop. This was deliberate in order to obtain better synchronization and convergence of R&D efforts for serving national goals and to encourage cross-sector projects and programs. A corollary workshop effect was that it led to discussions and, hopefully, to the creation of informal but effective interinstitutional and interagency linkages. Another workshop on the same topic was conducted in December 1978 with participants from TISTR, Kasetsart University, and the Industrial Science Institute.

Also at the request of TISTR, DRI presented a five-day workshop on R&D institutional management. This workshop secured financial support from the Thai government and from USAID through DRI. The objectives of the workshop were to increase the effectiveness of TISTR's management at the institutional level, to impress on the representatives of organizations important to TISTR the value of such an institution to the nation's development, and to acquaint those organizations with the particular problems faced by a contract R&D organization. DRI's two-man workshop team made

Figure 2. Hierarchy of Workshop Activities



*NWA refers to network analysis.

presentations in group dynamics; communications; skills and information transfer; project selection, planning, and proposal development; project evaluation and follow-up and policy planning and implementation; and research administration. The team conducted in-depth discussions directing the substance of these topical areas to particular questions, issues, and problems faced by TISTR. To accomplish the second and third objectives, TISTR invited representatives from the National Research Council, the National Economic and Social Development Board, the Budget Bureau, the Department of Technical and Economic Corporation, the Office of the Prime Minister, the Board of Investment, and the Industrial Finance Corporation of Thailand to participate.

During the course of the February 1977 OST review of this contract, it was decided that the linked institutes should be provided with more training and assistance in obtaining technological information so that they can become more independent in this area of expertise. Thus, a staff member of the Thai National Documentation Center of TISTR was brought to the United States for one month, beginning in mid-March 1978, for training in modern techniques in management and operation of information systems in the United States. The training was conducted at DRI, NTIS, the Library of Congress, the National Library of Medicine, the National Agricultural Library, VITA, Worm World, Inc., the National Center for Atmospheric Research, the Colorado Technical Center, the Solar Energy Research Institute, and Information Handling Services. Following this training, a DRI information specialist assisted TISTR in reorganizing the Thai National Documentation Center and in planning a workshop on technological information services that was subsequently conducted in Thailand in August 1978.

Technical Assistance

Technical assistance is defined as those activities that emanate from specific requests by the linked institutes to solve a particular problem. Invariably, these involve the conduct of technical information searches through DRI's "Know-how Information Service" (KIS) prior to DRI providing the technical assistance. During the latter part of the contract, however, some of the requests were for management assistance. These included efforts to improve the ARI's operations in order to allow for more effective interaction with potential public and private sector clients, to establish or to improve a technical information service in the ARI, or to assist in the design and implementation of a new project. Every attempt was made to provide assistance that could benefit either medium- or small-scale industry. Experience has shown that the governments of the three linked ARIs are pressuring these organizations to undertake programs that are important to the national planning process. Some requests for technical assistance related to these increased pressures.

IIT

In September 1978, a DRI packaging specialist visited IIT to discuss IIT's plans and objectives in food packaging R&D. Discussion concerned the development of a national center for packaging at IIT, but it was determined that at that time, standardization of the food products themselves was a more pertinent issue. After consulting with various IIT staff members, it was decided that, given an appropriate product, IIT would become involved in establishing a packaging center to develop and test food containers first for the domestic market and later for export, if such a market were to develop.

A coal research section was set up at IIT and is now engaged in coal technology programs. The chief sponsors of IIT in this and other areas include the Banco de la Republica, the Federación Nacional de Cafeteros, the Empresa Colombiana De Petroleos, the Caja De Crédito Agrario, and the Instituto De Fomento Industrial.

The assignment of Raymond Zimmerman, DRI consultant, was with the coal section of IIT. More specifically, his responsibilities concerned the following subjects:

- technical assistance for coal preparation technology, including sampling and testing procedures; various unit processes involving crushing, blending, coal washing, and storage systems; and allied research projects involved with coal preparation;
- coal utilization research projects involving the substitution of coal for oil and gas;
- coal preparation seminar for organizations involved in coal development, including workshop discussions;
- field trips to typical coal mines, coke ovens, and thermal power plants using coal; and
- suggestions regarding library reference material on coal and additional equipment needed at IIT.

Mr. Zimmerman's one-month stay in Colombia resulted in his making the following conclusions and observations:

- Colombia has extensive coal reserves, widely scattered throughout the country. Extensive drilling is taking place in the El Cerrejón coal region; however, similar programs should be instituted in other important areas.
- Colombia is currently producing over 3 million tons of coal annually, of which some 300,000 tons (including coke) are exported. Various plans are proposed to increase production to over 35,000,000 tons within the next 10-15 years, and this will call for considerable research as to quality and type of coal to be produced.
- The most severe obstacle in achieving increased tonnage is the transportation bottleneck and other infrastructure, including the need for consolidation of the many small mine operations.

- Although Colombian coals are geologically young, as a result of Andes tectonic influence, metamorphism has produced coals of all ranks, from lignite to semi-bituminous, and all classes of bituminous coals, to anthracite. It is necessary to more closely delineate these coals by rank and quality. Most of the coal is used in a raw or run-of-mine state; however, analyses indicate a wide range in ash content. Much of the coal should be cleaned by some degree of preparation.
- Some of the coals are high-quality coking coals. IIT tests show that there is considerable potential in coking coals by proper coal preparation and blending.
- Much of the analytical data available on Colombian coals are given in terms of proximate analyses and calorific value, with sulfur as "total" sulfur. There is a need for more detailed coal analyses, such as mineral analyses of ash, ultimate analyses, and ash fusions, and for trace element analyses. Little washability data are available (specific gravity distribution of the coals), particularly on a run-of-mine basis. Sulfur content should be further split into the forms of sulfur, particularly organic and pyritic.
- Examination of the two thermal power plants using coal indicates a wide variation in coal quality. Closer quality control is required. Stockpiles on fire, as a result of spontaneous combustion, show the need for proper methods of coal storage (layer piling with compaction).
- Only two small coal-washing plants exist in Colombia (200 T.P.H.). The one at Cali has been shut down for a number of years. The other one is at the Paz del Rio steel works and is of relatively modern design.
- There is a definite need for more precise sampling of the coals, because laboratory coal analysis can be misleading. The core analyses of El Cerrejón, however, appear to have been done correctly and completely.
- The research work of the IIT coal section has been noteworthy given the limitations of the staff and equipment. A larger staff is required if IIT is to assume the importance in Colombian coal technology that it should. It is fairly well-equipped but in need of basic items. It is the only laboratory in Colombia that is equipped with suitable petrographic apparatus, and greater use should be made of this method of coal analysis.
- Fourteen subject areas were identified that IIT could or should research, provided that the organization is financed. Coal is of primary importance to Colombia, and there is an urgent need to proceed along the lines suggested. Some of the most important are: (a) study of systems for the substitution of coal for oil and gas; (b) study of the coking coal potential and coking qualities; (c) more detailed analyses of coals for particular end use, including export requirements;

(d) more uniform procedures for sampling and analysis of Colombian coals; and (e) a study of current coal gasification and liquefaction techniques for potential long-term use.

- It is suggested that a high-level coal research committee be formed to allocate urgent research activities and provide the funds for implementing them.

PCSIR

The linkage activities with PCSIR were constrained by the uncertain political situation in Pakistan during the course of the project. As a result, emphasis on occasion focused more on planning than on implementation. Nevertheless, notable progress was attained in several significant areas.

PCSIR was asked to contribute significantly to the formulation of the next Pakistani six-year plan with respect to minerals resources development. PCSIR had available approximately \$2 million in foreign exchange to invest in upgrading its minerals extraction and beneficiation laboratories. During the last two years, DRI provided technical assistance to PCSIR in planning a number of activities related to minerals resources development. These included:

- two months of training in the United States for the director of the Peshawar laboratories of PCSIR in minerals processing and related activities;
- assistance in the design of new minerals research facilities;
- technical assistance on process development; and
- assistance in organizing and conducting a Pakistani Minerals Development Conference and a group research project.

The minerals conference was held in Peshawar in the spring of 1979. DRI's assistance in this program consisted largely of identifying appropriate U.S. experts and recruiting them to prepare and present papers during the conference. Some of the principal conference agenda items were:

- occurrences and characteristics of commercially exploitable mineral resources in Pakistan (presentation by a Pakistani expert);
- status of minerals exploration technology, ranging from satellite applications to ground survey techniques (presentation by a U.S. expert from Hazen Research, Inc. of Golden, Colorado);
- state-of-the-art discussion of current mining technology, particularly that which is applicable to medium- and small-scale operations in Pakistan (presentation by an expert from Jet Propulsion Laboratories of Pasadena, California);

- current developments in extraction and beneficiation technology applicable to the Pakistani minerals situation (presentation by a representative of Hazen Research, Inc., Golden, Colorado);
- world markets and projections for minerals utilization, with special reference to those occurring in Pakistan (presentation by a representative of the AMAX Corporation of the United States); and
- Pakistani minerals industry development needs and opportunities, including financial resources and the type of government-sponsored investment inducement programs that may exist (presentation by two dozen Pakistani experts).

The Peshawar conference was also attended by other foreign minerals industry representatives, including delegates from Indonesia and the Peoples' Republic of China. The conference was successful in focusing attention on the various aspects of small-scale minerals industry development and in providing input for national development planning in this subject area. Field trips to bauxite and sapphire mines were arranged for the participants to illustrate the types of problems facing the Pakistani mining industry.

The head of the DRI Electronics Division spent three weeks at PCSIR in September 1976 to evaluate the resources and capabilities of PCSIR's electronics program and to make recommendations for enlarging and strengthening the electronics activities of PCSIR. He visited numerous Pakistani electronics industries jointly with PCSIR staff and provided advice and consultation to PCSIR relative to specific projects.

A jointly conducted techno-economic feasibility study on bitters ("Production of Chemicals from Bitters: Techno-economic Feasibility") was also completed and published by PCSIR. Since publication, DRI has distributed the report to other interested ARIs in order to demonstrate the potential of such studies in their institutes.

In response to PCSIR's request for a techno-economic study on the utilization of mazri in the production of commercial fibers, DRI conducted a preliminary study and forwarded to PCSIR the outline for the proposed techno-economic survey. Technical assistance was also provided on a fish protein concentrate (FPC) study, which was conducted during the spring of 1978.

At the request of the EPA, DRI assisted PCSIR in developing three proposals to be supported by that agency using \$250,000 of rupee-equivalent PL-480 funds (pollution in the Lyari River and Arabian Sea area around Karachi; water reuse from mercerizing waste and desizing wastes of textile-printing industries; and evaluation of the relative importance of agricultural and industrial wastes). As of January 1980, these proposals were still awaiting approval by the cognizant Pakistani governmental agencies.

In June and July 1978, DRI provided the services of an Operations Research (OR) expert to assess the needs and opportunities for OR in Pakistan, to develop plans for organizing and training an OR cadre, and to identify related facilities (and the need for these), such as computers. Although the need and opportunity for OR activity was well demonstrated, this activity has not yet been implemented due to personnel and funding limitations.

Both the previously mentioned electronics survey and the OR study pointed the way for desirable technical diversification for the PCSIR, and the institute intended to go forward in these and other subject areas. However, due to both internal constraints within PCSIR and within Pakistan itself, these actions have not yet been taken. This illustrates some of the opportunities for future development effort that were at least perceived as a consequence of the DRI program of support in Pakistan.

In other subject areas, the relationship of PCSIR and DRI made possible by the AID-supported program resulted in joint action by the two institutions. In one instance, PCSIR and DRI joined with a third U.S. engineering firm to prepare and submit a proposal for an extensive feasibility study for production of alumina from Pakistani deposits of bauxite. This USAID-sponsored project was consonant with the minerals development interests of the PCSIR, and it was gratifying that, although the consortium's proposal came in only second, an encouraging start had been made toward such international collaboration.

In another instance, DRI, with PCSIR as subcontractor, was successful in its proposal to the Appropriate Technology Development Organization of Pakistan for an extensive study and development effort in the area of village-level food technology, with specific reference to rice bran, sugarcane, and oil seeds processing. This three-year project has progressed to the point where the fourth and final phase is now getting underway. The principal R&D effort and overall project direction are being performed by PCSIR--this responsibility having been progressively taken over from DRI as experience and competence were gained. This program has served as a demonstration of the feasibility of the technology transfer and R&D management capability being developed and transferred to Pakistani entities; it was clearly made possible as a consequence of the AID-sponsored linkage between PCSIR and DRI.

Although numerous problems occurred during the course of the PCSIR linkage, the feasibility and productivity of the linkage have been well demonstrated. This experience has shown the utility of the linkage mechanism and illustrated the need for diversified and flexible support relationships as well as for adequate time to permit the relationship to mature and become productive.

TISTR

One of the roles of TISTR is to assess barriers to national development and subsequently to design R&D programs that will assist in overcoming such obstacles. By 1977, it was clear to TISTR management that poor packaging of agricultural products was causing severe product and income losses in both domestic and export markets. While TISTR had some expertise in this area, it did not believe itself sufficiently competent in preparing a proposal to the Thai government for the establishment of a laboratory at the institute that would develop standards, establish packaging material-product compatibility, and so forth, for agricultural products. To prepare a proposal for funding of the laboratory, TISTR requested DRI assistance in identifying packaging problems and assisting in the design of an appropriate packaging laboratory.

A DRI packaging expert spent the month of August 1977 in Thailand working with TISTR staff members to define the needs and parameters necessary to prepare a laboratory design and a report, "Technical Assistance Required for the Creation of a Laboratory for Packaging Development, Evaluation, and Testing of Food Products at TISTR." DRI and TISTR staff members surveyed thirteen companies, four food markets (governmental operation and privately owned), and six governmental agencies involved in packaging. General conclusions concerning the need for technical assistance in the creation of a food packaging development and testing laboratory were:

- domestic packaging of food (processed and natural) varies widely in quality;
- the degree of sophistication in applying technology is very haphazard;
- very good packaging has evolved in industries where export markets have been established with developed countries whose quality control standards in processing and packaging have been transferred to Thai companies;
- the most developed packaging technology occurs with companies with the following linkages: (1) multinational companies that have captive packaging material suppliers who utilize the most recent technical equipment and standards of production; and (2) users or suppliers of packaging materials that have technical linkages with foreign machinery suppliers that supply quality control procedures, material specifications, and technical assistance;
- quality control in the bulk of local small Thai packaging material suppliers and user industries can be considered nonexistent; it is mainly concerned with visual inspection, and it is assumed that suppliers are responsible;
- no private or governmental institution has the capability to develop expertise in new materials performance or present materials performance or food compatibility studies (package material-product);

- studies by UNIDO and the EEC further support the need for a food packaging development and testing laboratory; and
- to develop foreign markets for Thai agricultural products, particularly in the areas of fresh fruits, produce, and processed agricultural products, extensive work is needed to develop standards of processing and packaging that are acceptable on an international level.

Subsequently, the DRI TISTR-DRI linkage coordinator assisted the TISTR staff in preparing a proposal, based on the report, to the Thai Department of Technical and Economic Cooperation (DTEC) for the establishment of a food packaging development and testing laboratory at TISTR. DTEC is the Thai agency that prepares the list of projects for which Thailand is seeking international development assistance. After studying the proposal, DTEC placed this project on its list. Subsequently, the Belgian government expressed interest in supporting the multimillion-dollar project. Funding has been approved by the Belgian government for a first phase training activity.

At the request of the governor of TISTR, the DRI assistant director for operations, who was participating in the December 1977 workshop on project management and development, made an investigation of the policies and procedures of TISTR. Concurrently, the DRI TISTR-DRI linkage coordinator prepared a report on the same subject for selected members of TISTR's top management.

These investigations produced three perceived needs requiring changes in a number of associated administrative procedures if TISTR is to meet its goals:

- TISTR wishes, over the long run, to become an autonomous, self-supporting, not-for-profit contract research institute serving the government and private sectors of Thailand. To reach this goal will require not only action on TISTR's part, but also significant further development in the Thai economy and in the government's ability to package and contract for research needs. As this is accomplished, TISTR needs to gain a better perception of its research goals--particularly the average staff members. Although the TISTR board has set general directions, a detailed operational plan prepared by the TISTR staff and subsequently communicated to the rest of the staff is needed.
- The long-range goal of TISTR's relationship to the Thai government and private sectors needs to be further impressed upon the staff.
- The third perceived need is to create an incentive system that will encourage the staff to strive to achieve TISTR's goals; this is not believed to exist at present, although some of TISTR's ideas concerning the use of bonuses are certainly steps in the right direction.

These reports significantly influenced a recent reorganization of TISTR.

In December 1977, the manager of DRI's Office of International Programs Information Service was asked to assist TISTR in evaluating and preparing a development plan for the Thai National Documentation Center (TNDC)--a division of TISTR. The objective was to assist TNDC in obtaining and responding effectively to technological information requests on its own, rather than to continue depending on DRI as a source of information. The assistance resulted in the preparation of two reports to TISTR/TNDC. These were:

- a Review of Internal Management of TNDC; and
- suggestions for a Development Plan for TNDC and TISTR.

The suggested goals/programs presented to TISTR and TNDC are summarized as follows:

- Create an "information officer" position to act as a liaison with TISTR. The liaison would be able to anticipate TISTR's information needs and to supply exactly what was needed. The information officer would attend all departmental and divisional planning meetings, policy meetings, and research meetings, creating a visible information link with TISTR.
- Write a document to convince the budget bureau of TNDC's need for additional staff. This concept paper of future activities would include justification for increasing TNDC's staff. (The existing five-year plan is too general.)
- Encourage the integration of TNDC's skills and resources with TISTR's planning for the rural development programs. TNDC is capable of assuming a major role in repackaging the technical data files and increasing its cooperative exchange program with Kasetsart University (agricultural extension services), the Ministry of Science, and ASEAN libraries. TNDC, relying on its translating services and its in-house information-gathering skill, could fill the technology transfer gap from spoken skill transfer to rural implementation through many information forms (e.g., newspaper articles, radio education shows, extension newsletters, nutrition information fliers, and so forth).
- Develop a selective dissemination of information service to TISTR researchers. By compiling profiles on each research area (key subject terms) and updating the profile periodically, TNDC could fill all anticipated information needs and keep the researcher up-to-date in his particular area of interest.
- Conduct technical and abstract writing skill courses for TISTR personnel.
- Encourage TISTR to issue a concept paper on research directions for the next two years so that TNDC can

tailor its information acquisition activities to meet TISTR's needs.

- Develop the technical data files to reflect the most recent research information. The following steps may be taken:
 - Work out selective dissemination of information and search methods coordinating all review/ scanning activities occurring presently within TNDC.
 - Expand information exchange with ASEAN libraries and appropriate technology centers to gather relevant information.
 - Send subject list of technical data files to TISTR researchers on a monthly basis.
 - Index data files to facilitate searching within files.
- Continue coordinated area acquisitions to avoid purchasing expensive reference materials owned by nearby libraries. Convince TISTR researchers that cooperative buying is the only solution to the lack of adequate acquisition funds.
- Encourage continuing education programs for staff. These programs/skills acquisitions should reflect technical skills needed for effective response to TISTR's needs.

The Korean food industry is using increasing amounts of high fructose syrup (HFS) as a sugar substitute in the food industries; HFS is currently imported into Korea. KIST has developed a technology for the production of HFS from starch, but an insufficient supply of starch is produced in Korea to meet future demand for production of HFS. At the same time, Thailand produces abundant quantities of tapioca, which is a good source of starch.

Thus, DRI arranged for a cooperative program between TISTR and KIST, with the objective of transferring the KIST HFS technology into Thailand. The program involved a techno-economic feasibility study for the construction of an integrated plant for production of HFS in Thailand, using the KIST technology, the product of which has a potential for importation in Korea. Several Thai manufacturers expressed interest in financing the commercialization of HFS.

The technical assistance was to be conducted in three stages. In November 1977, two TISTR staff members visited KIST to obtain information on the KIST technology and to provide data necessary for the feasibility analysis of the technology transfer. In May 1978, three KIST staff members visited TISTR to survey the status of the starch and sugar industries. Upon completion of the feasibility study, a meeting was held among potential clients in Korea and Thailand to provide the opportunity for undertaking commercialization of the process.

DRI's role in this transfer of technology between two developing countries consisted of making arrangements for cooperation

between KIST and TISTR based on knowledge of both the KIST technology and the Thai potential for producing large quantities of starch. A DRI staff member accompanied both teams to coordinate the joint effort.

Information Services

Goals and Activities

The overall objective of DRI's information service program and, more specifically, of the Know-how Information Service (KIS), was to assist selected ARI personnel in technical information centers in improving their skills for the delivery of technical information in support of research activities. The secondary objective was to disseminate the results to the research institutes on a worldwide basis.

To accomplish these objectives, several goals were established:

- to increase awareness of the fact that technical information systems are an integral part of the research process;
- to increase the ability of research institute information personnel in anticipating and answering information needs of their users;
- to create awareness of worldwide resources, resource gathering techniques, and various methodologies available for information programs and projects;
- to disseminate, based on the experiences of the program, a handbook for accessing S&T information; and
- to establish a foundation for growth of information services within the research institutes.

Several activities were initiated under this contract to achieve these goals. It should be noted, however, that the KIS activities grew out of the technical assistance segment of this contract, linking the information activities with technical assistance and services. The purpose of the information program was to enhance existing projects and to insure that the development of an information system was an integral part of the research institute. This goal also led to the creation of a support structure of researchers who were previously unaware of the benefits of an effective information system.

The KIS program element at the beginning of the contract focused on the supply of information to the research institute information personnel, as expressed below:

The know-how information services provided by DRI to its linked institutes and others differ markedly from the scientific and technical information usually accessed from world data banks. DRI is primarily concerned with obtaining technical information of specific interest to

linked institutes who are trying to solve industrial problems--"know-how information" on the state of the art for appropriate processes, sources of components, and equipment specifications and designs which may be required by medium- and small-scale industrial clients. Assistance in accessing computerized scientific information systems is also provided, but the emphasis is on practical information which is immediately useful and needed by the industrial client. This service is used frequently and successfully by the linked institutes and appears to be providing valuable assistance to them.

By the end of the first year, a shift had occurred, with emphasis being given to training and the development of tools that would allow the ARIs to continue pursuing their objectives after the project had ended. The decision to shift the program emphasis resulted from the fact that a supply mode creates dependence, and, as a member of PCSIR succinctly expressed it, "No businessman likes to keep a third party involved any longer than possible."

Therefore, the second KIS program element focused on providing policy guidance and assistance on information issues to USAID and to the linked institutes. While DRI continued to respond to specific information requests as a component of the ongoing or anticipated technical assistance activities, the major information emphasis with the linked institutes was directed toward the development of information extension capabilities during the remainder of the contract.

The supply activities included projects designed to support individual linked institute programs and to provide a model for future information acquisition. The DRI information response model became the transition tool for phasing out supply activities. Other activities, such as newsletter exchanges, a conference information dissemination program, technical resource file exchanges, and a model selective dissemination of information program, were initiated to facilitate the transition from supply to training/policy development programs. These transition activities served a dual purpose: (1) to encourage the development of network activities among research institutes exploring similar research activities; and (2) to establish model acquisition programs for information personnel to adopt.

The training activities encompassed individual training programs, management studies involving internal reorganization and assessment of training needs, and technical information workshops and seminars for target groups. All activities contributed to the goal of transferring information skills to the information personnel in DRI's linked institutes so that they would be better able to utilize S&T resources.

Each linked institute determined its own training priorities, with some information centers requesting more training than others. The unequal request for training activities was a result

of several factors, including institute support of information programs, political influences, liaison with the information director, and existing skill levels. The training goals were individually determined with each institute, and the overall goals of the other DRJ-supported institute activities were kept in mind. It should be stressed that the training activities were based on an evolutionary process, not a prescriptive process.

Network Development Activities

The thrust of the network development activities was based on the same premise that upholds the Technical Cooperation among Developing Countries (TCDC) program sponsored by the United Nations. The TCDC concept includes:

programmes and projects to establish and strengthen the organizational infrastructure and substantive capacities of developing countries for promoting mutual cooperation among themselves. This includes the provision and utilization by developing countries of know-how and expertise, consultancy services, training facilities, equipment, supplies, etc., available within developing countries.⁴

The overall goal of network development activities was to create a resource-sharing program among ARIs that would foster lateral technology transfer flows. Other goals included: (1) the provision of a model for alternative methods to S&T information acquisition; (2) encouragement of cooperative resource sharing; and (3) the creation of an awareness of the benefits of low-cost acquisition projects.

Six activities were designed to meet these goals:

- newsletter exchange program;
- conference information dissemination program;
- selective dissemination of information program;
- lateral technology transfer exchange network;
- directory of company/industrial contacts; and
- technological opportunities file.

All of the linked institutes participated in the above activities, with other research institutes participating in selected projects. Detailed explanations of the activities follow.

Newsletter Exchange Program. Most of the research institutes with which DRJ was in contact during the OST contract published

⁴Economic and Social Commission for Asia and the Pacific. Consultancy Services Available in Developing ESCAP Countries (Bangkok, Thailand: ESCAP, 1977), p.i.

newsletters. These periodic communications contained valuable information on recent research results, new programs and projects, publications, conferences, personnel expertise and changes, facilities, and general developments within and surrounding the institute. DRI collected newsletters from eight institutes, photocopied them, and sent them to each information manager with an explanation of the project. Information officers were requested to review the newsletters, show them to colleagues, researchers, and other institute personnel, and to decide whether their institute would like to be on the subscription list. If so, they were to contact the editor directly. The project also included sending titles and subscription information regarding subject-specific newsletters available from worldwide institutes and organizations to each information manager. The title lists were tailored to address each institute's research interests.

Outcomes of the program were difficult to measure, for the only feedback was conversations with selected information officers or carbon copies of order letters. Language was a barrier. For instance, Pakistan was interested only in English language newsletters, and Brazil preferred Spanish or English language newsletters, but not Arabic. The response to the subject-related newsletter lists was positive, since most of the newsletters were free or available at a nominal cost.

Conference Information Dissemination Program. One of the reasons for the establishment of a conference information dissemination network was that conferences serve as a forum for presentations of research results that usually have not been published in trade journals or magazines. Another reason was to demonstrate an alternative method for receiving papers and conference results without attending the conference. For researchers constrained by small or nonexistent personal development budgets, attending work-related conferences is almost impossible. The information manager can anticipate research needs by modeling a program after the DRI conference information dissemination program.

To utilize conference disseminated information and to familiarize information directors with the range and frequency of conferences of worldwide interest, the OLP information center circulated announcements of conferences and of the presented papers to information directors at seven ARIs around the world. Invited to participate in a conference information dissemination network were: ICAITI, Guatemala City, Guatemala; ITINTEC, Lima, Peru; RSS, Amman, Jordan; TISTR, Bangkok, Thailand; PCSIR, Karachi, Pakistan; IIT, Bogotá, Colombia; and IPT, São Paulo, Brazil. Selected conference announcements and papers to be presented were sent to each of the information directors of these organizations. They, in turn, circulated the information to researchers, inviting feedback and requests. The results were fruitful; the list below gives an initial indication of the response.

- International Congress of Essential Oils, Tokyo, Japan-- IIT, PCSIR, TISTR, IPT, and RSS requested papers.
- International Food Technology Conference-- IIT, PCSIR, and ICAITI requested an average of twenty-five papers each.
- Caribbean Conference on Energy for Development-- IPT researchers requested papers.
- Food Industries Conference in London-- IIT and PCSIR requested papers and proceedings.
- Fifth Energy Conference and Exposition, Washington, D.C.-- IIT, IPT, and PCSIR requested information papers.
- Resources Policy Conference, Great Britain-- IIT researchers requested information for future conferences.

DRI requested copies of the presented papers from individual authors and disseminated them, as received, to each institute. The contributing authors were quite cooperative, and few requests were left unfilled.

The outcome of the program was a display of great interest levels by several institutes. Among six institutes, 360 papers were requested. Colombia concluded that this was the most valuable of all KIS activities. Several information directors have instituted similar programs within their own institutes. The success is attributed to the eagerness of researchers to communicate with colleagues. Written communication through scholarly papers is the first step to the formation of the "invisible colleges" deemed so important by researchers and scientists.

Selective Dissemination of Information Program. The major objective of this program was to demonstrate the advantages that could be derived from an aggressive information philosophy and its implementation within a research institute. To anticipate information needs and to design complementary programs is a foreign concept to most research information personnel. For many reasons, information personnel become reactive concerning technical information services.

DRI developed a model for a selective dissemination of information (SDI) program to be implemented by interested personnel. The program consisted of supplying, on a periodic basis, conference announcements, recent publications announcements, newsletter articles, government publications, or whatever seemed appropriate to the researcher known to be working on a particular project. The SDI was channeled through the information officer to facilitate interaction between researcher and information specialist. A subsequent component included instructions on how to gather profiles of current, future, and possible interests from the institute researchers. These profiles, updated through periodic interviews or questionnaires, were to be kept by the

information specialist, who tried to match interests with information supply and acquisitions. As materials came into the information center, or as time was made available to search, information was supplied to the researcher. Feedback systems to refine the profiles were instituted.

The SDI program attempted to accomplish two goals: (1) to bring the researcher into closer contact with the information specialists so that a better understanding of the capabilities and resources of the information center would be developed; and (2) to familiarize the information specialist with the research programs/needs and to demonstrate the necessity for information services and systems to be linked to the research process.

The DRI-supplied SDI to the linked institutes was gradually phased out. One of the three institutes elected to adopt an SDI program. Success was hampered by lack of information management support, confusion as to whether researchers would like the new role of the information center, a belief that researchers should ask for services even if they are not aware of them, and the general hesitancy to try a different approach. However, DRI believes that the participating institutes recognized the value of anticipatory information programs, especially in realizing the benefits of more tailored acquisition programs.

Lateral Technology Transfer Exchange Program. DRI initiated a program for the increase of communication and the exchange of technical information among developing country research institutes. It was believed that direct communication among research institutes working on similar problems and studying similar solutions is the best opportunity for relevant document exchange. Rather than relying on an information broker in the United States (DRI), a direct exchange network was set up among the institutes. This network complemented other KIS activities and hopefully developed resource alternative skills among institute information personnel.

The lateral exchange network was set up in the following way:

- DRI selected seven research institute information officers to participate in the pilot program.
- DRI compiled a list of existing technical information files created by the OIP information staff in response to technical questions from around the world; this list was circulated to the information officers.
- Similar subject data file lists were requested from the seven participating institutes, then redistributed to each information officer with encouragement to contact the institute directly for further information.

The outcome of the program included several documented lateral transfers and a continuing awareness on the part of all participating information personnel of the resources and strengths of the various research institutes. Additionally, the updated DRI

subject files list has been distributed to numerous research institute personnel, resulting in the transfer of S&T information originally gathered for another developing country research institute.

Directory of Company/Industrial Contacts. During 1978, the OIP information center staff that was involved in the OST contract compiled a directory of company contacts made during and for the KIS activities. The directory was designed to serve as a model to the linked institutes, exemplifying the positive aspects of organized approaches to information-to-industry.

The directory was organized by subject; the subject thesaurus was determined by past requests for information under the OST activities. Within the appropriate subject categories, entries were made for those companies that had contributed technical information to DRI. With the address, phone number, and contact person within the company available, future questions on a similar subject requiring private industry input could be easily accessed.

The outcome of this project included the introduction of this model to a TISTR information staff member during a two-week specialized training program in Denver. Also, the OIP staff used the directory for the duration of the contract.

Technological Opportunities File. The OIP information center created a file of documents, papers, and articles for a technological opportunities file. This was designed as a resource of ideas that may serve as reference for future projects. The file included solutions to existing problems that have not been fully explored but are being examined on a limited basis.

The file was made available to the OIP staff so that when they were planning and working with the linked institutes, technological opportunities would serve as resources for idea generation and program planning.

Linked Institutes--Supply and Training Activities

TISTR. During the three years of the DRI-TISTR linkage, several programs were designed to meet the information needs of TISTR. The majority of KIS requests concerned technical questions related to research projects within TISTR, mainly in the areas of agriculture and rural development. The information contributed to feasibility studies, state-of-the-art studies for appropriate processes, sources of components, and equipment specifications and designs for pilot plant development or the acquisition of equipment.

In 1977, seventeen KIS requests were made by TISTR in the following areas: (1) machinery and process information (solar and wind, fungal protein from agro-waste, grease, packaging, lignite); (2) pharmaceuticals (tetracycline, digestible detergent from sugar, sea salt); and (3) tropical agriculture (cashew and

macadamia nut, instant rice, citronella, herbicides, rice, small-scale fertilizers, winged bean, integrated rural development). In 1978, nine KIS requests were made from TISTR: (1) machinery and process information (freon, fructose, wind turbines, freeze driers, lead into gasoline, high test molasses); and (2) tropical agriculture (bentonite, irradiation of fruits and vegetables, transportation and storage of fruits and vegetables).

Information was viewed as an integral part of all activities at TISTR and not just as a function of KIS. Network information programs were an important part of TISTR's activities as well as of the KIS research requests. TISTR learned of a PCSIR project relating to minerals from bittern through the lateral technology transfer program. The transfer of state-of-the-art bittern information saved TISTR much time and money in a similar program.

At TISTR's request, DRI instituted a selective dissemination of information (SDI) program at TISTR. Whenever the OIP information staff discovered materials that appeared to be of interest to TISTR, copies were sent. TISTR is now performing a similar SDI service in a more formal manner through the researcher profile development. TISTR was also an active participant in the newsletter exchange and the lateral technology transfer programs.

In addition to the training components of the KIS and network development activities, TISTR requested two major training programs: (1) U.S. S&T information training for a member of TISTR's information center (Thai National Documentation Center); and (2) a technical information workshop in Bangkok for TISTR and community-related information specialists and researchers.

The S&T information training was presented in April 1978 at DRI and NTIS in Washington. At DRI, training in collection organization, gathering KIS information, and the integration of formal and informal information sources occurred. Visits to several special regional libraries and a tour of Information Handling Services were arranged. The most important part of the training was the individualized instruction on the utilization of research tools and the art of negotiating reference questions.

Several months later, an information workshop was held in Bangkok at TISTR; a planning liaison was established between DRI and TISTR for facilitating workshop arrangements. The information workshop was designed to establish communications between scientists and information specialists and to increase the use of formal and informal information sources. The approach involved the introduction and discussion of various issues surrounding the acquisition, dissemination, and use of technical information. Thirty participants from TISTR and the scientific community of Bangkok attended the workshop; approximately 50 percent were information specialists, and 50 percent were scientists from food-science-related disciplines. This combination of participants from various organizations and disciplines contributed to the creation of an informal network of scientists and information specialists within Thailand.

The response to the workshop was positive. Feedback at the end of the workshop and six months afterward praised the workshop, noting that it facilitated overall improvements in the quality and quantity of information inquiries, in the access to sources of information outside Thai organizations, and in the general understanding of the system within which the various aspects of scientific research operate.

During the DRI-TISTR linkage, much worthwhile information was transferred to TISTR. The relationship grew from one of supply to one of training. TNDC information researchers are now much better equipped to gather information. The strong relationship with TISTR was partially due to a solid DRI presence in Thailand.

Twice as many requests were placed in 1977 as in 1978, which implies that TISTR became more adept at finding answers through its own network and resources. Also, the TISTR research questions became better phrased so that DRI could answer requests more effectively. In 1978, many requests were made to locate articles and reports that were difficult to obtain in Thailand, again demonstrating that by 1978, TISTR was better equipped to do more of its own research.

Although KIS requests were the central part of the DRI/TISTR relationship, many of the spin-off programs brought more immediate results and actually were integral to the KIS success. One example is worm farming. During the individualized training in Denver, DRI contacted a worm farm company, since worm farming had been designated a research program at TISTR. Due to the technical information carried to Thailand after the training in Denver, serious consideration was given to the biodegradation of waste. Subsequent activities included the transport of worms to TISTR, where breeding and research into the viability of the project have taken place since August 1978.

KIS services were generally viewed in a positive manner by TISTR. It would have been helpful if more continuous communication could have occurred between TNDC and DRI. This is a problem with any type of information transfer to developing countries--the long distance and lag time in transfer of materials remove some of the spontaneity from the research. Also, the reluctance on the part of Thais to detail criticisms made KIS less effective than it might have been. As an example, only ten of the twenty-six requests filled received evaluation responses from TISTR, and some responses were only to acknowledge receipt of information. DRI continually encouraged evaluation of information by sending forms and asking that they be filled out. It is possible that cultural etiquette caused the Thais to neglect evaluation if it involved criticism.

Both positive and negative responses were made to KIS research. The greatest problem seemed to be that the researchers did not detail their questions adequately to be answered effectively. This problem was somewhat ameliorated by training in

the information workshop. The value of the information workshop was, in DRI's opinion, greater than the service of answering KIS questions. After the workshop, KIS became an easier task for both parties because a human element had become involved. This again supported the hypothesis that a combination of formal and personally supplied sources gives the best results in information transfer.

PCSIR. PCSIR used KIS extensively during the linkage program, and it participated in the network development activities; however, no formal training occurred (i.e., information seminars, individualized training). Reasons for the lack of training programs include change in PCSIR management direction, lack of consistent and continuous DRI presence at PCSIR, and general difficulty generating an awareness of the value of such training. All KIS requests were related to specific industrial problems, not merely to further the scientific base of PCSIR.

The majority of the KIS requests were for technical machinery (e.g., patents, manufacturers) and process information directly related to specific industrial problems. During 1978, KIS supported technical assistance and grants programs at PCSIR.

PCSIR was an active participant in network development activities. It appears from the response to the conference information dissemination project and the lateral technology transfer program that PCSIR was anxious to broaden its information acquisition base.

Lateral technology transfer among applied research institutes:

1978-- solar drying of grains
fungal fermentation of agro-waste
polyvinyl chloride materials

Conference information requested:

August 1977--Institute of Food Technologists--papers sent.
1978--Seventh International Congress of Essential Oils.
1978--Solar Energy.

Whether the information personnel initiated similar programs at PCSIR after introduction of the model is unknown. Communications between DRI and PCSIR were difficult due to a lack of consistent DRI personnel presence.

KIS activities were viewed as valuable to PCSIR, yet in a narrow dimension--industrial client activities. Some positive outcomes did evolve from the KIS-supplied information. The general feeling, expressed by the director of PCSIR, was that KIS information was reliable and accurate. Often requests to other information supply brokers outside Pakistan were left unanswered. However, a need for a more effective KIS delivery system

definitely existed, because information was at times withheld from the end user by the information receiver at PCSIR for causes not entirely understood by DRI. The reason for the lack of interest in training programs is not clear. Perhaps DRI did not explain well the value of such programs.

The comments below detail the usefulness of KIS-supplied information:

- Re: Nickel-Cadmium Electrodes
"Valuable information--gave an option (otherwise, project would have ended immediately or gone into a five-year, open-ended project)."
- Re: De-Laval High Speed Separator--fish oil concentrate project
"We got a better offer for a separator from Japan. We had only one quotation, and your information helped us to identify the Japanese offer as the best and most economical."
- Re: Fish Protein Concentrate (FPC)
"The FPC pilot plant should be on-line before the end of the year, thanks to your help."
- Re: Dobby Loom
"We wrote the KIS-supplied company to ask about the possibility of a joint venture. We have now developed a negative Dobby, and it has been put in production in September 1978. In three months we will have perfected a new one. This was done with DRI's information as a research basis; Crompton Knowles said we were not advanced enough in our research for a joint venture."

IIT. IIT was an active user of KIS and the networking and training activities. The main focus of KIS was to support technical assistance activities between DRI and IIT personnel. With help from DRI, IIT information personnel organized an information-for-industry workshop for twenty-five participants in the Bogotá/Medellín area. An information person also visited the United States for an overview of S&T resources and accompanying procedures.

KIS-requested information was used largely during the preliminary stages of the technical assistance activities. Information requested concerned the following categories: wood waste; spaghetti extrusion for nonwheat flour; sugarcane extraction; coal briquetting; standards for digestibility of starches in baby foods; organic bleaches from pamela; and fermentation of bagasse for livestock feed.

IIT was one of the most enthusiastic participants in network development activities. Information personnel reported that the IIT researchers considered the conference information the most valuable of all DRI-initiated information programs. The lateral technology transfer project was actively supported by IIT, and a continuation program was set up.

A specialized information seminar was organized with IIT and presented in February 1979 in Bogotá, Colombia. The philosophy of the workshop embodied the perspective of valuing information as an integral part of the institute's work in applied research. This focus, information as a component of the research project, has allowed for improvement in the supply, transfer, and facilitation of the use of information by those within the institute and those whom the institute exists to serve.

The workshop was designed for an audience of industrial information users and suppliers and combined scientists and information specialists. Through various exercises, the information problems and goals of the two disciplines became apparent and allowed for observation and assessment of the components of effective service to STI clients.

Three major problems surfaced during the KIS activities: communications, reorganization delays, and internal information barriers. The communication problems centered around the difficulty in obtaining detailed, accurate, and timely information requests. The lack of such requests caused the sending of less-than-optimum information, resulting in discouragement of IIT researchers as to how KIS could benefit their research. As the contact increased and the information users became more adept at requesting S&T information, the satisfaction level rose.

The reorganization of IIT management and personnel caused program delays and inconsistencies. These delays were transferred to KIS in the form of slow feedback, nonresponses to information utilization questions, and general confusion as to whether continuous information supply was appropriate.

Several internal information barriers surfaced at IIT that caused a breakdown in information flows. These barriers were unknown to DRI until the final evaluation data were gathered. In retrospect, a different information flow system should have been set up, recognizing clearly the necessity of identifying the end user and making sure that he received the needed information, rather than going through an intermediary.

Information Handbook--Worldwide Dissemination Tool

The information handbook was suggested at the January 1978 OST review as a final piece to document KIS activities relating to small-scale industry development and was funded under a separate OST contract. The handbook is intended to serve as a guide to developing countries using S&T formal and informal information

resources. It combines methodologies for accessing information, examples of reference tools, and case studies of successful reference searches.

Summary

The OST-supported information program was a valuable component of the overall institute building experiment. Because it grew out of the technical assistance activities, thus linking it to research projects and goals, and because it supplied hard-to-find information, the information program had support from many sectors of the overall program.

The know-how information services were also made known to sixteen other research institutes with information needs. DRI responded to these organizations on a task-order basis. These institutes had special information needs that were not being filled by other information services. DRI information personnel and other researchers believe that the success of the services was due to the interface of S&T information tools and the combination of formal and informal information sources. Also, the service did not merely supply an answer, but gave references to bibliographies, newsletters, personal contacts, and other sources upon which the end user could call for future reference.

Women In Development

Background

The potential of using women in national development has become a topic of current interest to many governmental agencies, private voluntary organizations, and international organizations. Specifically, the Percy Amendment encourages U.S. foreign assistance to be administered with particular attention to the integration of women into national development efforts. In response to this amendment, DRI was encouraged to enhance the role of women within the overall OST contract work. The DRI interpretation of this mandate was to heighten the utilization of all human resources in social, political, and economic development by facilitating access to technologies and skills that are relevant to current roles and activities of women.

Thus, the DRI task involved the following general objectives:

- to enhance the ability of women in the ARIs to perform more effectively in their positions; and
- to assist women in promoting the flow of technology from ARIs through existing transfer agents to the rural users.

To address these general objectives, DRI developed two areas of activities:

- enhance the role of women in overall OST contract activities; and
- create a special program, the Development Training Forum, to provide specific skills for women in organizational planning and program management.

Technology Transfer Model

The ARIs serve as a source of technology and as a focal point for S&T development within a developing country. Women's organizations or private voluntary organizations are also present with varying degrees of outreach and development potential throughout the country. The hypothesis for this model is that the women's organizations, or PVOs, as existing, functioning networks, can serve as potential intermediaries or transfer agents in the technology transfer process within a developing country. One of the concerns of the research institute is to develop technology appropriate to local rural and urban users. Often, the institutes do not have a well-developed outreach or extension capability, and therefore they lack access to knowledge about local users' needs, resources, and capabilities. Similarly, local users are rarely aware of or infrequently benefit from current technological developments. Therefore, it would seem that if a more efficient channel of communication between sources of technology and potential users could be set up, the process of technology transfer might improve.

OBJECTIVE: Women's organizations can serve as effective agents in identifying local needs for technology, in expressing those needs to sources of technology (applied research institutes), and in facilitating the transfer to the rural user.

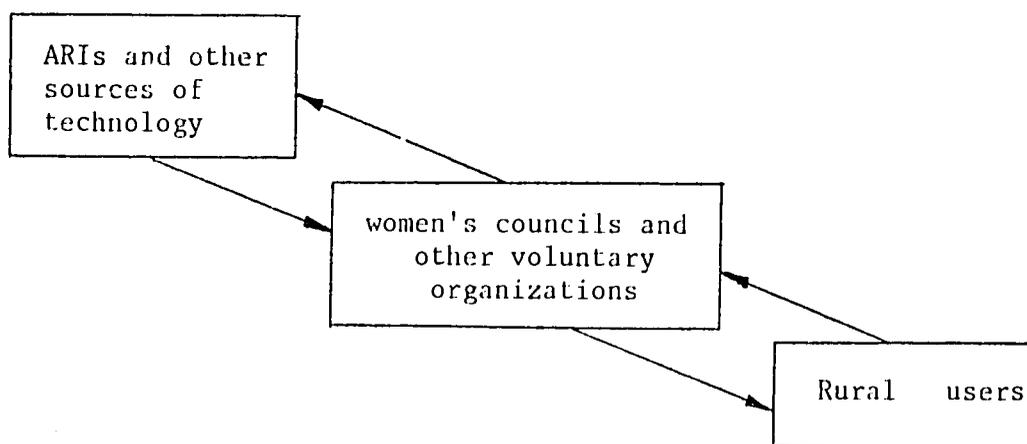


Figure 3
Technology Transfer Model Using Women's Organizations

Integrated OST Contract Activities

In order to address the general objectives and test this model, DRI attempted first to enhance the role of women within current contract activities. This involved information exchange and management development and training.

Information Center. A small information collection was set up with the following general topics:

- women, food, and nutrition;
- population studies and women;
- women in science and technology;
- women's service organizations;
- research on women: status and role;
- management training for women;
- women and national development;
- development planning and women;
- appropriate technology for women;
- impact of technologically induced change on women;
- women and small-scale industry;
- women, education, and labor force participation;
- methodology and data collection on women;
- conferences, meetings, etc.;
- organizations assisting women in developing countries; and
- women's organizations in developing countries.

A two-way information exchange was facilitated. Information on U.S. projects and research directed toward women was collected and made available for dissemination to women in developing countries. Similarly, DRI collected and disseminated in the United States and other developed and developing countries current information on the role and participation of women in developing countries. This exchange was solely on an informal basis.

Management Training. In other OST contract activities, increased recognition was given to the quantity and quality of women's participation. The initial management training activities involved only a few women. Although it cannot be said that a steady and obvious increase in the number of women participants occurred, increasingly active participation by women took place in the management development and overall linkage activities. In particular, several women served as professional role models in linkage activities. Questionnaires were used to collect information on women in research institutes and on the role and participation of women.

Due to the addition of WID activities to the contract, DRI staff have become increasingly aware that contract activities should be designed so that both men and women are recipients of foreign assistance.

Development Training Forum (DTF)

From information gathered through sources in the research institutes, it was determined that a need for training in planning and management skills existed among the women in the target countries--Thailand and Colombia. Such skills, when combined with the capability to train others, would allow more women to participate more actively and effectively in national development. Furthermore, such training would be used to test the technology transfer model and possibly initiate the essential contracts to promote a more efficient transfer process.

Thus, DRI created the Development Training Forum (DTF). Through the use of a simple participatory planning method, the DTF teaches participants basic organizational planning and program management skills. To demonstrate the use of the six-step planning method, the forum focuses on a specific topic relevant to the participants' work. Using participant input, a program plan is produced that can be implemented by participants and their organizations.

The planning methodology used in the DTF involves six basic steps:

- vision -- creates the general parameters of the topic;
- constraints -- determine underlying obstacles or problems to vision attainment;
- proposals -- develop major strategies or solutions to address constraints;
- programs -- provide structures to activate proposals;
- tactics -- describe practical steps to implement programs; and
- scheduling -- establishes tasks in a time frame.

The internal structure of each step is similar:

- brainstorm/group discussion;
- data organization/gestalt; and
- group titles/group consensus.

A series of training forums was held in Thailand and Colombia. Participants of the initial forum occupied professional, technical, and volunteer positions in governmental, nongovernmental, and scientific/technical organizations.

The participants from the initial forum were key individuals who were instrumental in conducting sessions at the provincial and village levels. A "multiplier effect" was thereby produced, with participants from the provincial level forum working closely with individual villages. The series of forums trained in both Thailand and Colombia a corps of women capable of using organizational and planning skills and of teaching those skills in the future without DRI assistance. Furthermore, the planning documents from each forum were used by the respective groups of

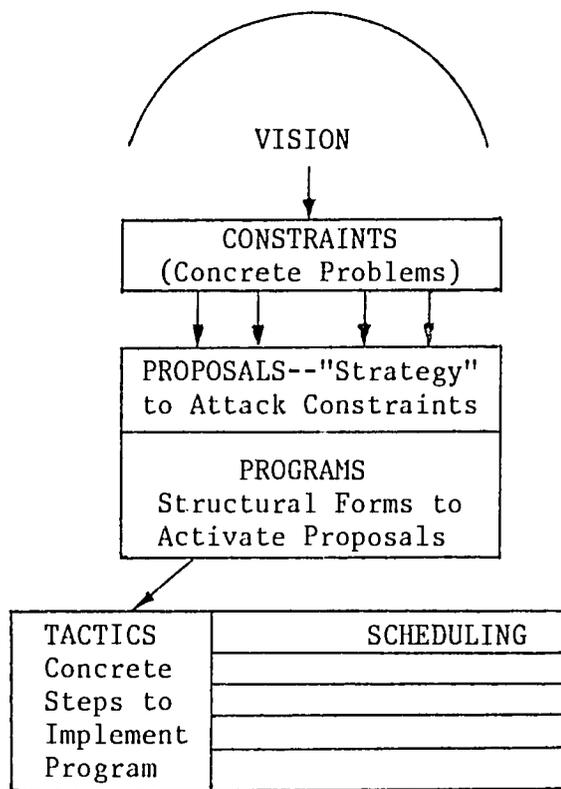


Figure 4
Major Steps of the Planning Methodology

Example

VISION

- Increased participation of women in income-generating activities.

CONSTRAINTS

- Limited access to capital resources/minimal family savings.
- Skills training predominantly male-oriented.

PROPOSAL

- Improve capital funding programs specifically designed for women, or
- Establish women's capital investment program directed toward improving women's participation in income-producing activities.

PROGRAM

- Women's Capital Investment Program.
- Women's (Income-Generating) Skills Training School.

TACTICS

- 1. Organize women's cooperatives in selected marketable skills.
- 2. Contact key women's organizations to arrange for trainers in selected skills.

SCHEDULING

- Tactic 1 to be initiated in Week 3; concluded in first Trimester
- Tactic 2 to be initiated in first week.

participants in their collaborative and individual ongoing and new activities.

In Thailand, the initial forum was conducted in English; the second, in Thai; and the third forum was conducted in English, with participants from the ASEAN nations. All forums in Colombia were conducted in Spanish. The last forum in Colombia was conducted with people working directly at the community level.

Figure 5 illustrates DTF activities.

Figure 5 WID--Development Training Forum Activities	
THAILAND	
<u>Bangkok:</u>	"The Role of Women in Rural Development" July 1978, six days
Sponsors:	TISTR, DRI, NCWT (National Council of Women in Thailand)
Participants:	Twenty-five women from TISTR, private organizations, and governmental agencies.
Training:	Planning method; program review; skills inventory; proposal preparation.
<u>Phuket:</u>	"Administrative and Community Development Skills for Provincial Leaders" February 1979, six days
Participants:	Sixty provincial-level community leaders and workers.
Training:	Planning method and application to large groups; problem-solving; evaluation techniques.
<u>Bangkok:</u>	"ASEAN Regional Consultation" May 1979, four days
Participants:	Twenty governmental and women's organization representatives from ASEAN.
Training:	Program design and implementation; program priorities.
	"NCWT General Meeting: The Role of Women's Organizations in Supporting Governmental Activities" May 1979, two days
Participants:	200 provincial-level representatives.
Training:	Modified three-step planning method.

Figure 5 (cont.)
WID--Development Training Forum Activities

COLOMBIA

- Bogotá: "The Role of Women in Food and Nutrition"
December 1978, three days
Sponsors: IIT, DRI, PAN (National Program for Food And Nutrition)
Participants: Thirty-two representatives from IIT, universities, central, and four field offices of PAN, NCWC, and affiliates.
Training: Planning method.
- Bogotá: "Technology for the Development of Self-Help Programs"
October 1979, three days
Sponsors: IIT, DRI, CCTV (Coordinating Committee for Voluntary Work)
Participants: Twenty-four representatives from training groups for coordinating committees of voluntary organizations, representing eight departments.
Training: Planning method; techniques for training trainers.
- Bogotá: "Technology for the Programming of Self-Help Activities in Child Development"
November 1979, five days
Participants: Sixteen representatives from regional committees of IYC, representing six departments.
Training: Planning method; practicum.

The underlying assumption for the WID project was that national development would proceed at a much faster rate if women, who perform much of the work in rural areas and who are primarily responsible for the well-being and early education of their children, were given greater access to improved technologies and were allowed to benefit from advances in scientific knowledge.

Two hypotheses were addressed by the WID program:

- The methodology used in the DTF has both topical and cross-cultural application and therefore has the potential for use in many cultural situations focusing on a wide variety of topics and involving a broad range of groups, organizations, or individuals. The methodology is an effective tool that can enhance the participation of women in developing countries.

This hypothesis, based on the limited activity in Thailand and Colombia, is shown to be true, indicating that the DTF has great potential in organizing and structuring local input into program design and implementation. The DTF addresses the crucial need for local input and long-range planning for effective development and is an asset to successful and appropriate social change.

- A technology transfer process within a developing country can involve the following actors: the ARI with managerial training assistance from DRI; women's organizations or private voluntary organizations as transfer agents; and the local rural and urban users. This process can be useful in channeling more appropriate technology to local users and enabling local input into technological design.

A small group of "trainers" as the critical mass for more effective development work was the initial target group. The model of "training trainers to train others" had as an ultimate target group the women leaders in provincial areas and village women. During the short course of this activity (one and one-half years), it was possible only to set the groundwork for reaching the ultimate target group by training the "critical mass" or core group of trainers in each country. The model was tested by using the planning methodology as the "technology." In the future, other technologies could be transferred in the same way.

Accomplishments. (1) Total participation. A core group of approximately one hundred people was trained in each country. By the time that the third forum had been given in Thailand, a second level of training by Thai trainers had been given to over two hundred people. In Colombia, almost seventy-five participants were directly trained by DRI in the use of the methodology. The last two forums were conducted very late during the project. However, by the time that the third forum was given, DRI was

already receiving reports of second-level training. (2) Workbook/reports and teaching materials. These materials are now available in English, Thai, and Spanish and are hence made available by the ARI and local cooperating groups to interested organizations and individuals. English materials have been widely requested (see Figure 6).

Figure 6
Requests for Materials

Mission Evangelique, Ivory Coast
 International Programs for Human Resources Development,
 Washington, D.C.
 Office of Research, De La Salle University, Manila
 African-American Institute, New York
 Development Training Center, Indiana University
 Commission on Social Service and Development, Causeway,
 Rhodesia
Federación ae Desarrollo Juvenil Comunitaria, Inc., Santo
 Domingo
 UNESCO Regional Office
 Commission for Agriculture, Entebbe
 International Learning Cooperative, Oslo
 National Center for the Development of Learning Activities,
 Jayagiri, Lembaug-Bandung, Indonesia
 School of Social Work, UNC, Chapel Hill
 International Center for Research on Women, Washington, D.C.
 Equity Policy Center, Washington, D.C.
 Office of Technology Assessment, U.S. Congress
 Trans Century, Secretariat for Women in Development
 Overseas Development Council, Washington, D.C.
 Overseas Education Fund, Washington, D.C.
 World Bank
 Nonformal Education Information Center, Institute for Inter-
 national Studies in Education, Michigan State University
 Experiment in International Living, Brattleboro, Vermont
 Women and Development Unit, University of the West Indies,
 Barbados
 U.S. Peace Corps, Manila
 AID/WID, Washington, D.C.
 Various AID missions and bureaus.

In Thailand, DRI has documented the following examples of local replication:

- The Girl Guides of Thailand in Chiang Mai used the method repeatedly in planning their own programs and village development projects.
- The National Council of Women of Thailand (NCWT) conducted leadership training in the provinces of Lampang and Chachoengsao. DRI training assisted the

- NCWT in implementing its community development projects in these provinces, with funding from AID/Thailand.
- In three northeastern provinces of Thailand--Vdonthani, Sakonnakorn, and Nakhonpanom--the DTF methods were used by NCWT with community and women's groups on topics of consumer education and child development. The method was taught by participants from the initial DTF.
 - The DTF methods were used at a rural leaders seminar at Mahasarakham Teachers Training College.
 - The methods were used at a session with the home economics faculty at Kasetsart University on the topic of graduate school training.
 - A member of the NCWT modified the training methods for use by the Women's Secretaries Association.
 - The Thai director of American Field Service (AFS) used DTF methods in planning office and program activity.
 - The director of Mahedol University expressed interest in adopting the method for use by his staff after sending two staff members to observe the ASEAN meeting.
 - One of the Thai trainers recently became director of the International Training Program on Development and Management of Community-Based Family Planning, Health, and Development Programs of the Asian Center for Population and Community Development in Bangkok and indicated that the DTF planning methods would be an important element of her training program.

In Colombia, the second and third forums were only recently conducted; therefore, the documented replication is less than that in Thailand. The women of IIT and PAN indicated that the planning method from the first forum has been helpful in their work. Unfortunately, there was little continuity from the participants in the first forum, and little replication has resulted from the collaboration with the National Council of Women of Colombia. The second and third forums were conducted with the assistance of the CCTV (Coordinating Committee for Voluntary Work in Colombia). The second forum was conducted with the training representatives from CCTV coordinating committees from eight departments (geopolitical subdivisions) in Colombia. The third seminar included participants from six departments who were actively involved with community-level projects for the International Year of the Child. The single example of replication occurred one week after training: the methodology was used in designing a one-year program plan for the Medellín YMCA, a community-level, volunteer organization. The training was done by two participants from the second forum.

Although there were no major changes in the basic design and use of the methodology, some modifications occurred in specific uses of the forum in order to adapt the method to local cultural or social customs or traits. However, the basic methodology proved to be flexible, adaptable, and of great use to a variety of participants. General modification occurred in the following ways:

- Language. A simple use of language is necessary for implementing the method with village-level groups or with second language speakers. A more sophisticated use of language is possible with more experienced groups or native language speakers.
- Focus of DTF. The subject matter or topic varied. Some of the topics that were used as a focus for the DTF included:
 - The Role of Women in Rural Development,
 - Administrative and Community Development Skills for Provincial Leaders,
 - Women's Organizations and Community Development,
 - Women's Organizations as Agents of Technology Transfer,
 - Non-Governmental Organizations (NGO) and Governmental Collaboration for Child Development,
 - Community Actions in Consumer Education/Child Development,
 - The Role of Women in Food and Nutrition,
 - Technology for the Development of Self-Help Programs, and
 - Technology for the Programming of Self-Help Activities in Child Development.
- Participation. Participants were from a variety of organizations and represented varying levels of experience and social groups. The size of the participants' groups ranged from sixteen to two hundred people.
- Time Frame. The duration of the forum and the number of methodological steps varied from three hours (three steps) to seven days (six steps plus supplementary sessions). Intervening time periods between steps can vary also.
- Additional Sessions. The method can be enriched by the addition of complementary sessions, such as skills analysis, budget planning, project implementation, survey techniques, research methodology, proposal writing, or project funding.

Besides these general categories of method modifications, the following examples illustrate specific modifications made during the use of the method under this contract work:

- The original word "Contradictions" for the second step initially posed problems of comprehension for some participants. The word "Obstacles" was used for awhile, and finally "Constraints" was determined to be better understood by the participants.
- The process of moving from "Proposals" to "Programs" posed serious problems for the Colombian participants. Two remedies for this were developed by the participants themselves. One was to have the facilitator (or group leader) name the Programs from the Proposals, then move into the tactics step; as an alternative, the tactics step could follow the proposal step with the gestalt of tactics thereby being named as programs.

- Tactics--to avoid data that were project phases instead of specific activities, it was necessary to drop the instruction of listing the tactics in order of priority.
- Scheduling--due to problems encountered in planning, according to the three time frames, it was easier to begin with the long-term time frame (five years) and proceed toward the shorter time frame (three months).
- One day was suggested as a practicum so that participants were given an opportunity to try out new skills before leaving the DTF setting and returning to use the skills in their home institution.

The planning method also proved useful to the DRI staff in project and program planning and was used in other contract work.

A variety of social and cultural factors also influenced the design and use of the DTF.

The brainstorming step. This was popular in Thailand and was used almost to the exclusion of the rest of the method. A possible explanation for this might be that status tends to influence who talks within a group situation. The brainstorming step opens avenues to participation and thinking not traditionally used in Thailand. Encouraging this process is important because it stimulates a more complete utilization of human resources.

The group as an important entity in other cultures. The ability to work within a group is a key social skill that has many cultural rules. Participants expressed that the group participation methods used in the DTF gave them new ways to be creative, interact with other participants, and still honor traditional patterns.

The receptivity to aspects of the method will vary. For example, in the first forum in Colombia, participants had considerable difficulty with the scheduling step. In Thailand, much ceremony and protocol were necessary in holding the forums, which may have detracted slightly from concentration on the methodological presentation and process. These are aspects that must be carefully considered when planning a training program.

The approval and support of key people are necessary for endorsement of the training techniques. In Thailand, it became obvious that key individuals actively supported and intended to replicate aspects of the training. This served an important legitimizing function, motivating others to become actively involved in the training process.

Language was another key factor in using the DTF. It is obviously preferable to have native speakers do the training. When training is conducted in English to nonnative speakers, shorter, less sophisticated phrases and a more simple vocabulary must be used. This slightly inhibits an in-depth and fluid analysis of the pedagogical and methodological points. However,

this does not severely restrict the training process. In Colombia, all of the training was done in Spanish, with assistance in the last forum by native Spanish speakers.

The quantitative measures of the scope of impact of this training include a list of the organizations represented and supplementary reports on local replication. Figure 7 illustrates this in Thailand.

Modification of method is essential for each situation, as previously indicated. The method is a procedure, not substance, in that its content relies upon the local wisdom and experience of the participants. However, the trainers must be extremely sensitive to and able to adapt the method design and use it according to formal and intuitive influences. The method must be applied with this cultural sensitivity in order to be useful.

It may be possible to use the DTF methodology at the local level, even with a majority of people unable to write. However, the language and methods must be simplified. The DTF methods are reported to be used at the village level in northern Thailand by the Girl Guides.

The methods of the DTF draw upon the experience of the participants regardless of culture or status. The topics and methods used during the course of this program cut across cultures and give depth to the products. The development of global equity and equality is a trend that fosters the use of the DTF method. That is, all participate throughout the forum, fostering local or "grass-roots" input to planning or decision-making. Finally, the DTF planning method fosters "learning by doing," a technique applicable in all cultures.

Problems do occur in the use of the DTF. The following is a list of specific problems and lessons that can be learned from an understanding of a given situation.

- Problem: The lack of a clearly defined topic, objective, or interest on the part of the local counterpart can result in a poorly focused forum and data.
Lesson: A need to strive for a well-defined product and clearly understood motive for the DTF. Therefore, a preforum consultation is suggested as an opportunity to visit the locale and confer with local institutions in order to gain a firsthand idea of the local cultural, political, and social situation and in order to clarify the topic, outcome, and expectations of local groups.
- Problem: It is important and often difficult to reach the right key people and have a group responsible for making local arrangements and facilitating execution of the DTF.
Lesson: An entry point, such as the ARI, is essential for making local contacts and arrangements. In all cases, the institute was invaluable in arranging for

FIGURE 7
SCOPE OF IMPACT - THAILAND: PARTICIPATING ORGANIZATIONS

Bangkok	Phuket	NCWT	ASEAN
NCWT	<u>Bangkok Area</u>	Representatives from 93 organizations from around the country.	Faculty of Pharmacy, Mahedol University
President, Women's Association Nakon-Sithammarat	Home Economics Association-Thai-President		Department of Home Economics-Kasetsart University
President, TUWA	Representative from Thai Red Cross Society		Supervisory Unit, Department of Teacher Training, Ministry of Education
Deputy Secretary-General for Natural Sciences National Research Council of Thailand	NCWT		Ministry of Foreign Affairs
Chairperson, Promotion of CD through women	Officers of CD-Ministry of Interior		Faculty of Science, Chandrakasem Teachers College
Trainer, Girl Guides Association of Thailand	Representative from St. Joseph Alumni Association		Thai Home Economic Association
Social Science Researcher, National Research Council	Department of Technical and Economic Cooperation		Kasetsart University
Thai American Technical Co-operation Association	National Women Defense Association		Faculty of Nursing - Mahedol University
ISRA-Kenny Dental Clinic	Local Scout of Thailand		Teacher Training Department, Ministry of Education
ASRCT	Thai Muslim Women's Association		AFS - Thailand
Director of Environmental Biology Division, ASRCT	<u>Provincial Representatives</u>		NCWT
National Economic and Social Development Board	Red Cross Society of Trang		
President of Vocational Training Program, Thai Muslim Women's Association of Thailand	Red Cross Society of Narthivas		
Social Worker for Foundation For Thai Rural Reconstruction Movement	Women's Association of Narthivas		
Director, Pharmaceutical Research Division, ASRCT	Red Cross Society of Songla		
Foreign Relations Officer Social Studies and Planning Division, Department of Public Welfare	Women's Association of Phuket		
	Women Cultural Promotion Association of Petchuraboon		
	Red Cross Society of Chai Yapoom		
	Women's Cultural Promotion Association of Chiangrai		
	Nakornrajasima's High School		
	Women's Cultural Promotion Association of Chaiyapoom		
	Red Cross of Ubolrajathani		
	Women's Cultural Promotion Association of Ubolrajathani		
	Konkhaen's Kalayanavat High School		
	Women's Cultural Promotion of Mahasarakham		
	Women's Cultural Promotion of Phangna		

local support staff and assisted DRI in modifying the DTF design for local conditions.

- Problem: A problem exists in documenting the application and replication of the training, motivating the participants in their use of the skills, and ensuring general follow-up.

Lesson: Such continuity and support must be given by a local entity to encourage continued use of the training. In Thailand, the local support from the NCWT was a key to widespread replication. However, as the leadership changes, such support may not be so formal. In Colombia, there is an excellent opportunity for replication as the local entity is committed to and capable of such continuity and follow-up.

Once an initial program is developed for a country, replication of the DTF is inexpensive. Additional money, however, should be made available to the local institution to conduct follow-up and ensure continued replication of the method. Furthermore, seed money to support the project ideas developed during the forums should be made available. This provides a better link between planning and project development and could serve as a strong incentive for local organizations.

Conclusion

The WID program was extremely successful in achieving the desired objectives. It helped to expand the participation of professional women in achieving recognition and advancement in the following ways:

- by exposing the work of the women in the ARIs and the work of the ARI to the general public, voluntary organizations, and provincial and rural users;
- by training women in the ARIs and other organizations in planning skills and organizational management, useful in their work, within their organization, and in their daily life; and
- by providing a forum for discussion on topics of mutual interest to women in ARIs, government, and private organizations.

The measures of impact were both quantitative (replication and use of the DTF method; training held for other groups; activities designed and implemented using this method by the individuals/organizations that were trained) and qualitative (interviews and discussions with personnel in ARIs and other participants). In both countries, the method was enthusiastically viewed as practical, useful, and flexible.

The DTF focused on women and assisted in promoting their enhanced participation in national development. However, the use of the DTF has broader implications and can be a key to enhancing the more effective utilization of all human resources in development activities.

CONCLUSIONS AND RECOMMENDATIONS

The general conclusion is that the linkage experiment proved the hypothesis that a linkage between industrialized and developing country institutions can be an effective mechanism for strengthening the developing country institution. However, a caveat is appropriate. Not all attempts at establishing linkages are successful, and certain factors affect the degree of success of a functioning linkage. These factors and other conclusions are noted below, followed by recommendations concerning institutional linkages.

Conclusions

- For a linkage to be successful, the management of both institutions must have a good understanding of the goals of the linkage (these need not be specific) and of the capabilities and limitations of each institute in achieving the goals. Each institute must in some way benefit from the linkage, and the management of each must recognize the interests and needs of the other.
- Conditions, problems, and opportunities are in a continual flux within an ARI. The rate of change increases as an institute moves more into a contract research mode of operation. As a result, several conditions are placed on a linkage for it to be successful. First, regular contact must be maintained with the developing country institute to insure that assistance is directed toward a current need or opportunity. Second, the industrialized country institution must have the flexibility to change the type or form of assistance offered as conditions change. Third, the industrialized country institution must be able to react rapidly to needs of and opportunities for the developing country institution.
- Because of the nature of research and the changing environment within which a research institute operates, the payoff from some linkage activities will inevitably be difficult to define.
- One person needs to be present at each linked institute to coordinate the linkage. Otherwise, confusion, duplication of effort, and a lack of mutually supportive activities are likely to result.
- A linkage develops over time. As the staff of an institute develops rapport with members of the other institute, and as they come to know the capabilities and limitations of each other's institution, they are more likely to work together more effectively. With each of DRI's three linked institutes, the rate of benefit accruing to the linked institute increased as a function of time.
- A multifaceted approach--providing technical and management assistance, information, and training--was most useful in the DRI linkages. Besides being able to

respond to different and rapidly changing needs and opportunities, it often was possible to schedule supportive tasks.

- Combining on-the-job training with technical assistance activities was an effective way to transfer technical and management skills.
- A particularly important aspect of the three DRI linkages was the increased confidence that they provided the staffs of the institutes in their own ability to conduct projects and to request assistance from DRI if necessary. It similarly increased the confidence of the clients of the linked institutes.
- As the linkages progressed, conducting joint projects became increasingly important. By the end of the project, DRI and the linked institutes were preparing joint venture proposals. The management of the linked institutes repeatedly noted the value of this type of activity to their staffs in terms of building confidence and skills.

Recommendations

The experiment demonstrated linkages to be useful in strengthening ARIs in developing countries. DRI therefore recommends that AID missions make wider use of this mechanism in upgrading the S&T capabilities of developing countries. In particular, DRI recommends a continuation of the linkages between DRI and IIT, PCSIR, and TISTR, because these have reached a highly productive state. IIT, PCSIR, and TISTR are now making significant contributions to the development of their nations.

Strong evidence indicates that joint ventures between industrialized and developing country institutions are one of the most effective means of transferring technical and managerial skills internationally. DRI therefore recommends an experiment aimed at assisting institutions of industrialized and developing countries to form linkages based on the principle of conducting joint venture contract research. These might be called "second generation" linkages.

R&D MANAGEMENT DEVELOPMENT

One of the perceived weaknesses of S&T organizations in developing countries at the initiation of this experiment was in the area of management. This is understandable, because the R&D institute is one of the most difficult types of organizations to manage, regardless of location. Several reasons explain this phenomenon. First, many, if not most, of the R&D institutes' projects and activities are nonrepetitive in nature. Second, because of unknowns in research, engineering, and environmental response, greater uncertainty occurs in the outcome of projects of R&D institutes than in the output of most other types of organizations. Third, the product of an R&D institute is largely a mental output as opposed to a physical one. Thus, similar arrangements of factor inputs in R&D will not necessarily give the same results. This compounds the uncertainty associated with management. Finally, the staff of R&D organizations tend to be creative and individualistic. The productive management of such people calls for imagination and flexibility beyond that called for in the management of many other kinds of organizations.

The experimental R&D management program element should be differentiated from the management development activities aimed at the staff and management of the linked institutes. The major objectives of the experimental R&D management program element were twofold:

- to discover optimum methods for training institute executives; and
- to find appropriate mechanisms for initiating indigenous R&D management development programs and for training local instructors.

It should be noted that other project considerations affected the way in which DRI pursued these objectives, and these to some extent complicated the task. Basically, AID and DRI wanted the program to have as large a positive impact as possible on ARIs worldwide. This influenced the entire program design.

Figure 8 lists the location, number of participants, and number of ARIs and countries represented at each workshop held during the experiment. This also includes workshops held under AID contract AID/CM-ta-C-73-21. The last four workshops were conducted under the present contract. In addition to the workshops, a handbook on management development for ARIs was prepared to disseminate the lessons learned from the experiment and to help in the initiation of indigenous R&D management development programs.

THE WORKSHOPS

The four workshops held under this contract were in Tunisia, Thailand, Guatemala, and Indonesia. They focused primarily on

experimentation with workshop objectives and on the use of local faculty and leadership.

FIGURE 8
R&D Management Program Element

Workshop Location	Participants	Applied Research Institutes	Countries
Sao Paulo	23	8	4
Bangkok	36	13	9
Ankara	32	10	8
Denver (for workshop directors)	7	4	4
Karachi	20	6	1
Tunis/Gabes	44	11	10
Bangkok/Phattaya	19	9	6
Guatemala	19	14	14
Yogyakarta	35	18	5

The Tunisian Workshop

The Tunisian workshop, hosted by the Laboratoire Central de Tunisie (LCT), was held in June and July 1976. Its focus was to be on establishing effective linkages between research organizations and industry. DRI played only a supporting role, with LCT taking the lead in planning, organizing, and conducting the workshop. It is estimated that the LCT financial contribution toward the workshop expenses exceeded that of USAID.

However, DRI has several criticisms of the workshop. First, the program was too heavily oriented toward what Tunisia was doing in the field of science and technology. Too little emphasis was given to the management areas that the workshop ostensibly was to address. This was also the view of a number of foreign participants. A second problem concerned the simultaneous translation, which was considerably less than adequate.

On the positive side, the participants seemed to gain stimulation as a result of their ability to exchange ideas concerning mutual problems and to discuss these with the DRI

participants. The unanimous recommendation of the participants was that a follow-up Middle East/North Africa workshop be conducted. This was made in a memorandum that the participants prepared at the end of the workshop for submission to their respective governments. Other recommendations were:

- to allocate funds for the extension of industrial research programs;
- to adopt industrial policies that are in harmony with the problems of environment and requirements of rapid development;
- to focus attention on problems of industrial legislation;
- to insure the appropriateness of imported technologies so that they are in harmony with the economic and social factors of their countries;
- to promote mechanisms and institutions to supervise the investments of foreign capital;
- to promote policies for the commercialization and protection of the results of research;
- to optimize the activities of ARIs by creating national coordination structures to channel energies and to avoid duplication of research among different institutes;
- to help create a standards institute in those countries not having one;
- to assist the participating institutions in organizing and conducting a follow-up workshop to the present one in approximately one year;
- to establish an association comprising industrial research bodies of Asian and African countries for the purpose of exchanging information, know-how, visits, and staff, making available the facilities of participating institutions to others in the association and conducting joint research projects; and
- to promote within the framework of industrial research a policy of cooperation among developing countries.

Finally, the workshop participants believe that research institutes, through their appropriate national representatives, must participate in an effective way in the development of policies, strategies, and national development programs. Representatives of industry should be on the board of directors of research institutes to help with the strategic orientation of programs. Industrial enterprises should encourage the development of industrial research activities by:

- financing research programs at the level of laboratories and pilot plants;
- using the information dissemination services of research institutes;
- allowing the research institutes' staff to work in the enterprises' plants from time to time so as to better understand industry's problems;

- consulting ARIs on the problems of industry; and
- establishing regular contacts with ARIs to familiarize them with their real needs.

The Thailand Workshop

The Thailand workshop, hosted by TISTR, was held in August and September 1976. Its focus was on alternative approaches to effective contract research activities. DRI again played primarily a support role, with TISTR taking the lead in planning, organizing, and conducting the workshop.

One significant element of the program was a "homework assignment" from a 1974 workshop conducted in Thailand under contract AID/CM-ta-C-73-21. At that time, each participating institute agreed to engage in one or more of the following activities that were identified, in 1974, as being potentially useful for increasing the institutes' effectiveness with industry:

- industry seminars;
- ARI-industry interchange;
- industrial liaison;
- in-house management seminars for lower echelon staff;
- industry subscribers; and
- internal evaluation of ARI successes and failures in industry interaction.

It was a general consensus that these activities had been useful, and many of the institutes planned to continue them. Figure 9 summarizes the participating institutes' involvement in the exercise.

Another focus of the workshop was to examine the hypothesis that by forming a network of regional contract research institutes, the participating institutes could increase their effectiveness in obtaining industry and government contracts. The following key ideas and opinions were agreed on as important to a viable network:

- Industry, governments, and international organizations have a real need for broad-based research services and are willing to pay for them.
- A significant capability exists in the present ARIs of the region, and this capability needs to be effectively marshalled on a regional basis.
- To create a regional contract research capability will require more than just an organizational mechanism--it will also require a driving force that could take the form of a regional communications and promotion operation with a techno-economic studies and analyses capability.
- While the major source of funds for network operations will be contracts with industry, governments, and international organizations, start-up and overhead costs will need to be covered by some means.

Figure 9. HOMEWORK ASSIGNMENT OF WORKSHOP PARTICIPATING INSTITUTES

Participating Institutes	Industry Seminars	IRI-Industry Staff Interchange	Industrial Liaison	In-house Seminars	Industry Subscribers	Internal Evaluation
Applied Scientific Research Corporation of Thailand	* †	Δ †	†	Δ †	Δ †	†
Department of Science of Thai Ministry of Industry	* †		•	•		
National Institute of Scientific and Industrial Research of Malaysia	Δ †	* †	Δ †	Δ	Δ	
Singapore Institute of Standards and Industrial Research	Δ		•	•	•	
Agency for Industrial Research and Training of Indonesia	* †	* †	* †	Δ †		
Philippine National Institute of Science and Technology	* †	†	* †	•	◊	
Pakistan Council of Scientific and Industrial Research, Karachi Laboratories	* †	•	* †	Δ †	•	•
Pakistan Council of Scientific and Industrial Research, Lahore Laboratories	Δ	•	Δ	Δ	•	•
Korea Institute of Science and Technology	* †	* †	* †	* †	* †	Δ †

* Activity conducted at time of follow-up visit in early 1975.

Δ Activity started since 1974 workshop.

† Indicates activity ongoing at time of 1976 workshop; however, lack of † means information on activity's continuation is not known.

◊ Attempted but unsuccessful.

- The network must not be too large either in terms of geographical region or number of participating institutions. The management of the participating institutions must be able to get to know each other as well as to know the capabilities of the participating institutions.
- The policy and will must exist to make the network a success--the type of condition that exists within the ASEAN region.
- Implementing institutes must be involved in creating the network as well as setting its policy--the network should not be politicized.
- Networking institutions is a better concept than networking projects or research fields. It is also a more viable concept than the creation of a regional institution. The emphasis must be on strengthening national institutions.

Prior to the end of the workshop, the participating institutes agreed to form an informal network to pursue, on an ad hoc basis, contract opportunities that presented themselves. TISTR was asked to serve as the network's secretariat, and it agreed.

Another interesting development in connection with the workshop was TISTR's use of National Institute of Development Administration (NIDA) faculty as workshop faculty members. One of the recommendations of the final report on contract AID/CM-ta-C-73-21 was that in attempting to develop indigenous capabilities for training R&D institute management, the R&D institutes should involve local management faculties in such efforts. While these persons may have little or no experience with the peculiarities of R&D institutional management, they could work with the management of R&D institutes to gain this understanding. At the same time, they can convey to the institute staff, who have normally had little or no formal management training, some of the basic principles of management as well as management training techniques.

As would be expected, the NIDA faculty presentations were not always relevant to the needs of the R&D institute participants, nor were the TISTR staff always effective as management trainers. However, DRI believes that these efforts are in the right direction to develop a capable indigenous R&D management faculty for the future.

As with the Tunisian workshop, there was some criticism of the amount of time spent on describing what was happening in science and technology in Thailand. The tendency in this direction, however, was less in the Thai case.

The Guatemala Workshop

The regional management workshop for senior management of fourteen Latin American institutes was co-hosted with Instituto

Centroamericano de Investigaciones y Tecnologia Industrial (ICAITI) in Guatemala City during June 1978. Nineteen participants from the institutes attended the workshop. A different workshop format was used as an experiment to increase participation in discussions and activities by the attendees. In most of the sessions, after introductory comments, participants were assigned to one of four working groups in order to formulate opinions about the topic under discussion. Each group rapporteur presented the conclusions of his group in plenary session, followed by general discussion of the conclusions. It is believed that this approach improved materially the participation of each attendee and drew out comments and observations that would not have otherwise appeared if group discussions only had been used as a workshop format.

Also, two attendees were assigned to each session to collaborate in the preparation of a brief report for that session which summarized the conclusions and recommendations.

Some of the recommendations made by the participants for consideration in future workshops (and similar to those made by participants in other workshops) would include sessions:

- for ARI middle management of a similar nature;
- on promotional activities in technological institutes;
- concerning orientation of the workshop to technology and presentation to ministers of industry, commerce, economy, etc.;
- on research methodology (including budgeting, cost, and technical supervision);
- on preparation of proposals for contract research;
- that provide a review of government (banking and other schemes leading to the promotion of R&D in other countries) activities;
- on administrative systems for administrative heads.

These topics have been included in nearly all of the workshops conducted in DRI's linked institutes. The recommendations lead to the conclusion that a need exists for a new round of regional workshops directed toward middle management and project leaders rather than toward ARI directors.

The Indonesian Workshop

The final workshop under this experiment was held in September 1978 in Indonesia. Its theme was "Increasing the Utility and Utilization of Applied Research Institutes through Regional Networking." This reflected a continuation of a topical theme that was examined in the second Asian regional workshop held in Thailand in 1976--that is, regional networking of institutes. The Indonesian workshop took a micro-approach and focused on only one aspect of the ARIs' functions, that is, the marketing (promotional) aspect of the network's R&D capabilities. The Indonesian workshop was hosted and organized by the Research and

Development Centres, Indonesian Ministry of Industry, in collaboration with the Indonesian Institute of Sciences, in Yogyakarta. Attending the workshop were senior management from eighteen ARIs in Indonesia, Malaysia, Thailand, the Philippines, and Korea.

The main objectives of this workshop were, as the theme suggests:

- to increase the effectiveness of the marketing function of network institutes;
- to equip the top management of network institutes with a better appreciation of the problems of marketing joint ventures; and
- to create stronger linkages that will lead to network contract research projects.

One month prior to this regional workshop, a national workshop was held in Bandung as a preparatory meeting among the participating ARIs in Indonesia to ensure the achievement of the above objectives. The Indonesian government provided \$50,000 to assist in the preparation and conduct of the workshop.

The workshop consisted of three phases:

- Phase I. During the three days of phase I, discussions were held on two specific topics:
 - Promotion (marketing) as an ARI function.
 - The concept paper and the proposal--promoting and selling a project, and four country papers on "promotion" in Malaysia, the Philippines, Thailand, and Indonesia. The participants then were divided into five teams in accordance with five subject areas of regional interest identified during the discussions. Subsequently, concept papers and proposals were prepared for the activities of the next phase.
- Phase II. During the four days of phase II, promotion exercises were conducted on the above-mentioned areas. Promotion (marketing) field activities carried out by the teams were as follows:
 - Agro-based industry team, consisting of eight persons representing eight institutions. The location for marketing activities was Yogyakarta.
 - Building materials and industrial minerals team, consisting of eight persons representing eight institutions. Locations for marketing activities were Bandung and Jakarta.
 - Nonconventional energy team, consisting of seven persons representing seven institutions. Yogyakarta, Bandung, and Jakarta were locations for marketing activities.
 - Metal processing team, consisting of six persons representing six institutions. Ceper, Tegal, and

Bandung were locations for marketing activities; and

- Pollution abatement team, consisting of seven persons representing four institutions. Yogyakarta, Magelang, and Bandung were locations for marketing activities.
- Phase III. The last phase of the workshop, which occupied two days, was used for review and discussions of the exercises and for strategy formulation with respect to furthering marketing of the proposals and concept papers and strengthening the network of ARIs in the ASEAN region.

As noted in the report on the workshop prepared by the Indonesian Ministry of Industry R&D Centres, the results of the workshop were as follows:

- Project areas of regional interest identified were:
 - agro-based industry;
 - building materials and industrial minerals;
 - nonconventional energy;
 - metal processing industry; and
 - pollution abatement.
- The five concept papers and proposals produced on the corresponding areas were as follows:
 - commercial production of coconut milk as part of an integrated coconut-processing industry in Indonesia;
 - technical cooperation among ASEAN countries for the development of building materials for low-cost housing;
 - unconventional energy technologies for rural and village areas;
 - transfer of an appropriate technology of cast iron production from a village in Indonesia to villages in other ASEAN countries by networking research institutions; and
 - an action plan to control industrial effluent.
- The workshop participants agreed upon strategies to obtain support from the governments of participating countries and international organizations for the projects formulated during the course of the workshop. Discussions conducted during the field exercises with observers from international organizations and various local agencies indicated substantial possibilities for such support.
- The workshop resulted in a greater spirit of cooperation and involvement among the network institutes.
- The further development and promotion of the concept papers and proposals would be carried out by the individual teams through the Network Secretariat.
- It was agreed that concentrated efforts should be made to obtain further USAID and UNIDO support for strengthening the network.

- It was agreed that a continuation of this workshop series was highly desirable, and it was generally accepted that the next workshop would be held in the Philippines with NIST as host.

DRI believes that this workshop was successful in achieving the main workshop objectives. One indication of this is that UNIDO, which had a representative at this workshop, has expressed an interest in supporting a fourth Asian management workshop to continue the development of linkages among Asian ARIs.

HANDBOOK FOR WORKSHOP MANAGERS

Based on DRI's experiences in conducting the workshops as well as on other related information, a Handbook on Management Development for Applied Research Institutes was prepared to provide the ARI reader with a step-by-step guide on how to organize and conduct a successful and effective management development workshop. Since it is based on a foundation of experience as well as recognized theory, the handbook is intended to be pragmatic and practical.

The handbook is divided into six sections:

- Introduction--describes the background leading to the handbook and the objectives of the handbook.
- Section I--focuses on the thought process and the steps one should take prior to any decision to conduct an R&D management development workshop.
- Section II--deals with workshop planning. How do you organize a workshop in terms of its structure and organization? How do you select your instructors and the participants?
- Section III--describes various workshop techniques. What are the alternative techniques? What are the advantages and disadvantages of each?
- Section IV--deals with conducting the workshop. How does one ensure that the maximum benefit is derived from the workshop by all the participants?
- Section V--treats evaluation of the workshop. Why is this important? How should this evaluation be carried out? What steps should one take following the completion of the workshop?

The handbook was completed in March 1978 and distributed to ARIs and USAID missions worldwide. The response has been favorable, with USAID having an additional printing of the handbook in 1979 and DRI having a supplemental printing during 1979. The handbook has been translated into at least one additional language--Indonesian.

CONCLUSIONS AND RECOMMENDATIONS

The experiment confirmed the hypothesis that improved R&D management is needed within developing country ARIs. Further, well-conceived and conducted management workshops can help meet this need. DRI believes that this experiment made a substantial contribution toward identifying appropriate approaches, techniques, and procedures for conducting such workshops.

Within two countries--Thailand and Indonesia--in which the experimental management training activities were held, indigenous R&D management training capabilities are being developed. While many questions remain open with respect to the best approach for developing such capabilities, some insight was gained.

More specific conclusions and recommendations follow.

Conclusions

- Originally, DRI lacked perception concerning the difficulty in increasing management capabilities and particularly in training others to do so. This caused problems and disappointments during the first portion of the experiment, conducted under AID contract AID/CM-ta-C-73-21, when DRI failed to communicate to some participating institutions what was involved in terms of work and commitment from them. This difficulty may have also been caused in some cases by the management of participating institutes having goals different from those of the experiment.
- While the ability of individuals to transfer concepts and lessons from strange contexts varies considerably, DRI found that many R&D managers, trained in the fields of engineering or science, had difficulty in seeing the relevance of management concepts, techniques, or lessons unless these are portrayed in the context of a research institute--some needed to see the lesson, concept, or technique demonstrated in the context of an institute within their own country before it had relevance to them.
- As this program started, one of DRI's questions was: how receptive would ARI institute management be to some of the more advanced management training techniques such as the case study method, management games, in-basket exercises, and role playing? By and large, participants were receptive to these techniques even though the methods were in many cases new and strange to them.
- If participants will make a commitment to utilize concepts or lessons learned at a workshop--perhaps in the form of a written plan--and if follow-up consultation visits are scheduled, then the chances that the participants and their institutes will benefit from a workshop are significantly increased.

- DRI's experience suggests that behavioral evaluation some months after a workshop can increase the likelihood of positive results. For this to occur, (1) the participant should be informed during the workshop that this follow-up evaluation will be made, and (2) the participant's superior should be actively involved in the evaluation. If the participant knows that he is to be evaluated at the behavioral level by a workshop leader and his superior, he will make efforts to have the evaluation positive; that is, he will attempt to implement workshop concepts, practices, and techniques. The perhaps subtle aspect of the second condition is that there is often little that a participant can do to implement workshop ideas unless his supervisor supports the action. In fact, in many developing countries, a person would not have the temerity to even suggest changes to his supervisor without first being asked--thus, the reason for bringing the supervisor into the evaluation.
- With respect to host country leadership in conducting the second series of workshops, DRI found that:
 - host countries universally did a good job in organizing workshop facilities, logistics, and such;
 - most did a good job in planning workshop content--no one did a poor job in this respect; and
 - the local faculty contribution was varied.

At the second Thailand workshop, TISTR invited the Thai National Institute of Development Administration to assist in providing the workshop faculty. This was an interesting approach to developing a local cadre of R&D management trainers. On the one hand, the professional management trainers know management in general but probably know little about the special characteristics of R&D management--this they can gradually learn through their association and work with the professional R&D managers. On the other hand, from experience, the R&D managers know much about R&D management but have little experience in structuring their special knowledge into management training modules--the management trainers can help them with this.

Recommendations

- Lack of management capability as opposed to technical capability is a major factor limiting the contribution of ARIs to the development of the countries in which they reside. Therefore, management development assistance to these institutions should have high priority with AID missions.
- There is a paucity of management training materials, such as case studies and management games, aimed specifically at training the developing country ARI manager. OST should initiate a program to develop and distribute such materials.

- Developing indigenous R&D management training capabilities in countries is movement in the direction of self-sufficiency. While some understanding of methods was attained as a result of this experiment, much is still speculative or unknown. Thus, DRI recommends that AID or some other appropriate organization continue this aspect of the experiment.

RESEARCH GRANTS PROGRAM

The research grants program was conceived as a means to stimulate the effectiveness of research institutions in the developing countries in R&D activities as they relate to industry and other users. It had been observed that in too many instances a significant lack of relationship existed between what occurred in the research laboratory and what was ultimately shown to be useful and commercially viable in the economy.

The reasons for this disjointure were rooted in several characteristics or situations that are common to the typical research institute's operations: utilization of recent technical graduates without industrial experience, lack of communication between the research institute and the user communities, perceptions on the part of industry managers that R&D was expensive and ineffective, absence of the laboratory equipment and pilot plants needed to demonstrate the technology, import policies and other governmental actions that tended to minimize or discriminate against the research institution, and similar activities. Therefore, those same reasons that constituted the basis for the other elements of the DRI program of institutional assistance also formed the background for the grants program.

Specifically, the research grants program was structured to provide, in selected instances, catalytic amounts of funding and technical assistance to enable the grantee institution to carry out highly directed research having specific commercial or other objectives that would demonstrate the utility and effectiveness of developed or adapted technology. It had been observed that in many instances otherwise practical research projects were delayed or prevented by the absence of relatively small amounts of "hard currency" to provide equipment or technical services from foreign specialists. The intent of the grants program was to experiment with modest infusions of such capital under regulated conditions, to determine if this procedure would show results sufficient to cause consideration of it as a programmatic device for general use in the developing countries with such research institutions, which comprise the large majority. The purpose here is to assess the outcome of this program and present conclusions.

Over the course of the project, ten grants to eight different institutions in as many developing countries were made. The results ranged from failure to appreciable success, demonstrating the value of the method and resulting in recommendations for further experimentation and use of the concept.

Although the grants program was a natural concomitant of the other aspects of the DRI program, including linkages and management training, it was conducted independently of them in order to provide a wider base of experience. It included institutions that for various reasons otherwise might not have been included in the DRI programs. However, several of the institutes that were involved in other DRI activities were also incorporated into the grants program.

GRANTS PROGRAM METHODS

Several criteria were used to select grantee institutions:

- The proposed R&D activity needed to show reasonable promise of being commercially or otherwise useful to the intended user, there being too many examples of research institution projects that ended up as technical successes but commercial failures.
- A number of projects were to be included that reflected the "appropriate technology" concept in that they were to result in labor-intensive technologies, to have minimal capital requirements, to be widely applicable in rural areas, and to benefit principally the least advantaged strata of the population.
- A fairly broad geographic distribution of the participating institutions was desired.
- Some relatively sophisticated technologies were to be involved.
- The proposing institution was required to show evidence of sufficient technological and managerial competence and interest in the project to assure its ability to carry out the proposed program.
- The technologies involved were to cover a spectrum of product areas, including food and agroindustry, extractive industry, energy in some aspect, materials fabrication, and similar fields.
- Finally, another agency was to have a role in the actual application of the research results. This was to be a private or governmental entity that could but was not required to take a financial interest in the project. (This was another aspect intended to assure the practical exploitation of the research results.)

The initial round of proposal solicitations involved issuing letters of invitation to submit proposals. Invitations were sent to over sixty institutions throughout the developing countries; this list was garnered from the membership roles of WAITRO (World Association of Industrial and Technological Research Organizations).

The resulting proposals (thirty-four were received) were reviewed by a select panel of U.S. institutions (Battelle, Arthur D. Little, and Southwest Research Institute) and were judged on their technical and other aspects according to a list of selection criteria. From this process, eighteen proposals from as many different institutions were selected for final consideration. This selection took place during a two-day meeting of representatives from the judging institutions at DRI. The proposals were rank-ordered, and from this list, five institutions were selected to receive grants:

- Korea Institute of Science and Technology (KIST), Seoul, Korea;

- Thailand Institute of Scientific and Technological Research (TISTR), Bangkok, Thailand;
- Central American Institute of Industrial Investigations (ICAITI), Guatemala City;
- Institute of Industrial Studies (IIT), Bogotá, Colombia; and
- Federal Institute of Industrial Research (FIIR), Lagos, Nigeria.

In the second and final round of proposal solicitations, it was decided that preliminary visits would be made to specially selected institutes in order to determine their qualifications and interest and to identify possible proposal subjects that would conform more closely to the desired range of subject matter. This method was also used to avoid the problems that had arisen in the first solicitation process when thirteen otherwise meritorious proposals went unrewarded because of funding limitations.

In the second round, preliminary personal visits were made to seventeen institutions as follows:

- Leather and Electrotechniques Research Institutes, Indonesia;
- Ceylon Institute of Scientific and Industrial Research (CISIR), Colombo, Sri Lanka;
- Institute of Industrial Studies (IIT), Bogotá, Colombia;
- Institute of Technical Studies (IPT), São Paulo, Brazil;
- Technological Laboratory of Uruguay (LATU), Montevideo, Uruguay;
- Institute of Technology (INTEC), Santiago, Chile;
- Industrial Institute of Technology (ITINTEC), Lima, Peru;
- Litoral Polytechnique School (ESPOL), Guayaquil, Ecuador;
- Central American Institute of Industrial Investigations (ICAITI), Guatemala City, Guatemala;
- Dominican Institution of Technology (INDOTEC), Santo Domingo, Dominican Republic;
- Industrial Development Commission, Port au Prince, Haiti;
- Caribbean Industrial Research Institute (CARIRI), Port of Spain, Trinidad;
- Institute of Mining and Metallurgy (IIMM), Oruro, Bolivia;
- Council of Scientific and Industrial Research (CSIR), Accra, Ghana;
- Laboratoire Central, Tunis, Tunisia;
- Royal Scientific Society (RSS), Amman, Jordan; and
- Pakistan Council of Scientific and Industrial Research (PCSIR), Karachi, Pakistan.

Ultimately, proposals were received from each of the institutions except LATU, Laboratoire Central, CARIRI, The Haitian Development Commission, ITINTEC, INTEC, and the Leather Research Institute in Indonesia. Each of these had stated its intention to

submit proposals and had evinced interest in the grants program. However, for a variety of reasons ranging from political upset to failure to generate interest, they were not forthcoming. It is believed, however, that in most instances persistent pursuit of these institutes would have resulted in their participation. This simply was not done because so many promising submissions were received from others that oversubscription of funding, which had happened in the first round of solicitations, became a major concern.

Results of the proposal generation activity in both instances (i.e., when a general solicitation was used in the first instance versus a selective approach in the second round) provided useful and insightful information. A summation of negative observations about the proposals includes the following:

- Despite the provision of fairly detailed information concerning the desired content of the proposals, general deficiencies occurred in terms of meeting requirements.
- A lack of consistency, logic, and sequentiality were common in the proposal content.
- Even allowing for the effects of English as a second language for most of the proposers, an unexpected degree of awkwardness and misuse of language occurred among even those who had received graduate degrees in English-speaking countries.
- Particularly evident was insufficiency in estimating the costs of the proposed R&D, in preparing adequate estimates of the staffing requirements, and in developing a logical and consistent sequence of project steps.
- Despite instructions, a lack of economic analysis and the relating of the proposed R&D to national development goals, sponsor interests, and internal institutional activities often occurred.

The research proposals, particularly during the first round of solicitations, were so varied and insufficient that they were used as poor examples of proposal preparation in courses presented by DRI (the institutions were disguised for this purpose to avoid embarrassment). On the other hand, the reports of completed grant-supported R&D projects were generally more consistent and of better quality than the corresponding proposals.

A modified approach was consequently utilized in the second round of solicitations. It was thought that a more selective and intensive introduction to the subject, provided on a direct personal basis, would result in more responsive proposals--and this proved to be the case, although problems still occurred. It was for this reason that the research grant agreements in the second series were written to provide for preproposal studies of the respective subject areas. Each institution was initially funded to make adequate prior study of the subject and then to submit final proposals as the second phase. It was adequately

demonstrated that this phased approach to the generation of proposals was effective in terms of increasing the overall efficiency of the process and avoiding wasted effort and delays.

INDIVIDUAL GRANTS PROJECTS

The principal value in the research grants program is realized from a review of the individual experiences of the different grantee institutions in pursuing their particular projects.

Federal Institute of Industrial Research - Lagos, Nigeria

The research to have been performed by this institute was the development of a malting process utilizing locally grown barley as replacement for imported wheat (from the United States, principally) in the brewing of domestically produced beer. Beer, along with palm wine, is the principal alcoholic drink of the country; palm wine is locally produced--often with toxic effects--and the government wished to promote the production of a more consistent and less potentially lethal beverage without heavy dependence on imported constituents.

The DRI grant was to have provided equipment required for the laboratory malting and fermentation work. This equipment had a value of approximately \$15,000 and was to be obtained from manufacturing sources within both the United States and Europe. DRI arranged for the purchase and shipment of the equipment, which eventually was sent by air cargo in five separate consignments--two from the United States and three from Europe. Three different air carriers were involved.

Communications with the FIIR were extremely tenuous and undependable, but it was finally determined that only two of the five shipments were ever received. The remainder had been "misplaced" after having been received at the Lagos airport customs house, as certified by the involved carriers. The FIIR stated that they never received notice of arrival and that subsequent efforts to trace the equipment through the customs authorities were unfruitful.

Confusion in those communications that were received and several changes of personnel at FIIR added to the difficulties. It was reported by one carrier that all air cargo (which had built up considerably at the Lagos airport) had at one point been ordered removed from the site by the nation's president, who was preparing for the visit of the Queen of England and wished the site to be neat and presentable. This displacement resulted in the loss of much of what was then stored in the open cargo area.

In subsequent communications, the FIIR asked for replacement of the equipment plus the addition of new equipment whose cost far exceeded available funds. At last communication with the FIIR, some laboratory fermentation work had gone forward, but the

project could not be completed. Meanwhile, both the principal investigator and the FIIR director had accepted other assignments outside the country; at this point, communications ceased and nothing further was heard in the ensuing two years.

This project represents by far the least satisfactory of those that were attempted. It illustrates the difficulties that evolve when communications are poor and uncertain, and when control is lax and personnel turnover is high at the research institute.

Council of Industrial and Scientific Research - Accra, Ghana

In this situation, the proposed research was to have involved a feasibility study for the design and production of hand pumps within the country for use in an extensive tube-well project being conducted by other donor countries. The objective was to produce dependable, low-cost hand pumps with a high ratio of indigenous materials and labor, to be widely used in the rural areas. Much experimentation and development had already been conducted in this subject area under AID sponsorship, and this was to be reviewed and integrated into the project. The grant also called for inspection trips to sites of major installations in other countries. Costs for an extensive literature review and correspondence, in addition to travel and per diem expenses for the field visits, were to be covered by the grant. One of the major anticipated problems was in identifying or establishing an adequate manufacturing capability in the country, which lacked, for example, a competent foundry facility.

Again, delays and communication problems interfered with the project. But most detrimental was the instigation of two coups in Ghana that raised questions about the disposition of grant funds and the possibility of performing the work within an acceptable time frame. This ultimately resulted in abandonment of the project, because it was concluded that even if it were feasible to carry the work forward, it could not be accomplished in an acceptable time span.

Dominican Institute of Technology (INDOTEC) -
Santo Domingo, Dominican Republic

This grant was never actually made because of intervening circumstances, but it is included here for its instructional value. The project involved studying the feasibility of recovering waste sensible heat from the 60,000 ton/year slag dump of the Falconbridge ferro-nickel plant. Although recovery from this high gradient and consistent waste heat source is theoretically a good possibility, no serious worldwide attempt has been made to design and implement such a system. The approach of INDOTEC was interesting and judged feasible.

The project was not realized because of the demands of Falconbridge and the restrictions that it intended to impose on

doing the necessary research within its plant facilities. Additionally, the plant required exclusive access to the results of the work--a condition that was not possible under terms of the use of AID funds for the project.

INDOTEC subsequently was invited to submit other proposals for consideration and did generate two or three ideas that were not, however, developed into proposals in time to be considered for program funding.

National Institute for Chemistry - Bandung, Indonesia

Along with the National Institute for Electrotechniques in Bandung, a proposal was generated for studying the feasibility of upgrading and standardizing the production of tempe in Java. Tempe is a partially fermented product made from soybeans and is a low-cost, principal source of protein for low-income persons in the country. However, it is made typically by small, ill-financed entrepreneurs for highly localized consumption. The production process varies widely in terms of standardization and is usually unsanitary, leading sometimes to toxic effects on consumers. The objectives of the proposed R&D was to develop designs for better equipment, to devise more sanitary production methods, and to provide better standardized cultures with which to initiate fermentation. The work was to involve the local cooperatives of tempe producers and was to be disseminated through their assistance.

However, the second version of the proposal for this work proved to be little better than the first unsatisfactory submittal. This occurred despite a personal visit to Java to discuss desirable proposal content and format. When improvements were suggested in writing, no response was made and DRI concluded that interest was insufficient to pursue proposal development.

Institute for Technical Investigations (IIT) - Bogotá, Colombia

IIT participated in two research grant projects. The first one concerned the development of a method for neutralizing a highly caustic and toxic refinery effluent that was being discharged into a tributary of the Magdalena River, a major source of domestic water in the country. The potential for poisoning people who were drawing water from the stream was appreciable. The refinery was owned and operated by the government.

A private firm of consultants approached IIT with a proposal for a joint development effort on a process that could then be marketed to the refinery management. Laboratory bench-scale studies showed that not only could the effluent be neutralized, but commercial values of naphthenic and crysilic acids could be recovered in the process and sold, probably at a net profit. When this possibility was presented to refinery management, for unexplained reasons they declined to participate in the financing of the necessary treatment facility. Neither did they desire to

pay for its design nor to enter into a contract with the consultants that would enable them to put such a facility into production. In the meantime, it was reported that the nature of the effluent had changed and that its potential toxicity for water users had declined. IIT is currently trying to interest other refinery operators in the process, but with no success to date.

In a subsequent grant, IIT undertook to study the technical and economic feasibility of adapting "extrusion cooking" to the production of pastas for consumption by low-income Colombians. Such pastas are a staple of the diet in that country and in other Andean nations. Extrusion cooking utilizes the mechanical energy exerted through a screwlike device that both mixes and simultaneously cooks combinations of food grains and extrudes them in the form of standard pasta shapes. Further, the process makes possible the use of domestically produced food grains such as rice and maize in place of imported wheat, resulting in a possibly lower priced and yet more nutritional product.

The grant to IIT supported a series of tests at the Korea Institute of Science and Technology on its own designed version of a small-scale extrusion cooker. IIT engineers were present at this test and exchanged information with the Koreans. The test demonstrated the feasibility of the concept and led to a proposal for construction of such a machine by IIT. At the same time, a market study was conducted in Colombia that indicated the number of machines that could be expected to be sold within the country to existing pasta manufacturers. (A market is also anticipated in other Andean countries.)

DRI worked with IIT personnel in a marketing effort and sought financial support from organizations in the United States and elsewhere to build a prototype machine and demonstration production facility in Colombia. Agreement was reached with a local manufacturer of food production equipment to meet 25 percent of the cost of this work in return for first option on producing the prototype equipment commercially.

Thailand Institute of Scientific and Technological Research
(TISTR) - Bangkok, Thailand

A grant was given to TISTR to procure a commercial-scale chemical process vessel for use in developing a process that will stabilize the oil that can be extracted from the seeds of rubber trees. This stabilized oil is a suitable substitute for linseed oil, which is presently imported into Thailand for paint manufacture. Unstabilized rubber seed oil deteriorates rapidly and is unusable; the addition of certain organic compounds under the right conditions of temperature and pressure will stabilize the natural product. This process must be carried out under controlled conditions of temperature, pressure, and agitation in specially designed equipment.

DRI located, refurbished, and shipped the required pressure vessel to Thailand that permitted development of the process. The product was introduced to Thailand Paints & Chemical Company, Ltd. (TPCC) who conducted a market survey using the stabilized oil produced at TISTR. At present, TPCC is studying the possibility of constructing their own commercial plant for producing stabilized oil. (Rubber seed, heretofore a waste agricultural product, may soon be profitably collected by low-paid agricultural workers during slack seasons between rice and other harvesting activities.)

Central American Institute of Industrial Investigations
(ICAITI) - Guatemala City, Guatemala

Like IIT in Bogotá, this institute also received two research grants. The first grant supported the development of a process to treat cottonseed cake, a livestock feed. Cottonseed cake contains an enzyme (gossypol) that renders the feed toxic when ingested by swine, chickens, and other animals that have only one stomach. The treatment process involves the introduction, at a raised temperature, of measured quantities of an iron compound that reacts with the enzyme and destroys its toxicity by forming other compounds.

Although the treatment process was already known, it was necessary to design an efficient system at acceptable cost. ICAITI envisioned a system that utilized a fluidized bed reactor, a device for continuously intermixing particulate matter under controlled conditions of temperature and rates of energy transfer. With technical assistance from DRI and help in acquiring special components, a successful prototype was designed, built, and tested--including the development of a computer model of the energy transfer process that established design parameters. Experimental results conformed closely to the predicted behavior of the system.

Depending upon the market value of cottonseed cake, which is a government controlled commodity, the detoxified product may be mixed with other animal foodstuffs to produce a protein-enriched food for the livestock market of Central America, where much cottonseed cake is generated by the oil extraction industry.

Under another grant, ICAITI developed a theoretical heat transfer model of a small-scale solar grain dryer and produced a design concept for its manufacture. This device is intended for low-cost production and for sale to farmers in the Central American region, where significant post-harvest losses occur with maize and bean crops, especially during the wet season. The design could be commercialized through the efforts of the "collectivos" or farmers' cooperatives that are supported by the Honduran and other governments in the region.

DRI assisted ICAITI in exploring possible sources of finance for carrying this project forward. DRI personnel arranged for

visits and accompanied ICAITI staff on fund-raising efforts with such organizations as the Interamerican Development Bank, Appropriate Technology Incorporated, the Interamerican Development Fund, Rockefeller Foundation, ADELA, and others.

Korea Institute of Science and Technology -
(KIST) Seoul, Korea

Korea imports large amounts of foreign wheat to meet the increasing demand for baked goods that has accompanied its rapid economic growth. Barley can be grown as a second crop after rice, the principal food grain crop of the country, and barley is presently used to augment rice supplies. KIST food technologists had the idea of producing a composite flour that would substitute quantities of home-grown barley for imported wheat, if technical difficulties and consumer taste preferences could be accommodated.

This involved extensive laboratory and production testing of various ratios of wheat/barley mixtures. Also, consumer acceptance testing was necessary to determine the marketability of the product; important questions of product texture, protein availability, color, shelf life, and taste had to be answered. The DRI grant provided the full cost (\$48,000) of this R&D effort, which resulted in the development of a product that not only met the consumer preference requirements, but also was compatible with the commercial bakeries' production equipment and methods.

The Minister of Agriculture became very interested in the KIST project and was on the verge of promulgating the composite flour development throughout the country by making production of the new bakery products mandatory. However, at latest information, effects of world wheat prices combined with Korean agricultural priorities resulted in temporary shelving of the program, although it is expected ultimately to be implemented.

Ceylon Institute of Scientific and Industrial Research
(CISIR) - Colombo, Sri Lanka

Food coloring is widely used in the traditional dishes prepared in Sri Lankan homes and restaurants. Presently, most coloring agents are imported and are of synthetic origin, following contemporary trends in the developed countries. On the other hand, numerous indigenous plants contain extractable pigments and may prove to be safer than the synthetic imports that are now under suspicion as sources of cancer. The gathering of wild species of such plants, and the cultivation of others, could provide employment in the rural sectors, which are presently among the world's lowest income areas.

The DRI grant to CISIR funded an extensive study tour to the United States and the United Kingdom by one of the institute's senior scientists, who visited experts in the food colors field and contacted commercial import firms that might wish to handle such products. This staff member subsequently accepted a two-year

visiting scientist post in Guyana, which left the project objectives unfulfilled. The new program head, a Ph.D. food scientist, was well trained but lacked the extensive experience of her predecessor and, of course, lacked the advantage of the two-month tour.

To partially compensate for this loss, DRI provided an expert in the food coloring field, on-site in Colombo, where he advised on the technological and commercial aspects of the project and helped to prepare a proposal for completing the experimental program, including potential sources of funding.

Institute of Mining and Metallurgy (IIMM) - Oruro, Bolivia

Bolivia depends primarily on tin ore concentrate exports for its earnings of foreign exchange and the general support of its economy. Unlike the placer deposits of Malaysia and Thailand, Bolivia's ore has always been mined from hard-rock veins. The cassiterite (tin ore) in these deposits is highly dispersed and occurs in very small grains in a matrix of quartz and other minerals. As a result, from 50 to 60 percent of the contained tin in the ore that is delivered to the primary crusher at the mill ultimately ends up in the tailings due to the high recovery costs. With world tin prices at five to six dollars per pound, appreciable investment could increase recovery ratios and still be profitable.

Another national problem is stream pollution, caused by mining operations, which threatens the domestic water supply of various Indian communities downstream.

Under the DRI grant, two mining engineers from IIMM visited the United States under a special program arranged by a minerals consulting firm. Their purpose was to make laboratory studies of new chemical and magnetic beneficiation methods and to study mine waste water handling systems that have been developed in this country. This had two immediate results.

First, plans are underway for tests to be conducted in the United Kingdom on a bench-scale high gradient cryogenic magnetic separator, which represents the latest technological development for achieving higher tin ore separation ratios by magnetic means. In this process, electromagnets are subjected to extremely low temperatures, which greatly increases the strength of their fields. This higher intensity may make possible selective separation of the paramagnetic gangue materials accompanying the cassiterite on a much more effective and economic basis than by conventional magnetic separation.

It is also proposed to prepare special polymeric materials to act as "carriers" for various reagents used in the "selective flocculation" process of separating tin ore from its unwanted associated materials.

Of special interest in each instance was the willingness of a U.S. consulting firm to undertake a joint venture with the IIMM, and possibly with DRI itself, in order to perform the necessary R&D on the basis that future profits, if realized, would be shared on some agreed-upon basis and that a stock company or limited partnership would be formed for this purpose. As in the case of the TISTR (Thailand) rubber seed oil process, the prospect exists of generating new enterprises and sources of income for research institutes through this joint undertaking.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations resulting from the research grants program tend to reinforce observations that have been made by numerous other investigators and observers of research institutions in the developing countries. That is, no great revelations have resulted. What has been accomplished, however, is to give considerable structured, empirical evidence that is useful in further exploring the ramifications and potentials for utilization of this institutional support concept.

The general conclusion is that the research institute in the developing country--when appropriately organized, equipped, and related to other elements of the economic development process requiring the application of technology--can be an invaluable link in the chain of development efforts. Further, the attainment of these precedent conditions is both feasible and desirable. Specific conclusions and recommendations follow.

Conclusions

- Inevitably, time delays and communications difficulties customarily exceed expectations and significantly hamper progress in technology identification, acquisition, and application. With the gaining of experience by those concerned, and with improved communications, it is anticipated that these problems can be significantly ameliorated, although underlying cultural factors that contribute to these problems may not be expected to yield so rapidly to change.
- Similarly, many institutions face problems and restrictions in gaining proficiency in the conceptualization and development of adequate research proposals. This is not strictly a language-related problem but seems to have its roots in more profound, deeper considerations, possibly cultural in origin.
- There is a lack of sensitivity to the techno-economic aspects of R&D projects, stemming probably from the lack of training in these aspects on the part of most institution staff members, who have been trained rather dogmatically only in "hard science" subjects.
- Rapport with the user community is frequently underdeveloped and reflects a customary absence of direct industrial experience on the part of professional staff

members, or a lack of training and emphasis on this relationship.

- In too many instances, facilities are lacking or inadequate to carry out R&D effectively; this is especially true with regard to the provision of pilot plant and demonstration facilities that are even more important in the developing environment than they are in the developed countries. Gaining access to information, both technical and commercial, is a concomitant difficulty.
- Most staff members are formally trained as scientists rather than as engineers, and a consequent shortage of persons with these technology application skills exists. Industry demand for engineers is characteristically so great that retaining persons with these skills in the institution is very difficult.
- Most potential users of institute R&D services view ARIs as high risk ventures, unlikely of producing commensurate results and representing poor prospects of a sufficient return on their investment versus alternative opportunities. They may feel that public-supported institutions should provide services at no charge. Their understanding of the nature and utility of R&D is often poorly developed.
- In the DRI grants program experience, and given the expectations held at the outset for its effects, it is concluded that the ratio of results has been within what reasonably might be expected in terms of "successes" versus "failures," and that improvement in the application of the grants concept was demonstrated over the course of the two cycles that were undertaken.
- It is clear that the research institution is an important element in technology utilization and that its performance in this regard is susceptible to significant improvement in most instances, given sufficient resources and appropriate planning and direction. However, it is equally clear that this type of institution is but one element in a chain or sequence of functions and organizations required to successfully identify, acquire, adapt, develop, and apply technology.

Recommendations

It is proposed that the experience gained from the research grants program, coupled with the lessons learned in carrying out the OST-sponsored program, be utilized to elaborate the experimental program. A structured approach that would include the missing elements in the technology application process referred to in the last of the conclusions should be employed. Such elements would include:

- training as needed for all those associated with the technology application endeavor;

- performance of feasibility studies and surveys for determining technology needs and approaches in specific instances;
- specific technological support and consultation in both the natural and social sciences as required;
- provision of facilities and equipment (especially pilot plant and demonstration units) and access to needed information to carry out R&D programs;
- mechanisms and means for forming effective links to user communities, investment sources, and government entities; and
- assistance in organization, management, and marketing functions and in identifying entrepreneurs and assisting them in making successful technological innovations.

The DRI grants program has been too restricted in its scope and, in order to provide an adequate test of the hypotheses relating to the implementation of technology in pursuit of development, should be broadened to include these other necessary functions in the experimental matrix and not be restricted solely to working with the technological institutions. The utility of this is partially demonstrated by the research grants program in that it has shown progress by extending the range of DRI support to some of these elements outside the research institution itself.

A concept for implementing this extension is contained in a proposal for experimenting with a "Technology Development Corporation," which was prepared three years ago and may form the basis for accomplishing and carrying out this recommendation through some institution such as ISTC or the UNDP.

GLOSSARY OF ACRONYMS

AID	Agency for International Development
ANDI	National Association of Industrial Development
ARI	Applied Research Institute
ASEAN	Association of South East Asian Nations
ASRCT	Applied Scientific Research Corporation of Thailand (now TISTR)
CARIRI	Caribbean Industrial Research Institute (Trinidad)
CCTV	Coordinating Committee for Voluntary Work in Colombia
CISIR	Ceylon Institute of Scientific and Industrial Research (Sri Lanka)
COLCIENCIAS	Fondo Colombiano de Investigaciones Cientificas y Proyectos Especiales
CSIR	Council of Scientific and Industrial Research (Ghana)
CSU	Colorado State University
DOE	Department of Energy
DRI	Denver Research Institute
DTEC	The Thai Department of Technical and Economic Cooperation
DTF	Development Training Forum
EPA	Environmental Protection Agency
ESPOL	Litoral Polytechnique School (Ecuador)
FIIR	Federal Institute of Industrial Research (Nigeria)
FPC	Fish Protein Concentrate
GRA	Graduate Research Assistant
HFS	High Fructose Syrup
IDB	International Development Bank
ICAITI	Instituto Centroamericano de Investigación y Tecnología Industrial

IFT	Institute for Food Technologists
IIMM	Institute of Mining and Metallurgy (Bolivia)
IIT	Instituto de Investigaciones Tecnológicas (Colombia)
INDOTEC	Dominican Institute of Technology (Santo Domingo)
IPT	Instituto de Pesquisas Tecnológicas (Brazil)
ITINTEC	Instituto de Investigación Tecnológica Industrial y de Normas Técnicas
KIS	Know How Information Service
LATU	Technological Laboratory of Uruguay
LCT	Laboratoire Central de Tunisia
NCWT	National Council of Women of Thailand
NGO	Non-Governmental Organizations
NIDA	National Institute of Development Administration (Thailand)
NTIS	National Technical Information Service
NWA	Network Analysis
OAS	Organization of American States
OR	Operations Research
OST	Office of Science and Technology, AID
PAN	Plan for Food and Nutrition (Colombia)
PCSIR	Pakistan Council of Scientific and Industrial Research
PVO	Private Voluntary Organization
R&D	Research and Development
RSS	Royal Scientific Society (Jordan)
S&T	Science and Technology
SDI	Selective Dissemination of Information

STI	Scientific and Technical Information
TISTR	Thailand Institute of Scientific and Technological Research (formerly ASRCT)
TNDC	Thai National Documentation Center
UNDP	United Nations Development Program
USDA	United States Department of Agriculture
VITA	Volunteers in Technical Assistance
WID	Women in Development
WAITRO	World Association of Industrial and Technological Research Organizations