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ASIA TECHNOLOGY

COMMERCIALIZATION STUDY

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LIST OF ACRONYMS

ABLE	American Business Linkage Enterprise
ACE	Agricultural Commercialization and Enterprise
A.I.D.	Agency for International Development
ALCOA	Aluminum Company of America
APPROTECH-ASIA	Asian Alliance of Appropriate Technology Practitioners
ARRI	Aquatic Resources Research Institute
ASEAN	Association of Southeast Asean Nations
ATI	Appropriate Technology International
ATT	Agricultural Technology Transfer
CAD	Computer Assisted Design
CEICAP	Center for Export Inspection and Certification of Agricultural Products
DNAP	DNA Plant Technology Corporation of New Jersey
DOLD	Department of Livestock Development
EEC	European Economic Community
ELISA	Enzyme-Linked Imunosorbent Assay
FDA	Federal Drug Administration
FTDI	Fishery Technological Development Institute
GOI	Government of India
ICICI	Industrial Credit and Investment Corporation of India
ICS	Industrial Consultancy Services
IESC	International Executive Service Corps
M.I.T.	Massachusetts Institute of Technology
MOAC	Ministry of Agriculture and Cooperatives
MOSTE	Ministry of Science, Technology, and Environment
MTEC	National Metal and Materials Technology Center
MTCI	Manufacturing & Technology Conversion, Inc.
NAS	National Academy of Science
NCGEB	National Center of Genetic Engineering and Biotechnology
NECTEC	National Electronics and Computer Technology Center
NEROA	Northeast Regional Office of Agriculture
NGO	Non-Governmental Organization
NSTDA	National Science and Technology Development Agency

LIST OF ACRONYMS (Continued)

NSTDB	National Science and Technology Development Board
PACER	Program for the Acceleration of Commercial Energy Research
PACT	Program for the Advancement of Commercial Technologies
PITO	Private Investment and Trade Office
R&D	Research & Development
RD&E	Research, Development, and Engineering
RPI	Rensselaer Polytechnic Institute
RTG	Royal Thai Government
S&T	Science & Technology
SME	Small and Medium-Scale Enterprises
SPREAD	Sponsored Research and Development
STAMP	Support for Technology Assessment and Mastery Program
STDB	Science and Technology Development Board
STDP	Science and Technology for Development Program
STQC	Standards, Testing, and Quality Control
TCCR	Thermal Chemical Conversion Reactor
TCS	Technology Commercialization Study
TDICI	Technology Development and Investment Corporation of India
TEC	Tata Electrical Consultants
TEST	Trade in Environmental Services and Technologies
TIAC	Technical Information Access Center
TIPS	Technology Initiative for the Private Sector
UNDP	United Nations Development Program
USIS	United States Information Service
UST/COST	U.S.-Thailand Commercialization of Science and Technology
UTI	Unit Trust of India
UPLB	University of the Philippines at Los Banos
USAID	United States Agency for International Development
WIDTECH	Women in Science, Technology, Training and Consultancy Program
WISE-T	Women in Science & Engineering - Thailand

EXECUTIVE SUMMARY

ASIA TECHNOLOGY COMMERCIALIZATION STUDY

A. THE SCOPE AND PURPOSE OF THE STUDY

The Study was undertaken to document the implementation experience and impact on development of five technology commercialization projects funded by USAID Missions in the Asia region over the past decade. The five projects include:

The Program for the Advancement of Commercial Technologies (PACT) Project in India. PACT funds are used to help small and medium-scale manufacturing enterprises and research institutions develop innovative and commercially-viable technologies through joint venture arrangements with U.S. companies. The Industrial Credit and Investment Corporation of India (ICICI) is managing implementation of the project.

The Technology Initiative for the Private Sector (TIPS) Project in Sri Lanka. TIPS funds are used to encourage small and medium-scale Sri Lankan private sector enterprises to acquire new technologies from U.S. or other developed country sources by attending trade fairs, through industry visits, or by using U.S. and other technology sourcing services. The U.S. International Executive Service Corps (IESC) is managing implementation of the project.

The Science and Technology for Development Program (STDP) Project in Thailand. The main thrusts of the STDP project are to bolster the R&D capabilities of Thailand's universities and public and private R&D institutions, and to create the linkages needed to ensure more effective interaction between the R&D community and Thailand's private industrial and commercial sectors. Project implementation is being managed by an agency of the Thai Ministry of Science, Technology and Environment (MOSTE), with technical assistance from the U.S. National Academy of Science (NAS).

The Agricultural Technology Transfer (ATT) Project in Thailand. The ATT project is designed to bring "state of the art" agricultural production and processing technology to Thailand, adapt it to Thai farming conditions, and transfer it to farmers and small and medium-scale food processors. Implementation of the project is being managed by line agencies of Thailand's Ministry of Agriculture and Cooperatives (MOAC).

The Appropriate Technology International (ATI) Project for Small-Scale Rural Producers in the Philippines. The ATI project uses community-based non-governmental organizations (NGOs) to transfer to low-income coconut farming communities, processing technologies that are commercially viable and that enable the low-income communities involved to gain a greater share of the value added derived from coconut processing and marketing activities. Project implementation is being managed by Appropriate Technology International (ATI), a U.S.-based private voluntary organization (PVO).

B. FINDINGS OF THE STUDY RELATED TO PROJECT DESIGN AND IMPLEMENTATION

The Study found that the varied approaches to technology commercialization employed under the five projects depended largely upon the objectives of the project being implemented, the sectors covered, the state of technological development in the countries involved, and the types of technology being developed or transferred, and were influenced by certain other modifying factors, as noted below.

1. **The countries involved feel a need to develop or acquire innovative technologies to be able to compete for global markets.** This was a key element in the design of the PACT, TIPS and STDP projects, and one that has taken on increased importance as global competition for markets has heightened in recent years.

2. **The countries involved believe that improving technologies will lead to increases in local value added.** The application of improved processing technologies to increase local value added was a key factor in the design of the ATT and ATI projects and was directed to increasing income levels in low-income farm communities. Modifying existing technologies to increase local value added and foreign exchange earnings from exports emerged as a focus of R&D efforts during implementation of the STDP project.

3. **Cultural resistance to change has in some cases been an impediment to the achievement of project objectives.** Thai firms have traditionally relied on foreign firms to introduce needed technological innovations. Thus, RTG efforts under the STDP project to bolster the R&D capacities of local research institutions predictably did not lead to the level of interaction between Thailand's R&D institutions and private industrial firms needed to ensure the successful commercialization of locally-generated technological innovations. Despite their low incomes, small-scale coconut farmers in the Philippines have not moved to diversify their line of products even though a number of these can be profitably produced at the village level.

4. **Targetted approaches are needed to reach low-income beneficiaries such as the rural poor.** The ATT project has had considerable success introducing innovative production and processing technologies to rural communities in Thailand. The role played by Thailand's Ministry of Agriculture and Cooperatives (MOAC) in targetting low-income farmers in selected geographic areas as project beneficiaries was a major contributing factor. The use of community-based NGOs as intermediaries under the ATI project illustrates further country recognition of the need for using targetted approaches in situations where low-income groups such as the rural poor are the intended beneficiaries of technology improvement or commercialization programs.

5. **Adequate financing is key to the successful commercialization of innovative technologies.** The importance of finance was particularly evident in the case of several PACT sub-projects which showed market potential but which required drawn-out gestation or prototype testing periods. ICICI took steps to fill this need through the establishment of loan reflow use arrangements. The availability of funding and level of funding per activity were also significant factors under the TIPS and ATI projects in that they conditioned the kinds of assistance that could be provided. In both cases, the availability of project funding to procure needed equipment would have greatly facilitated the achievement of project objectives.

6. **Technology commercialization activities contribute significantly to the achievement of USAID development assistance objectives.** Activities financed under the PACT, TIPS and ATT projects have demonstrated that technology commercialization projects contribute significantly to broad-based economic growth through job creation and spread effects, and to environmental preservation objectives. Various activities financed under the PACT, ATT and ATI projects have successfully addressed problems in other areas of traditional USAID concern such as health and agricultural development.

7. **The bilateral nature of U.S. assistance is a desirable feature of USAID technology commercialization programs.** The bilateral nature of U.S. assistance was singled out as a highly desirable feature of USAID technology commercialization programs by business firms involved in the PACT and TIPS projects. The specific advantages cited were the direct access which the bilateral approach provides to U.S. sources of technology and U.S. markets, and the management know-how that can generally be assimilated under bilateral arrangements.

C. FINDINGS AND CONCLUSIONS RELATED TO THE DEVELOPMENT IMPACT OF PROJECT-FUNDED ACTIVITIES

1. **Project-funded activities have had measurable impact on economic growth.** Project-funded activities, which generally involve the development or expansion of R&D capacities, or the application or adaptation of new or improved technologies, contribute to economic growth through increased industrial production and productivity, job creation and expanded trade. The magnitude of impact is best measured at the micro-economic or participating firm level in terms of increased output or productivity, jobs created, and increased exports.

2. **The "componentry" characteristic of modern technology helps to ensure the sustainability of economic growth.** The ease with which modern technologies can be broken down into discrete "components", packaged and transferred, coupled with the ease with which components from diverse sources can be merged into a single product, help to ensure that economic growth resulting from technology commercialization projects is broad-based and sustainable.

3. **The "spread effects" characteristic of the technology commercialization process and the broad sectoral or geographic reach of USAID-funded projects also contribute to ensuring sustainable growth.** The "spread effects" emanate primarily from the establishment by primary beneficiaries of procurement, supply and marketing linkages with ancillary firms. The net effect is to enhance the sustainability of the growth process because of the broader underlying impact and support structures being established. The broad sectoral or geographic reach built into the five projects has also helped to ensure that economic growth resulting from technology commercialization projects is broad-based and sustainable.

4. **The Study showed job creation resulting from technology commercialization projects to be uneven from project to project.** The number of jobs generated under the PACT project has not been very large, although a high proportion of the jobs created have been highly-skilled ones. For the 48 client companies surveyed during a recent mid-term evaluation of the TIPS Project, full-time jobs roughly doubled within two years of project inception. Over 20,000 new jobs were created in the 22 plants established as a result of the surimi and imitation king crab meat sub-project funded under the ATT project in Thailand.

   The main recipients of newly-created jobs have been semi-skilled urban workers, low-income farmers, and workers in home-based or cottage industries. Team interviews with TIPS clients indicated that when the business activities of these firms picked up, they generally hired inhabitants

of the communities in which they were located. Because many of these firms were small or medium scale, the persons hired to fill the jobs were generally semi-skilled and low-wage workers. Job creation and job enhancement for low-income farmers has been achieved in particular through activities funded under the ATT and ATI projects which have targetted low-income farmers as project beneficiaries. Workers in cottage industries are benefitting from the creation of short-term "piece-work" jobs resulting from PACT and TIPS sub-contracting to cottage industries, and the expansion of ancillary industries taking place.

5. **Skills upgrading has been an important adjunct of project-funded activities.** Skills upgrading through industry visits and training was by design a key feature of virtually all of the PACT and TIPS-funded sub-projects visited by the Study Team. Skills upgrading was accomplished primarily through on-site training under the ATT and ATI projects. The PACT project was credited by beneficiary firms with contributing to a "reverse brain drain" by creating high-tech jobs and skills upgrading opportunities that had heightened professional and technical staff interest in remaining in India.

6. **Low-income groups are benefitting from project-funded activities primarily through increased incomes.** Low-income urban groups are benefitting from PACT and TIPS sub-contracting to cottage industries mainly through higher family worker incomes. Improvements in the standard of living of the poorest rural groups involved in the ATT project were confirmed through site visits and interviews in North and Northeast Thailand. The incomes of farm families which had shifted from subsistence to cash crop farming increased by 30 percent from income levels prevailing at the start of the project. Gross incomes were reported to have doubled over a four-year period for the mangosteen farmers of Southeast Thailand who had participated in an ATT-funded disease-control activity.

7. **Project objectives and the types of technologies being transferred or developed play a key role in determining the nature of project impact on development.** Under the PACT and TIPS projects, where obtaining the technologies needed to compete for global markets has been a primary objective, the tendency has been toward acquiring "high-tech" types of technologies to bolster the competitive capabilities of local firms, and the development impact of project-funded activities has been essentially economic. For the ATT and ATI projects, where rural income generation and increased agricultural production have been major objectives, the tendency has been toward acquiring "appropriate" or "state-of-the-art" technologies, and adapting them to basically "low-tech" farming conditions. The development impact has been reflected in increased social welfare and improved standards of living at the community level.

The experience of the five Asian projects has shown that innovative technologies will have appreciable impact, whether they are "high-tech" or "low-tech", if they are appropriate to the situation to which they are being applied and can be effectively utilized by the beneficiaries involved in their application.

8. **Project-funded activities have had beneficial effects in areas of traditional USAID concern.**

   a. **Agriculture.** During the first two years of the ATT-funded Lam Nam Oon sub-project, crop yields increased 6.5 times. Milk yields for dairy farmers participating in the ATT-funded Dairy Herd Management Improvement sub-project increased from 7-8 liters per cow per day during the rainy season and 3 liters per day during the dry season, to 12 liters per day throughout the year. Losses caused by diseases and insects were substantially reduced through the implementation of various other ATT-funded sub-projects with a consequent increase in farmers' incomes.

      Working under a PACT grant, the SPIC Foundation has been attempting to develop improved varieties of coffee and roses that are disease-free through a process called somatic embryogenesis, and to apply existing spin-filter bio-reactor technology obtained from a U.S. firm for the mass production of mature embryos.

   b. **Health, nutrition and population.** A number of ATT-funded sub-projects have been focussed on eliminating focal points of bacterial and viral infections in livestock, crops and fish products. One of the more significant efforts has involved the control of aflatoxin contamination in agricultural products. Reduced aflatoxin contamination is also expected in the Philippines as coconut farmers there adopt the improved copra drying process being introduced under the ATI project.

      The Zandu Pharmaceutical Works, Ltd., a firm based in Bombay, has been provided assistance under the PACT project to facilitate the laboratory research it is conducting aimed at producing low-cost herbal drugs that can be used in the treatment of Parkinson's disease. Cipla, Ltd., a pharmaceutical firm based in Bangalore that is also being assisted under the PACT project, is engaged in developing processes that enable it to extract alkaloids, which form the basis for the production of anti-cancer drugs, from indigenous plants using methods that assure greater yields, lowering the cost to Indian consumers.

   c. **Community development.** The ATT and ATI projects are targetted on and are impacting directly on low-income rural farm communities. The

community development impact of the various types of technologies transferred or developed under PACT and TIPS-funded projects has been indirect, and comes mainly by way of increased incomes for community members employed under these activities; through sub-contracts for materials supply, services or piece-work; and through improvements in environmental conditions and the establishment of low-cost sources of energy. The one striking example of direct impact has been the PACT-funded Georgio Foods/Ponds India mushroom growing project which has literally transformed the rural community in which it is located.

d. **Impact on women.** The impact of project activities on women is being effected primarily through job creation and training activities. Benefits specifically related to women have varied by social group and by sector. Except for the ATI project, and for selected activities under the ATT project, women as a group have not been singled out for special attention under the projects, nor identified as primary beneficiaries. In several of the sub-projects visited, such as the SPIC Science Foundation project in Madras, CEICAP's pre-export certification program in Thailand, and the Biopolymer Unit at Srinakarintrvirot University, female scientists constitute a majority of the employees and hold senior level management positions.

e. **Environmental preservation and energy conservation.** Among the more critical innovations supported through project-funded activities have been the development of integrated waste management and recycling processes for both industry and agriculture; the introduction and increased use of environmentally-friendly manufacturing techniques; and the development and application of energy-efficient technologies which both reduce energy use and promote the use of new and renewable energy sources. As implementation of the PACT project has proceeded, environmental concerns have been given increased attention. This has led to an increased focus on bio-technical projects that address environmental problems such as the substitution of biologically-produced pesticides and fungicides for chemically-produced ones; on horticultural and seed improvement projects; and on projects that foster the development of chemical process technologies that use agro-waste materials to generate electrical power in low-income agricultural areas, thereby reducing the country's need to import energy resources.

9. **The effects of the transfer of U.S. technologies on U.S. competitiveness in the region vary from sector to sector.** The effects on U.S. competitiveness under the PACT project are viewed as depending primarily on U.S. competitive strengths in each sector and on whether the Indo-U.S. joint venture arrangements supported under the project will lead to continued

future collaboration. In view of the comparatively small scale of the Sri Lankan economy and of the industrial and business firms that operate within it, the transfer of U.S. technologies to these firms is not considered likely to have serious effects on U.S. competitiveness in any sector. The thrusts of ATT sub-projects have been directed almost entirely towards alleviating problems affecting low-income farmers in remote rural areas of Thailand. The U.S. is not in competition with Thai agribusiness firms as regards this kind of effort. Similarly, the ATI project involves the production and export of coconut-based products, an area in which the U.S. is not competitive.

The Team found the information technology sector in India to be the one sector where the transfer of U.S. technologies might be problematic in terms of its effects on U.S. competitiveness in the South and East Asian regions.

D. RECOMMENDATIONS AS TO POSSIBLE FOLLOW-UP ACTIVITIES

1. The PACT Project would benefit greatly by adding to its portfolio of assistance, a range of business development support services comparable to those being provided under the TIPS Project in Sri Lanka.

Technology sourcing and market access support services, in particular, are needed to facilitate the process by which small and medium-scale firms in India find suitable business partners in the U.S. Providing such services would enable these firms to broaden their access to U.S. technology and markets.

2. It would be beneficial to convert the TIPS Project into a "for-profit" activity.

The Team endorses the recommendation cited in the recent mid-term evaluation report which suggested that a "for-profit" TIPS-type activity be established in Sri Lanka, with initial support from World Bank and USAID grants and loans, and with the idea that this "private" TIPS would become financially self-sufficient in due course.

3. If there were to be a successor project to the STDP project, it would be useful to incorporate the Support for Technology Assessment and Mastery Program (STAMP) as a key component of the project.

The Program enables Thai private sector firms to utilize the expertise of the country's leading technologists to help them in procuring new technologies and to instruct them on the effective use of the technologies once they have been procured. This facilitates the participation of private sector firms in technology commercialization activities in Thailand and enhances the prospects for the commercial success of these activities.

4. **In view of the closure of the U.S. bilateral aid mission in Thailand, the incorporation of ATT-type sub-projects under a USAID regional project would seem warranted.**

The Team recommends that any such follow-up activities be linked to relevant research efforts currently being pursued by Thailand's National Center for Genetic Engineering and Bio-Technology (NCGEB) to avoid possible overlaps and to take advantage of findings beneficial to agricultural development in the Southeast Asian region.

5. **The scale of the ATI project is too modest compared to the vast number of potential beneficiaries in the Philippines and should be expanded.**

The Team recommends that an expanded activity include funding for the procurement of the processing equipment needed to enable low-income rural communities to gain a greater share of the value added derived from coconut processing and marketing activities, the principal goal of the current ATI project.

6. **The Asia Bureau should consider conducting a roundtable conference to discuss beneficiary concerns regarding certain adverse world and local development trends and the extent to which continued USAID support for technology development and commercialization activities might help to reverse these trends.**

The Team believes that a roundtable discussion would be beneficial inasmuch as a number of the businessmen and agency officials interviewed during the course of the Study seem unduly concerned regarding certain current world and local development trends. They feel technologically under-equipped, for example, to meet the heightened and growing competition for global markets, and genuinely fear that population growth in their countries is beginning to outstrip the growth of food supplies and the availability of energy and water, and is contributing to accelerated environmental degradation. On the other hand, there is an expectation among these officials that the introduction and spread of more efficient and productive technologies will help to ameliorate the impact that such adverse trends will have on development prospects in their countries.

Topics for discussion might include the need to create new kinds of food products to offset diminishing agricultural land frontiers; promoting the increased use of agro-waste materials for environmentally-safe energy generation; accelerating programs to neutralize toxic chemicals; steps that might be taken by developing countries to realize greater value added from exports through increased in-country technology modifications and improvements; and the prospects of inventing and distributing really effective low-cost methods of contraception.

7. **In the event that such a conference is held and results in a decision to undertake follow-on or future technology commercialization projects, it is recommended that the Bureau take steps to:**

   a. **Ensure that project design takes into account the context of the country's technology research and development situation and the full range of requirements for successful commercialization.** Inasmuch as the approaches used for the five projects reviewed were necessarily limited and selective and no one project covered the broad range of activities incorporated in the overall technology commercialization process, gaps in implementation did occur.

   b. **Link future projects more closely to current USAID development assistance strategies.** The areas of concentration currently at the center of the Agency's strategies for assisting development include promoting programs to preserve the global environment and encouraging broad-based economic growth. The Study has shown that technology commercialization projects can contribute substantially to the achievement of these objectives.

   c. **Build into project design stronger links to the private sector to enhance commercialization prospects.** Thai government efforts to commercialize locally-generated technological improvements under the STDP project were not successful, primarily because of the lack of effective interaction between domestic R&D institutions and private industrial firms.

   d. **Provide for a greater share of the benefits of technology commercialization to be directed to secondary beneficiaries.** The Study indicated that technology commercialization projects need to be more strategic about how secondary beneficiaries are to be reached. The ATT and ATI projects illustrate how this might be accomplished.

   e. **Utilize "state of the art" technologies where feasible.** The ATT project has demonstrated that "state of the art" technologies can be successfully applied to the benefit of low-income beneficiaries.

   f. **Get community-based NGOs more involved in technology commercialization efforts.** The gainful role being played by community-based NGOs in introducing technological improvements to low-income coconut-producing communities under the ATI project, indicates that such organizations are well placed to perform a similar function in connection with other community-oriented technology commercialization activities.

ASIA TECHNOLOGY COMMERCIALIZATION STUDY

FINAL REPORT

I. THE SCOPE AND PURPOSES OF THE STUDY

Since the mid-1980s, USAID Missions in the Asia region have invested some $150 million in bilateral projects that fall under the broad heading of technology commercialization. These projects were developed in accordance with the development assistance strategy being implemented at that time by the ASIA Bureau of USAID, which reflected the conviction that scientific research and technology development leading to commercialization is critical for industrial growth and economic development and will ultimately facilitate social progress in developing countries.

In view of recent shifts in the overall focus of USAID programs, ASIA/TR considered that it would be useful to document the impact on economic development of several USAID-funded technology commercialization projects undertaken in selected Asian countries in recent years, and to determine the extent to which various low-income elements of the population have benefitted from these projects.

A two-person Technology Commercialization Study (TCS) Team, comprised of an economist and a social development specialist from Development Associates Inc. of Arlington, Virginia, was contracted by ASIA/TR to review and document the impact and experience of five technology commercialization projects that have been in various stages of implementation in four Asian countries since the mid-1980s. The five projects include the Program for the Advancement of Commercial Technologies (PACT) project in India; the Technology Initiative for the Private Sector (TIPS) project in Sri Lanka; the Science and Technology for Development Program (STDP) and Agricultural Technology Transfer (ATT) projects in Thailand; and the Appropriate Technology International (ATI) project for small-scale rural producers in the Philippines.

The Study Team embarked on a 6-week trip to the four Asian countries during November-December, 1993, to visit project sites and conduct first-hand interviews with the various personnel, e.g., project managers, beneficiaries, and USAID staff, who were involved in the design and implementation of these activities. This is a report of the Team's findings.

A. REVIEW OF PROJECT DESIGN AND IMPLEMENTATION EXPERIENCE

Technology commercialization in developing countries encompasses a broad range of activities. The process normally begins with the transfer of an innovative technology package from the U.S. or another developed country or with in-country research and development (R&D) activities, and can involve efforts aimed at adapting imported technologies to suit varied local conditions; the development of prototype plant and equipment; policy adjustments; product testing and market research activities; the development of suitable quality control and packaging procedures; acquiring access to competitive markets; gearing up for commercial-scale production; and the development of sustainable foreign and/or domestic market niches.

The scope of the technology commercialization activities included under the five projects that were reviewed and the approaches taken to implement these projects are discussed in some detail in Sections II through VI below. As indicated therein, the scope of the activities and the approaches to implementation vary from project to project reflecting differences in the state of technology development in the countries involved, the types of technology being transferred or developed, the mode of transfer, the cultural environment in which the transfers are being effected, and varying project and development impact objectives.

Through interviews and site visits, the Study Team attempted to assess the extent to which the design features of the individual projects and the approaches implemented thereunder have contributed to the achievement of project objectives and to measurable levels of development impact. Particular attention was given to determining whether the various factors bearing on project implementation were taken into account and the right approaches pursued, and to evaluating the advantages and disadvantages of each approach for achieving development objectives. The Study Team's findings with respect to these issues are summarized in Section VII.

B. ASSESSMENT OF PROJECT IMPACT ON DEVELOPMENT

The Team's analysis of the impact on development of each of the five projects, was framed in terms of the several areas of economic and social impact that generally reflect the extent to which development is being achieved. These are identified below.

1. The extent of project effects on economic growth

In addition to citing examples of project effects on economic growth and exploring the links that exist between technology commercialization and the growth process, an effort was made to determine whether these effects were measurable and whether the economic growth attributed to the projects was sustainable.

2. **The job creation that has resulted from the technology-driven growth of firms**

The Team's assessment related to job creation included: (1) ascertaining the extent to which job creation had occurred in the four implementing countries as well as in the U.S. as a direct result of the projects, and indirectly, as ancillary or support businesses grew up around firms that had been aided through the projects; (2) identifying the social groups that were the main recipients of newly-created jobs; and (3) determining whether significant transfers of job skills and know-how had taken place along with the transfers of technology.

3. **Project impact on secondary beneficiaries and community standards of living**

The Team's assessment of project impact on secondary beneficiaries and community standards of living was formulated in terms of the series of questions concerning project impact on secondary beneficiaries posed by ASIA/TR in the scope of work for the study (see Appendix A). The questions were aimed at determining whether and the extent to which additional or secondary beneficiaries, specifically urban workers and farmers, had benefitted from project-funded activities.

The Team also sought to determine whether project activities had directly or indirectly resulted in improved living standards for particular low-income social groups, and the extent to which the projects had promoted the empowerment of the poorer disenfranchised elements of the population.

4. **The types of technologies being transferred or developed and their impact on development**

The Study Team also addressed questions relating to the types of technologies developed or transferred under each of the five projects, including the ratio of "high-tech" to "low-tech" technologies transferred and the extent to which "labor-saving" or "labor-intensive" technologies were involved. Particular attention was given to determining the comparative impact on development of "low-tech" versus "high-tech" types of technology transfers.

5. **The effects of project-funded activities in traditional areas of USAID development concern**

The traditional areas of USAID concern include agriculture, health, nutrition and population; community development; impact on women; environmental preservation and energy conservation.

6. The effects of project-funded activities on U.S. competitiveness in the region

The Team's assessment of the impact on U.S. competitiveness was aimed at determining whether project-funded activities have been detrimental to U.S. competitiveness in the region, and whether the impact is problematic only in certain sectors or for certain types of technologies.

C. RECOMMENDATIONS AS TO POSSIBLE FOLLOW-ON ACTIVITIES

On the basis of its evaluation of the success of the different technology transfer models and its assessment of the impact project-funded activities have had on development efforts, the Team focused on identifying modifications that might be made to improve the future effectiveness of the projects and on determining the role that the Asia Bureau of USAID might continue to play in promoting technology commercialization in the region.

II. INDIA: THE PROGRAM FOR THE ADVANCEMENT OF COMMERCIAL TECHNOLOGY (PACT) PROJECT

A. THE BASELINE SITUATION

In the mid-1980s, when the Program for the Advancement of Commercial Technology (PACT) project was initiated, India was still predominantly an agrarian society striving to transform itself into a modern industrial one. interaction between the country's research and development (R&D) community and private sector enterprises was weak, and the pace of indigenous technological innovation slow and limited. The country's extensive network of national laboratories had not been very successful in developing commercially viable technologies nor in getting Indian firms to adopt innovative technologies that were potentially viable.

Private enterprise, which had historically accounted for only a small proportion of India's R&D expenditures, remained in the mid-1980s largely dependent on imported technology for new products and processes. R&D expenditures by private firms, though increasing, tended to be concentrated on the assimilation and adaptation of imported technology. Research projects leading to new products and processes were few.

B. THE MAIN FEATURES OF PROJECT DESIGN

The goal of the PACT project has been to accelerate the pace of technology innovation and commercialization in industries important to India's development. The program is focused on the "development" end of the R&D process, on supporting the efforts of Indian R&D institutions to develop new and innovative technologies and to incorporate these technologies into products and processes that are commercially viable. The program also helps small and medium-scale private Indian manufacturing enterprises enter into joint ventures with U.S. firms thereby enabling them to acquire innovative new technologies from the U.S., and to adopt U.S. management styles and marketing strategies that have been successful in implementing technology development and commercialization efforts in the U.S.

1. Models or approaches to technology commercialization employed under PACT

Four models or approaches to developing or acquiring new and innovative technologies with market potential are being used under the PACT Project. These are cited below, along with the number of sub-projects approved to date to which each approach has been applied.

- An Indian company implements R&D largely on its own. Its joint venture U.S. partner provides technical and research assistance and assists in marketing the product in the U.S. (7 sub-projects)

- The Indian and U.S. companies each perform about half the R&D work, and share relatively equally in the benefits of commercialization. (5 sub-projects)

- The U.S. company transfers key intellectual property involving a new technology to a private Indian research institution; the Indian institution undertakes further research to develop commercial applications for India. (2 sub-projects)

- The U.S. company provides a single high-tech component. Its Indian partner undertakes R&D incorporating the component and implements a domestic and or overseas commercialization program largely on its own. (31 sub-projects)

2. Sub-project selection and funding criteria

To qualify for consideration of PACT support, a proposed sub-project must involve the commercialization of an innovative product or process which will contribute to achievement of the country's economic growth objectives; be proposed by an Indian-U.S. company, consortium or joint venture; be capable of achieving the potential for product commercialization at a development cost of not more than $1.0 million over a three year period; and demonstrate that the parties involved have ready access to the technical and financial resources needed to implement the project.

3. Project funding commitments

Initial USAID funding commitments for the PACT project amounted to $12.1 million. Of this amount, $10.0 million was to be used to finance sub-project activities and $2.1 million for project operating expenses and various promotional activities. Additional commitments of USAID funding included a $5.5 million grant in 1990 and a grant of $2.0 million in 1993 to cover some of the commercialization costs of PACT sub-projects. Taking into account funds that may have been de-obligated, the total amount contributed to the project by USAID has been $18.8 million.

Indo-U.S. private sector firms participating in PACT-funded activities under joint venture arrangements are expected to cover from their own resources, 30 to 50 percent of the total cost of a sub-project.

C. SUMMARY OF PROJECT IMPLEMENTATION EXPERIENCE

An agreement to undertake the PACT Project was signed by the Government of India and the USAID Mission in August, 1985. ICICI, the Industrial Credit and Investment Corporation of India, is managing implementation of the Project.

1. ICICI's approach to managing the PACT Project

ICICI was set up in 1955 by the GOI as a quasi-governmental financial institution, to encourage and assist industrial development and investment, and the participation of private capital in the modernization of industrial enterprise. Since its establishment, ICICI has played a pioneering role in finding ways to accommodate the financial and technological needs of private sector Indian industries.

In implementing the PACT project, ICICI has from the outset tried to address the needs of small and medium-scale private firms for finance and innovative technologies, while adhering closely to GOI policy guidance related to achievement of the country's development objectives. Toward this end, ICICI has given primary consideration under PACT to financing sub-projects that are technology-driven; that have the potential to contribute significantly to solving industry-specific production problems; and that might lead to appreciable increases in export earnings, import substitution, or to the achievement of some other major development objective.

As implementation of the project has proceeded, this approach has led successively to a focus on: (1) projects involving information technology research and development, and the establishment within India of a broad-based software development industry; (2) biotechnical projects, specifically those that address environmental concerns such as the substitution of biologically-produced pesticides and fungicides for chemically-produced ones; (3) horticultural and seed improvement projects; and (4) projects that foster the development of chemical process technologies that use agro-waste materials to generate electrical power in low-income agricultural areas, thereby reducing the country's need to import energy resources.

2. Sectoral coverage and the status of implementation

Of the 45 PACT sub-projects approved to date, 18 have been classified as information technology projects; 9 are chemical process projects; 5 are energy or environmentally-related projects; 6 are electrical or mechanical engineering projects, including one in robotics; and 5 are bio-technological projects, involving research in areas such as plant genetic engineering and the production of bio-pesticides and hybrid seeds. The remaining two projects include one in horticulture, and one involving the development of a "high-tech" male contraceptive device.

Data provided the Study Team by ICICI indicate that 11 sub-projects have already been commercialized and an additional 9 sub-projects are presently being commercialized; implementation has been completed for 4 sub-projects that have not as yet begun commercialization; 15 sub-projects are under implementation; 5 sub-projects have not as yet been started; and one sub-project has been abandoned.

3. The "experimental" nature and "catalytic" effect of PACT implementation

The USAID Project Paper characterizes PACT as an "experimental" activity, stating that the project is intended to demonstrate the commercial viability and financial profitability of innovative R&D through Indo-U.S. joint ventures, thereby inducing India's industrial and business communities to develop effective R&D capabilities to sustain new businesses based primarily on Indian in-house technological advancement. More recently, USAID staff have ascribed to PACT the role of a "catalyst" for introducing the venture capital concept and for fostering the subsequent growth of a venture capital movement in India.

Study Team interviews with PACT beneficiaries have tended to confirm the "experimental" nature of the project, at least from a financial point of view. Beneficiaries are generally delighted to be able to access a source of funding that underwrites part of the cost of a "risky" venture, with no "pay-back" if the venture fails. At the same time, several of those who have undertaken successful ventures have indicated that a "pay-back" of two-and-a-half times the amount advanced by PACT appears excessive despite the risks involved. ICICI staff have noted that funds for venture capital activities were not available from Indian banking institutions on any terms at the time the project was being initiated.

The "catalytic" effect of PACT in fostering the growth of a venture capital movement in India and in stimulating greater investment in innovative and commercially-viable R&D, is evident from the various PACT-type initiatives that have been undertaken since project implementation began in 1985. These initiatives have included the following:

a. The Technology Development and Investment Corporation of India (TDICI).

TDICI was established by ICICI in 1986-1987, shortly after the launching of PACT, to attract venture capital for technology development and commercialization projects that were considered too risky or otherwise not eligible to obtain funding under PACT. Its primary objective is to arrange financing for small and medium-scale firms and entrepreneurs who are embarked on starting up new businesses or who are trying to bring innovative technologies to market. ICICI, the Unit Trust of India (UTI) and the World Bank have provided seed capital and technical support to TDICI.

b. The Program for the Acceleration of Commercial Energy Research (PACER)

PACER was initiated by the USAID Mission in 1987 to provide conditional grants to offset some of the financial risk inherent in innovative energy research and development projects. Such projects include the development of commercially-viable technologies to tap bio-mass or solar energy sources; the development of coal conversion technologies for India's low-grade coal resources; technologies to improve the efficiency of major end-use electrical equipment in industry, agriculture and the commercial sector; and technologies to make better use of the country's available power generating capacity. Like the PACT project, liability for repayment is incurred only in cases where the technology has been commercialized.

c. The Agricultural Commercialization and Enterprise (ACE) Project

The ACE project was formulated by the USAID Mission in 1991 to improve the investment environment for private agribusiness enterprises, and to develop a dynamic and efficient post-farm agribusiness system. The project's objectives are to increase private investment in the agribusiness sector; improve linkages between horticultural producers, processors, and marketers; increase farm incomes; and increase the flow of fresh and processed horticultural products to pre-targeted domestic and export markets.

d. The Trade in Environmental Services and Technologies (TEST) Program

The process of industrialization in India has created major pollution problems over much of the country's land areas. Bombay, Delhi and Calcutta are ranked among the world's ten most polluted cities. Small-scale industries, in particular, have not been able to handle the treatment of effluents nor to control emissions.

The TEST program was established by the USAID Mission in 1992 to address these problems. TEST provides loans and conditional grants, and underwrites the involvement of U.S. and Indian experts and consultants in environmental improvement activities. The objective of the program is to bridge technology gaps in the area of pollution prevention and abatement, and to provide small-scale industries access to the latest information available relating to the impact of these gaps.

e. The Sponsored Research and Development (SPREAD) Program

The SPREAD Program was established by ICICI to encourage industrial firms to expand their R&D programs, and to foster greater utilization of the country's extensive network of national laboratories and independent research institutions. The program, which is partially funded by the World Bank, provides financial support to

projects at all stages of the R&D cycle, including prefeasibility studies and pilot plant operations. Funds obtained from loan reflows are used to encourage small-scale industries to initiate R&D programs.

D. FINDINGS FROM INTERVIEWS AND SITE VISITS

The Team's findings regarding the principal R&D features of PACT-funded sub-projects, their current implementation status, and the extent to which they have had notable impact on India's economic and social development, are presented below. The findings are based on interviews with ICICI project managers and PACT grantees and on the review of documentation provided by ICICI and USAID, In addition, the Team visited twelve sub-project sites as indicated below. A listing of the sites visited is contained in Appendix E.

1. PACT-funded information technology projects

The Study Team visited four PACT grantees engaged in implementing information technology sub-projects. In all four cases, the U.S. company involved in the joint venture activity provided a single high-tech component, while the Indian partner undertook R&D to incorporate the high-tech component into its productive process, and implemented a domestic and overseas commercialization program largely on its own. The types of technologies being developed by the firms visited included:

a. The development of a software system to monitor performance and diagnose problems in local area networks

Frontier Software Development of India, a firm located in Bombay, has developed an on-line, real-time monitoring system for local area networks (LAN) to keep users informed of network performance and possible malfunctions. Beta tests of the system, by the Mitre Corporation, Compaq Computer, and the Massachusett's Institute of Technology (MIT), have been completed and efforts to market the software are underway. The monitoring system was featured in the "First Looks" section of PC Magazine's Network Edition of September 14, 1993.

b. The development of a low-cost high-performance industrial robot

Precision Automation and Robotics, a firm founded by two graduates of the Rensselaer Polytechnic Institute (RPI) in Troy, N.Y., and currently located in Pune, India, has developed a low-cost, high-performance industrial robot that can be adapted for use in light assembly operations such as automotive wiring, consumer electronics, industrial electronics, and light mechanical and electrical equipment industries. The product combines low-cost design and rigid light weight construction, and has

effectively indigenized robot assembly in India. To date, Precision has received ten orders for its product.

c. The development of a component information management system for large and medium-sized electronics companies

The component information management system, which was designed by DCM Limited of Bangalore, enables companies like Hewlett-Packard to shorten the time it takes to get software products to market while also increasing the productivity of a company's product design and development process. Inputs by DCM Limited's U.S. joint venture partner, the Aspect Development Corporation of Pennsylvania, included training in data development and the introduction of a high quality electronic design automation and manufacturing process.

The system was commercialized in 1991. Revenues in 1992 reached $1.85 million, more than double projected sales. Skills upgrades for Indian professionals were a key outcome of the system development process and reportedly heightened professional staff interest in remaining in India, thereby constituting a "reverse brain drain". The creation of 50 new, permanent high-technology jobs in Bangalore within two years of start-up was also a key outcome. Women occupy one-quarter of these new positions. In addition, the firm is planning to add another 12 graduate level positions to its engineering staff at the end of 1993.

DCM Limited's project manager indicated that learning to coordinate systems engineering operations closely with a U.S. firm had been the most difficult aspect of the joint venture. This required abandoning traditional Indian approaches to management which are generally based on vertically structured hierarchies. This was more than offset, however, by improvements in the project management skills acquired by DCM as a result of its links to a U.S. partner.

d. The development of a software system for LAN networks and hardware management

SR Associates, a firm located in Madras, initiated the system development effort. CyberMedia, its U.S. partner, had developed the core technology which consists of specifications for the development of software capable of performing diagnostics of PC computers and networks. SR Associates sent four of its staff to the U.S. to gain an initial understanding of the technology application process.

The software system is expected to be ready for release after 2-3 months of Alpha testing. With add-ons, the system can be applied in a number of areas, including factory plant automation. As in the case of the DCM Limited project, SR Associates sees its joint venture as a vehicle for retaining skilled manpower in India.

CyberMedia and SR Associates are currently discussing marketing arrangements and setting up marketing structures in India, Singapore, and the Middle East. CyberMedia will be the primary overseas marketer under the joint venture. SR Associates will market the product in India. Two small local ancillary companies are being tapped to provide hardware and specialized software. SR Associates has indicated that it will need a commercialization loan from ICICI as well as technical assistance to carry out its marketing scheme.

2. Energy-related and engineering projects

The Study Team visited 3 of the 10 sub-projects funded by PACT under this category, one of which is a mechanical engineering project, and two of which are energy-related engineering projects. The technological innovations or transfers encompassed under these activities are described below. PACT funding was used to procure needed technology, technical training and marketing assistance.

a. The development of a permanent magnet alternator suited to mobile applications

Globe Active Technologies, Inc., an engineering firm located in Bombay, has developed an advanced type of permanent magnet alternator that is suited to a variety of mobile applications (automobiles, earthmoving equipment, portable welding sets, railway carriage fans). The alternator has state-of-the-art components and can be produced and marketed globally at a competitive price. Active Technologies, Inc., the U.S. partner in this PACT-funded joint venture, provided software for the design of electronic controls for the alternator and will be providing marketing expertise to enhance sales of the product in the U.S.

When the product enters its marketing phase, which is to begin shortly, it is expected to have wide-ranging output and employment effects on the approximately one hundred ancillary small and medium-scale industrial firms currently being contracted by Globe to provide machine parts and castings for production of the alternators.

b. The development of an energy-efficient and environmentally-friendly air conditioning system

At present, reciprocating compressors which circulate freon, and which operate with belt or electric drives, are widely used in air conditioning systems. The Ecoair Corporation, a U.S. firm based in Connecticut, has designed and patented an air conditioning system that uses an environmentally-friendly refrigerant instead of freon. Globe Scott of India has been involved in research related to the development of high output, high efficiency miniature electric motors.

Under a joint venture arrangement and with PACT funding assistance, the two firms have worked to combine one of the miniature motors developed by Globe Scott with one of the freon-free compressors developed by Ecoair, to develop an energy-efficient, environmentally-friendly air conditioning system. The system is presently being tested for use in automobiles by the Ford Motor Company.

EcoAir will assist Globe Scott in marketing the product in the U.S. and elsewhere, once it has been tested and is deemed to be commercially viable. The project represents a case in which the Indian and U.S. companies involved in a PACT-funded joint venture activity are each performing about half of the R&D work involved, and plan to share equally in the benefits of commercialization.

c. The development of a combined steam heat and electric power co-generation system for small and medium scale enterprises that is capable of using a variety of fuels, including agro-waste materials

Laxmi Boilers and Turbo Tech Precision Engineers, two firms based in Bangalore, have collaborated on the design and development of a 500 KW co-generation system that will use agro-waste materials and low-grade coal for fuel. Such systems are particularly useful for processing industries with high steam usage and low to medium power requirements. PACT funding was used by Laxmi to procure a key component of the system: a single-stage impulse turbine gear box designed by the Barber-Nichols Engineering Company of Colorado.

According to S.B. Iyer, Laxmi's Technical Director for the project, development of the system has generated significant ancillary activity, as small processing and fabricating industries have been contracted to manufacture various system components. He expects that once the project gets into full production, substantial energy and foreign exchange savings will be realized. There will also be positive effects on rural incomes as farmers begin to provide agro-waste as fuel for co-generation units.

An impact report on PACT-funded projects prepared by Tata Electrical Consultants (TEC) of India, also pointed to the energy conservation potential of the system and the likelihood that the sale of agro-waste materials will open up a new source of income for farmers. The report also noted the system's potential for creating downstream linkages to rural agro-industries (including cooperatives), and to small and medium-scale urban enterprises in industries such as textiles, paper, pharmaceutical, sugar distillery and rubber products.

3. Chemical process and pharmaceutical industries

PACT has funded nine projects to date involving technology commercialization activities in chemical process and pharmaceutical industries. The Study Team made

site visits to four of the firms engaged in managing these activities. The technologies being developed and commercialized by the four firms include:

a. **The development of an indirect gasification (thermal-chemical conversion) reactor which can provide economically viable chemical pollution control**

In India, at present, over 80 small paper mills and 226 sugar cane distilleries have conventional effluent treatment plants which do not adequately meet pollution standards. Such systems are also not cost effective in terms of chemical and/or energy recovery.

Manufacturing & Technology Conversion, Inc. (MTCI), a U.S. firm based in California, has developed and demonstrated at pilot scale the feasibility of indirect gasification of softwood black liquor by building pulse combustion techniques into a Thermal Chemical Conversion Reactor (TCCR). The pulse combustor component of the reactor is modular in nature, making it feasible to build viable energy-efficient chemical recovery systems for small paper mills. Using pulse combustor techniques, the reactors can meet 80 percent of the energy requirements of a small distillery.

Esvin Advanced Technology Ltd., an Indian firm based in Madras, is attempting to adapt the reactor technology to paper, sugar and distillery plant operations in India, and plans eventually to manufacture conversion reactors in India. Esvin was given a PACT grant to help it set up and run a pilot plant operation, and entered into a joint venture arrangement with MTCI to obtain the technical assistance it needed. MTCI has recently built and installed a similar system at a paper mill in Ontario, Canada.

The Study Team conducted a lengthy interview with T.S. Venkataraman, the Managing Director of Esvin's TCCR project. Mr. Venkataraman noted that pilot plant trials were currently nearing completion, and that he planned to begin the commercialization phase of the project once the trials were over.

The Esvin project has the potential to generate considerable environmental benefits in terms of energy efficiency, chemical recovery, and greatly reduced pollution from paper, sugar and distillery plants. The economic benefits of the project are also likely to be substantial. Conversion plants can be built with indigenous materials, by local firms. Six small or medium-scale firms were involved in the construction of the pilot plant. In addition, once a plant becomes fully operational it will employ three shifts of workers, including four engineers, four supervisors, four plant operator-technicians, and five unskilled laborers for each shift.

b. Development of a system for the treatment of spent wash

Liquid effluent (spent wash) of molasses-based alcohol distilleries poses considerable hazards to the environment. Spentwash, which is toxic, is a matter of particular sensitivity in India following the Bhopal catastrophe. The treatment methods presently used in India are not cost effective and do not meet currently required environmental standards.

Four Eyes Research, a scientific research firm based in Pune, India, has undertaken extensive studies aimed at developing a filtering process that uses polymeric and ceramic membranes to convert spent wash into components that are amenable to concentration and isolation. A U.S. firm, ALCOA, has provided several novel designs of membranes (including ceramic membranes) for the filtering process. The import of membranes is expensive in terms of foreign exchange requirements. ICICI felt it important to encourage the Indian scientific community to establish a means for producing membranes domestically.

As it has turned out, the project has remained largely dependent on imported membranes, and its potential profitability was seriously diminished by the rupee devaluation imposed by the GOI in 1991. As a consequence, the project became commercially non-viable and has been put on hold.

The Study Team was told by the Executive Director of Four Eyes that he is confident that the technology needed to produce membranes domestically, comparable in effectiveness but lower in price than imported ones, could be developed in India within the next year through indigenous R&D. He also acknowledged, however, that getting the funding needed to underwrite a renewed research effort would be difficult.

c. The development of processes for the manufacture of certain anti-cancer agents and other drugs using herbs native to India

Cipla, Ltd., a firm based in Bangalore, is a well-established pharmaceutical company. The firm is engaged in developing processes that enable it to extract alkaloids, which form the basis for the production of anti-cancer drugs from indigenous plants, using methods that assure greater yields thereby lowering the cost of producing the drugs.

The anti-cancer drugs being produced by Cipla are considered to have significant export potential. Cipla enlisted the Byron Chemical Company, a U.S. firm based in New York, to assist in marketing the drugs in the U.S. Due to management changes at Byron Chemical, however, and a resultant lack of marketing expertise, expected foreign exchange earnings have not been realized and the focus of Cipla's marketing efforts has been shifted to India.

Despite the marketing problems encountered in the U.S., the project is considered to have been successful and the PACT loan is being repaid. Indian consumers are benefitting from the lower cost of the anti-cancer drugs that has resulted from use of the higher-yielding alkaloid extraction methods developed by Cipla.

d. The development of low-cost herbal drugs for the treatment of Parkinson's disease

Parkinson's disease affects coordination of movement and causes tremor, muscular rigidity, difficulty with balance, walking and depression. Most of these symptoms can be controlled by the use of drugs; however, no single drug is fully effective. L-dopa, a synthetic drug used alone or in combination with Carbi-dopa, another synthetic drug, controls most of the symptoms of the disease. Additional drugs are needed for those symptoms that are either not controlled or that are not adequately controlled by L-dopa.

The synthetic drugs, like L-dopa, currently being used in treatment of the disease are expensive. There are no low-cost natural preparations currently being marketed which are effective in helping to control the disease. As a consequence, lower-income older people afflicted with Parkinson's disease are often not getting adequate treatment.

Zandu Pharmaceutical Works, Ltd., a firm based in Bombay, has been conducting laboratory research aimed at producing low-cost herbal drugs that can be used in the treatment of Parkinson's. Through its research efforts, Zandu has developed an herbal formulation named mucuna endocarp, (code-named HP-200,) which it has been evaluating through clinical trials over the past three years. The trials have shown HP-200 to be effective in the treatment of Parkinson's with little evidence of disturbing side-effects from usage. According to Zandu, HP-200 is 30 to 40 percent cheaper than conventional formulations of L-dopa.

Zandu has received a PACT grant to assist it in marketing HP-200 in the U.S. The main obstacle at this point is getting FDA approval. Zandu has found it necessary to use high-tech laboratory testing procedures to demonstrate that its product will not produce serious side effects. A U.S. affiliate, Zandu U.S., is providing technical and research assistance and will help market the product once FDA approval has been obtained. Southern Illinois University is also assisting Zandu with high-tech testing and clinical trials of the product.

In addition to providing a low-cost medicine for the treatment of a major debilitating disease, and providing Zandu an opportunity to further its corporate goal of promoting the use of herbs in medical treatment, successful marketing of the product will result in increased employment for Indian farmers growing herbs.

4. Bio-technology and horticulture

The Study Team undertook site visits to two of the firms included in this category that have received grants under the PACT Project. As indicated below, one of the firms is engaged in bio-technological research and the second in adapting innovative horticultural technologies to growing conditions in India. The specific technologies being developed and commercialized by the two firms include:

a. The development of improved varieties of coffee, rose, banana and potato seeds by tissue culture, using a multiplication bio-reactor

The SPIC Science Foundation (SSF) is a private non-profit research institution based in Madras and linked to SPIC Ltd., a major Indian industrial conglomerate. The Foundation undertakes basic research in bio-technology including bio-pesticides, bio-nutrients, seed development, and tissue culture, and in agro-chemicals and non-conventional energy.

Working under a PACT grant, the Foundation has attempted to develop improved varieties of coffee and roses that are disease-free through a process called somatic embryogenesis, and to apply existing spin-filter bio-reactor technology developed by a U.S firm, the DNA Plant Technology Corporation of New Jersey (DNAP), for the mass production of mature embryos. The goal of the project is to produce larger numbers of seedlings of improved varieties of coffee and roses in order to lower the cost of seeds to coffee farmers and increase local production, and to increase the cultivation of roses for exports. Bananas and orchids have been selected as backup crops.

During an interview with Dr. T.S. Lokeswari, the Director of Plant Pathology and Plant Tissue Culture at the Foundation, the Team was informed that the research had not been successful in obtaining a commercially-viable product. Dr. Lokeswari said that she was now trying to adapt the embryogenesis process and bio-reactor technology to other crops, specifically orchids and roses, noting that there is currently a high demand for export flowers in India.

Though it did not succeed in attaining its initial goal, the project has had notable impact. In large part because of the marketing potential of the research conducted under the PACT-funded project, SPIC Industries established a commercial tissue culture division at the Science Foundation in 1990. The Foundation now has a total staff of 120, of which the biotechnology division employs 30, and of whom 20 are women.

Ancillary local manufacturing industries have also benefitted from the project. During the period when it was conducting research on coffee seeds, the SPIC Foundation localized its procurement of laboratory glassware and plasticware.

Because of increased bio-technical research activity by the SPIC Foundation and other research institutions in recent years, employment at these ancillary firms has also increased substantially.

b. The adaptation of high yield prime button mushroom technology to Indian conditions and raw materials

Mushroom growing technology is well-established worldwide. The challenge facing the principals involved in this PACT project was to adapt existing high-yielding techniques to the materials and growing conditions specific to India. Georgio Foods, Inc., a U.S. firm based in Pennsylvania and a leading mushroom processor in the U.S., initiated arrangements in early 1987 to enter into a joint venture partnership with Ponds India, Ltd., a subsidiary of Cheeseborough Ponds based in Madras. At the time, Georgio Foods was facing stiff competition from other major processors who had established commercial links with low-cost suppliers in Indonesia, China, Taiwan and other East Asian countries.

Under the joint venture arrangement, Ponds India obtained a conditional grant from PACT in June 1987. The PACT project involved: 1) developing a technological package using locally available raw materials for composting, casing, etc., thereby assuring that it could be replicated in other parts of the country; 2) developing hybrid strains suitable for local growing conditions; 3) maximizing the yield of the mushrooms; and 4) using processing techniques that would reduce shrinkage loss during blanching operations. The objective of the project was to achieve bio-efficiencies comparable to East Asian standards, enabling mushrooms grown in India to be price competitive in a global context.

Proceeds of the PACT grant were also used to support the establishment of an experimental farm and the construction of a pilot processing plant at a site in South India. These activities were completed in 1990. A commercial plant was built at the end of 1991 and is now operating at full capacity. The entire output of the plant is being exported to the U.S. and Canada (with some to Mexico) in cans and jars in different product lines (whole, sliced, stems and pieces).

The Georgio/Ponds project provides another successful example of a PACT-supported technology commercialization activity wherein the Indian and U.S. companies involved in the project have each performed about half the technical work, and are sharing relatively equally in the expected benefits of commercialization. Georgio provided technical assistance and training in mushroom growing and assistance in site selection and marketing, and used the pilot plant as a lab for experimentation. Ponds maintained the pilot operation, provided low-cost labor, and contributed critical information on local growing conditions and the availability of raw materials for composting and casing.

The project provided a new area for export development in India and has had a significant impact in terms of job creation. It has also triggered greater interest in horticulture in South India. The principal benefit to Georgio Foods, has been to provide a new low-cost source of supply for a high-quality product. As a result of Ponds India's success, four to five other mushroom exporting firms have been established, one or two of which have received financial support from the USAID-funded ACE project.

As noted, the project has had significant employment effects. About 400 new jobs were created in the Nilgiris District, the site of the processing plant. More than half the new workers are women. Most have a high school level of education. A quality circle management approach has been successfully used with the workers to identify and solve production and job-related personnel problems.

The project has also generated indirect employment for another 400 to 600 workers in the state of Tamil Nadu. Most of these are temporary rural workers who provide jobbing and transport services, construct packing cartons, and supply the agro-waste materials used in the mushroom growing process. The project has also contributed to increased jobs in the ancillary plants located near the project site which supply the plastic products used in the growing process, as well as the large cans and glassware used to export mushroom products.

E. ANALYSIS OF PROJECT IMPACT

The PACT project has demonstrated that helping small and medium-scale firms enter into joint ventures with U.S. firms can accelerate the pace of technology innovation in industries important to a country's development process. Under the PACT project, such arrangements have provided Indian firms access to new and innovative "cutting-edge" technologies in information technology and software development, bio-technology, chemical process and industrial engineering, and in horticulture.

The joint ventures with U.S. firms have enabled the Indian firms involved to acquire the managerial skills and marketing techniques needed to transform technology innovations into activities leading to market development and full-scale commercial production. This approach was particularly successful for project-funded activities in the information technology, software development, and horticultural industries.

Less successful commercialization results were obtained in the industrial engineering, bio-technological, and chemical processing industries. The availability of funding to support commercialization efforts, whether from PACT or from some other source, and the extent to which the U.S. partner has been able to gain access to U.S.

markets, were found to be key determinants affecting the success of commercialization efforts.

1. The impact of project-funded activities on economic growth

The Study Team found that the relatively modest scale of the PACT project compared to the size of India's overall economy coupled with the experimental nature of project-funded activities, limited the extent of project impact on the country's economic growth. At the same time, the "spread effects" of several project-funded activities and their impact on ancillary industries were found to be considerable.

The joint venture undertaken by Ponds Ltd. of India and Georgio Foods of the U.S., has provided Ponds with an innovative and highly-efficient mushroom-growing technology and sizeable export markets, and has led to significant levels of direct and indirect job creation.

The Laxmi co-generation project will have positive effects on rural incomes as farmers begin to provide agro-waste as fuel for co-generation units. Development of the system has already generated significant ancillary activity, as small processing and fabricating industries have been contracted to manufacture various components for the prototype unit. In addition, it is expected that once the project gets into full production, substantial energy and foreign exchange savings will be realized.

2. Project impact on job creation and skills levels

As indicated above, PACT-funded activities have not on average had extensive direct effects on job creation. The Ponds India/Georgio Foods mushroom growing project was an exception. As noted, some 400 new jobs were created at the site of the processing plant. In addition, the project generated indirect employment for another 400 to 600 temporary workers in rural areas surrounding the site, as well as contributing to the creation of uncounted jobs in ancillary support plants located near the site.

The information technology development projects funded by PACT had significant though less extensive direct job creation impact, as did the biotechnical, chemical processing and engineering projects. Though less extensive, most of the new jobs created in these industries were in technical or professional positions, and required well-honed high-tech skills.

Skills upgrading through industry visits and training was a key feature of project design and was evident in virtually all of the PACT-funded projects visited by the Study Team. In several instances the PACT Project was credited with contributing to a "reverse brain drain" having created high-tech jobs and skills upgrading opportunities that had heightened professional and technical staff interest in remaining

in India. DCM Limited and SR Associates, for example, both regarded their joint ventures with U.S. firms under the PACT Project as vehicles for retaining skilled manpower in India.

Industry visits and training were important elements, in particular, of PACT-funded projects in the information technology industry. DCM/Aspect included training and industry visits in their joint venture arrangement as a means of introducing DCM staff to the complexities of a high quality electronic design automation and manufacturing process. SR Associates sent four of its key staff to the U.S. to gain an initial understanding of the technology application process involved in its PACT-funded project.

3. Impact on secondary beneficiaries

The Study Team was not able to obtain reliable information concerning secondary beneficiaries and the extent to which they have benefitted from project-funded activities. Such information is not being systematically compiled.

Study Team interviews with the project's primary beneficiaries and with ICICI project managers did indicate, however, that project-funded activities have had considerable impact on various social groups that might be classified as secondary beneficiaries including workers in ancillary and downstream industries, low-income farmers, women, and persons in low-income communities afflicted with Parkinson's disease or with cancer.

4. The types of technologies transferred or developed and their impact on development

The types of technologies transferred or developed under the PACT project have been predominantly "high-tech" in nature. In line with the project's stated objectives, ICICI has given primary consideration to financing sub-projects that are technology-driven; that have the potential to contribute significantly to solving industry-specific production problems; and that might lead to appreciable net foreign exchange earnings. This approach has led to a focus on projects that have had a varied and broad impact on the industrial, agricultural and environmental aspects of India's development process.

F. RECOMMENDATIONS AS TO POSSIBLE PROJECT FOLLOW-UP ACTIVITIES

The PACT Project would benefit greatly by adding to its portfolio of assistance, a range of business services comparable to those being provided under the TIPS Project in Sri Lanka, including in particular technology sourcing and market access support services (See Section III below). These services are needed to facilitate the

process by which small and medium firms in India find suitable business partners in the U.S., and by which they attempt to gain access to U.S. markets.

III. SRI LANKA: THE TECHNOLOGY INITIATIVE FOR THE PRIVATE SECTOR (TIPS) PROJECT

A. THE BASELINE SITUATION

The small size of Sri Lanka's domestic market has meant that its productive industries need to target international markets if the country is to achieve its economic growth objectives. This will require that changes be made in both the policies that guide the behavior of industrial firms and the practices of the firms themselves, as they transfer their attention from servicing the protected domestic markets of the past to the much more demanding and competitive markets of international trade. The ability to choose, adapt and master technology in order to become and remain competitive in these markets has been identified as one of the country's most challenging objectives.

By 1990, when the TIPS project was authorized, Sri Lanka was considered to have reached the stage where its industrial base had been sufficiently developed to allow it to reach the status of a "newly industrialized country", within the next decade. In order to achieve this level of development, however, Sri Lanka's private productive sectors would first need to attain a greater awareness of export market opportunities and requirements. Secondly, they would need to establish effective links with suppliers and sources of technology in order to obtain the technologies needed to produce goods of the quality required to capitalize on export opportunities.

B. THE MAIN FEATURES OF PROJECT DESIGN

The goal of the TIPS project has been to increase the international competitiveness and capacity of Sri Lanka's private industries by improving their ability to acquire and master technologies with support from U.S. business and technology. The International Executive Service Corps (IESC) is implementing the project under a Cooperative Agreement with USAID.

The project has been designed to accelerate productivity growth in the enterprises that participate in the program, and to develop an active "trade" in technology advice and information between the U.S. and Sri Lanka. To do so, the project is directed toward accomplishing three principal tasks:

- Generating demand for technology upgrading from private firms in selected sectors; helping these firms diagnose their production and marketing needs; and inducing them to formulate requests for assistance to search for appropriate technological solutions.

- Improving private sector access to sources of information on technology upgrading requirements and marketing needs, and providing financial incentives to firms to reduce the risk and help offset the costs of acquiring needed technology.

- Providing private firms with the means to obtain rapid and reliable information on international technology, market conditions, and potential foreign business partners.

The Project has three major operational components:

The Technology Promotion Program conducts surveys of Sri Lankan industries for which U.S. technological skills are readily available, and in which technological improvements would likely lead to increased exports and employment. TIPS staff then try to impress upon the entrepreneur involved that technology improvement assistance is available and that its application will likely lead to increased profits.

The Technology Grants Program lowers the cost to a firm of identifying and acquiring the technological improvements that will enhance the firm's productive process.

The IESC Volunteer Executive Program complements the other two components of the project by continuing IESC's six years of successful experience providing specialized technical assistance to individual companies.

As shown in the table below, total project costs are estimated at $18,735,000, including $12.0 million in USAID funding and $6,735,000 equivalent in contributions from Sri Lankan private sector companies.

PROJECT COST ESTIMATE AND FINANCIAL PLAN (000)

Component/Program	USAID	Private Sector	Total
Technology Promotion	$4,000	-	$ 4,000
Technology Grants	6,300	$6,270	12,570
Regular IESC Program	1,200	465	1,665
Evaluation and Audit	200	200	
Contingency	300	300	
Total	**$12,000**	**$6,735**	**$18,735**

Source: Project Paper

C. SUMMARY OF PROJECT IMPLEMENTATION EXPERIENCE

The principal assistance activities conducted under the TIPS project since start-up in mid-1991 have included: (1) arranging site visits for TIPS clients to industrial firms located outside Sri Lanka, specifically firms that have the kinds of equipment needed by clients to enhance their productive capacity; (2) arranging visits to industry trade shows where appropriate new equipment and processes are showcased; and (3) introducing clients to U.S. companies that may be interested in undertaking some form of joint venture or contractual arrangement that would provide client access to needed technology. TIPS grants have also been used to bring to Sri Lanka consultants who can provide local firms with the expert knowledge needed to implement technology improvement activities.

Each of the foregoing activities has had an implicit training dimension as clients have been introduced to new manufacturing techniques, equipment and information sources. Training has also been effected through TIPS-sponsored seminars in Sri Lanka, and through workshops in the U.S. that have been conducted in conjunction with trade shows and industry visits.

Industry coverage under the project has been extensive. A list provided the Study Team by TIPS staff shows clients classified by eighteen different industrial categories,

ranging from agriculture, food processing and packaging, to plastic products. According to a mid-term evaluation report prepared by a U.S-based consulting team, some 257 clients have been assisted under the project, from start-up in July 1991 through June 1993. Among the industries showing the highest number of clients are food, jewelry, engineering, plastics and polymers, software, printing and toys. Industries at the other end of the spectrum are ceramics, glass, horticulture, and lab equipment.

The overall range of services available to TIPS clients is comprehensive, as indicated in Appendix F. Three types of services, i.e., consultancies, marketing assistance, and reconnaissance trips, have accounted for roughly 80 percent of total "client assistance events". The Study Team found IESC's automated ability to monitor project implementation to be a very useful management tool.

D. FINDINGS FROM SUB-PROJECT INTERVIEWS AND SITE VISITS

During its one week stay in Sri Lanka, the Team visited the seven clients identified below to record their comments regarding the kinds of assistance they had received under the TIPS project, and the extent to which this assistance had been instrumental in facilitating or enhancing the operation and management of their business enterprises. The project is geared to providing services to businesses classified as small to medium-scale enterprises. The average size of a TIPS sub-grant is $20,000. Of the seven sites visited in Colombo, all but two were located on either the ground floor of an urban or suburban residence or in a small warehouse located in a residential area.

1. Jayahastha Toys

The founder and proprietor of Jayahastha Toys, Mr. Jayantha Fernando, said that he had heard about TIPS through personal contacts. Upon applying for assistance it was recommended that he develop a brochure, and plan to exhibit his products at the next New York toy fair which was to be held in February 1993. TIPS staff told him how to show at the fair. TIPS also assisted in the development and publication of a multi-color product catalog.

As a result of Mr. Fernando's participation in the trade fair, Jayahastha received an order for four of the company's products valued at $35,000. This initial order was followed by a second order of $15,000. Mr. Fernando said that he had been redesigning his products and expressed strong interest in participating in the next fair to be held in February 1994, but would not be able to come up with the 50 percent matching contribution required for a TIPS grant.

Mr. Fernando normally keeps six persons working at his home-based factory. When necessary, depending upon his volume of business, he sub-contracts piece work with seven other nearby home-based family enterprises and places orders with small local suppliers to provide paints, sandpaper, timber, blades, packaging and freight forwarding services. During the 6-month period that his firm was engaged in filling the two orders that had resulted from his attendance at the New York toy fair, Jayahasta was temporarily emoloying forty craftspersons, thirty-four more than would have normally been employed.

2. Asian Toy Company Ltd.

After participating under TIPS auspices with Jayahastha and others at the toy fair in New York in February 1993, Asian Toy received an order from a U.S. company for wooden toy products valued at $25,000. The firm also received two additional orders during the year.

Mr. Mahendra Soysa, the firm's managing director, noted that his firm normally employs twenty-five skilled workers on a full-time basis and has temporarily employed up to an additional sixty-five unskilled workers when large orders are received, such as the order obtained following Mr. Soysa's trip to the New York toy fair. Work is sub-contracted out to another local small toy manufacturer when warranted. Local suppliers provide paint, wood, and other required materials. Packaging and freight forwarding services are also arranged through sub-contracts with local firms.

3. Amaran Gems and Lapidaries

After his participation in a jewelry trade show in Las Vegas under the auspices of TIPS, Mr. Amitha Gamage, the firm's Managing Partner, said that he was able to increase Amaran's sales of cut gems to the U.S. by 50 percent between 1991 and 1993. Mr. Gamage is now planning to obtain a high-speed cutting machine from the U.S. to enable him to expand exports of cut gems to Germany and Japan.

Mr. Gamage is highly entrepreneurial. He does experimental cutting, for which he gets ideas from a U.S. journal on gem cutting. He regularly recuts badly cut gems sent to him from Bangkok. U.S. firms send him mountings for which he makes calibrated cuttings of gems and then sends both back to the U.S. He has recently ordered jewelry casting machinery and laboratory equipment from the U.S. and is planning to expand Amaran's operations into that end of the business.

Since becoming involved in the TIPS project, Amaran has increased the number of its employees by 44 persons, from 20 in 1992 to 64 at present. Approximately 70 percent are women who have completed a one year specialized course in gem cutting after completing high school. Most of Amaran's workers come

from nearby neighborhoods. Employees receive fringe benefits in addition to Government-mandated benefits including loans for housing and medical insurance. Indirect employment effects are also evident since Amaran sub-contracts work out when necessary to other small local gem cutting firms.

4. Midland Retreads (Pvt) Ltd

The TIPS project assisted Midland Retreads, a tire retreading company, in acquiring new microwave pre-cure tire manufacturing technology. The retreaded tires produced using this technology will give higher mileage and higher reliability than conventional retreads, at lower cost to the user. Midland also recently purchased laboratory equipment from a U.S. supplier, which will be used to set up a mini-laboratory to check raw materials and rubber compounds in order to ensure compliance with international quality standards.

Mr. Palitha Jayatissa, the Managing Director of Midland, is a forward-looking, hands-on manager whose first business venture involved operating a roadside bicycle tire repair stand. Upon his return from a TIPS-funded visit to several tire firms in the U.S., he re-designed the layout of his plant floor to improve worker safety and working conditions. He also installed an experimental solar-based energy unit which reduced the plant's energy costs by 20 percent.

According to Mr. Jayatissa, worker salaries at Midland are higher than in comparable jobs, and monthly production incentives are offered workers as is a profit-sharing plan that is presently equivalent to seven months' salary. He also provides a transportation allowance. The community in which the plant is located has also benefitted from the firm's expansion. Midland recently shared the cost of paving a local road. The firm also purchases daily meals for workers from neighborhood shops.

Thirty-three new jobs were created at Midland as a result of the plant expansion. The firm now has 55 permanent employees. Most of the new workers are young men who were hired in line with the Managing Director's policy of providing jobs to unemployed youth. Mr. Jayatissa has also introduced a training program to upgrade skills among his workers. Eight young employees were recently sent to India for training.

5. Proplanka

Proplanka manufactures plastic bags for domestic consumption and for export. The firm has been in the plastics business for the past five years and currently holds a 50 percent share of the local market. The Managing Director of the firm is Mr. Mahinda Suraweera. Proplanka has used assistance provided under the TIPS project to expand its operations and to raise the quality of its product to international standards. The firm has also solicited information from TIPS on

international sourcing of suppliers and markets, and has attended an international packaging trade fair under TIPS auspices.

Proplanka buys most of the equipment and raw materials that it needs from East Asian countries. The firm has recently begun to export products to Ireland and Germany. Though it still ships through intermediaries, the firm has begun dealing directly with buyers in Australia and Singapore. Proplanka is in the process of building a new plant to meet increased export demand.

Approximately 35 new jobs have been created by Proplanka over the past two years. The present level of employment is 75. Most are women 18-20 years old, with 2-3 years work experience. Women are not ordinarily hired for executive positions by the firm because of their housekeeping workload at home. Supplies and services are generally obtained from local firms including ink, solvents, packing cartons and freight forwarding services.

6. Tea House

The Tea House started operations in November 1992, under a joint venture arrangement with an Italian firm. The firm packages a line of flavored teas for export. Exports to the U.S., Australia, New Zealand and South Africa reached $600,000 during the firm's first year of operation. The Team noted in this regard that the Managing Director of the firm has been active in the export tea business in Sri Lanka for some years.

The TIPS program provided marketing assistance to the firm, specifically the services of a Sri Lankan consultant who designed packaging that would meet international requirements for the export of a product line of teas.

Tea House currently employs 25 semi-skilled workers, most of whom are women. Other local small and medium firms provide a variety of production inputs including tea, wooden and cardboard boxes, labels, color screen printing, brochure printing, and freight forwarding services.

7. Kelani Cables Ltd.

Kelani Cables Ltd. is the leading Sri Lankan manufacturer of PVC electrical cables, aluminum conductors, television antenna and telecommunication cables, and enameled winding wire. Its products are shipped to local as well as export markets. Kelani has a well-established dealer network in Sri Lanka, and is the only local supplier of the products that it produces. Kelani is also the local representative of Nokia Telecommunications, a large international firm based in Finland, and is representing the firm on several telecommunications development projects that are currently underway in Sri Lanka.

TIPS assistance to Kelani was provided to support the firm in its efforts to expand its product line by producing ballast for fluorescent lamps for both export and local markets. TIPS funding paid for lab equipment and some training.

Kelani's new line of production has created 25 new jobs, with total employment projected at 70 workers. Almost all are semi-skilled workers who have been trained on the job. Local companies supply plastic parts and paints used in the ballast manufacturing process.

E. ANALYSIS OF PROJECT IMPACT

As noted, the goal of the TIPS project is to increase the capacity of Sri Lanka's private sector industries to compete internationally by improving their ability to acquire and master technologies with support from U.S. business and technology. From its quick review of the experience of project implementation to date, the Study Team sees this goal as being effectively achieved. The project has been successful in helping small and medium-scale Sri Lankan firms identify the technologies they need to improve the productivity of their operations. Technical and marketing assistance consultancies funded under the project have enabled a number of firms to use the technology they have acquired effectively in raising productivity, output and sales.

The site visits made by the Study Team also confirmed a finding of the mid-term evaluation report, namely, that TIPS clients have made considerable progress in becoming globally involved in business ventures. Managers of the companies visited reported that their export sales had increased significantly, as did imports. Much of the new imported materials and supplies were associated with technology development such as machinery, laboratory and quality testing equipment, and new components for higher value-added production.

1. The impact of project-funded activities on economic growth

Though modest in scale, the TIPS project has had extensive impact among Sri Lanka's small and medium-scale industries. Of the more than 250 enterprises which have benefitted from TIPS-funded projects to date, approximately one-quarter were start-up companies.

The TIPS effort to induce these firms to establish effective links with suppliers and sources of technology and to obtain the technologies needed to capitalize on export opportunities has been particularly successful. As noted in the report of the mid-term evaluation undertaken recently, project-funded activities have generated a 45 percent increase in new sales among participating firms, including a 34 percent increase in domestic sales and an approximate doubling of export sales. Additionally, according to the report, a 32 percent increase was registered in net output value and

there was at least a 10 percent improvement in productivity. In most instances, the sales growth of TIPS clients exceeded industry averages.

2. Project impact on job creation and skills levels

Reported employment changes for the 48 companies surveyed during the mid-term evaluation of the TIPS project, indicated that full-time jobs had increased from 4,202 to 7,012 during the term of the project to date. In addition to direct job creation, the evaluation report noted that there had also been a substantial increase in the number of contracted piece-rate workers.

A key point that emerged from interviews with TIPS clients during the site visits undertaken by the Study Team, was that the project largely involved small and medium-scale firms whose plants were located in suburban or semi-suburban communities. When the business activities of these firms picked up, they normally hired inhabitants of the communities in which they were located. Because many of the firms were small or medium scale, the persons hired to fill the jobs were generally semi-skilled and low-wage workers.

3. Impact on secondary beneficiaries

Except in a few cases, the main thrusts of the TIPS project have been technology sourcing and export business development not technology transfer and commercialization. Consequently, to the extent that there has been project impact on secondary beneficiaries, it has been realized primarily in terms of the increased jobs and incomes that have accrued to workers employed by ancillary firms and sub-contractors.

4. The types of technologies transferred or developed and their impact on development

The types of technologies transferred under the project have been identified by the project's managers as being "hard" or "soft", meaning machinery and equipment in the case of the former and business services with regard to the latter. The development impact of project-funded activities has been predominantly economic as reflected in the increased productivity, output, and export earnings achieved as a result of the successful implementation of project-funded activities.

Semi-skilled and unskilled workers employed by small and medium-scale industries have also benefitted from the project in terrns of increased jobs and, in some cases, higher wages and improved working conditions. Though minimal, these effects represent a certain level of project impact on the country's social development.

F. RECOMMENDATIONS AS TO POSSIBLE PROJECT FOLLOW-UP ACTIVITIES

The Study Team endorses one of the recommendations cited in the mid-term evaluation of the project, namely the suggestion that a "for-profit" TIPS-type enterprise be established in Sri Lanka with initial support from World Bank and USAID grants and loans, but with the idea that this "private TIPS" would become self-sufficient in due course.

The Study Team believes that it would be useful to have a prominent Sri Lankan businessman head up such an enterprise. The rationale of the proposed enterprise should be to strengthen U.S.-Sri Lankan business ties as they relate to the transfer of U.S. technologies to Sri Lanka and the expansion of bilateral trade between the two countries on the basis of those transfers. The objective of the undertaking from the U.S. perspective should be to gain an export advantage for small and medium-scale U.S. firms. The Team believes that World Bank participation might preclude U.S. efforts to establish such an advantage and, accordingly, should be reconsidered.

IV. THAILAND: THE SCIENCE AND TECHNOLOGY FOR DEVELOPMENT PROGRAM (STDP)

A. THE BASELINE SITUATION

By the mid-1980s, with the virtual closing of its land frontier and the gradual restructuring of industrial expansion into more technology-intensive sectors, Thai economic growth had reached a stage at which further sustained growth required the continued assimilation of innovative technologies by the country's productive industries. The government had developed a cadre of highly trained scientists and technologists who could contribute to this process, but they were underutilized and the linkages needed to create effective relationships among the various institutions engaged in research, development and engineering (RD&E) activities and between the country's RD&E community and its industrial and commercial sectors had not yet been established. Lack of demand for RD&E services among Thailand's manufacturing industries was a contributing factor. Thai firms have traditionally relied on foreign firms to introduce needed technological innovations.

B. THE MAIN FEATURES OF PROJECT DESIGN

An initial step designed to be taken under the STDP project was the establishment of a Science and Technology Development Board (STDB). The Board was intended to serve as executive manager of the Science and Technology Development Program (STDP) and to take a systems approach to managing project-funded activities. In addition, it was to be institutionalized as a permanent mechanism for promoting the development and application of science and technology in support of industrial growth during the course of project implementation. This eventually happened in 1991, with the establishment by the Royal Thai Government (RTG) of the National Science and Technology Development Agency (NSTDA).

USAID funds provided under the STDP project were to be used primarily for RD&E studies concentrated on solving technology-related industrial development problems and on identifying expanded industrial development opportunities in the high priority areas of bio-science and bio-technology, material technology, and applied electronics technology. The specific thrusts of STDP programming initiatives were aimed at:

- developing a program of policy studies directed at influencing policies and practices to stimulate the development and utilization of the country's scientific and technological capabilities;

- developing science and technology (S&T) resources through a fellowships program;

- developing industrial RD&E institutional capabilities by way of institution building grants;

- solving specific industry problems by generating industry research opportunities through grants to universities, public and private institutions, and private firms;

- increasing the quality of the country's industrial output with a standards, testing, and quality control (STQC) program that would operate through existing S&T institutions and agencies;

- developing a national network of information centers with access to industrial, business, scientific and technological information;

- initiating a program supporting firms in their efforts to develop or acquire technology; and

- providing RD&E consulting support to industries with consultants from Thai universities, private firms or public institutions.

The total USAID contribution over the 7-year life of the STDP project was projected at $35.0 million, of which $27.0 million was to be provided on a soft loan basis, and $8.0 million was to be given as direct grants. RTG "in-kind" contributions and budgetary support was estimated at $9.5 million. Contributions from private sector companies in Thailand were expected to amount to $4.5 million for a total host country contribution of $14.0 million. The projected total cost of the project was estimated at $49.0 million.

Of the total amount, roughly two-thirds or approximately $32.6 million was to be allocated for RD&E activities directed toward the development, transfer, application and use of technologies to address the country's development problems. Approximately $7.5 million was to be used to support the development of industrial standards, testing and quality control procedures; the establishment of a Technical Information Access Center (TIAC); and the establishment of a Diagnostic/Research Design Service. An estimated $6.9 million was to be used to support the operations of the STDB for policy review studies. The balance of $2.0 was reserved for project evaluations and audits, and for contingencies.

C. SUMMARY OF PROJECT IMPLEMENTATION EXPERIENCE

1. Project start-up and funding

The project was initiated in August 1985, when USAID and the RTG signed a $26.5 million loan agreement and an $8.5 million grant agreement. In June 1989, the loan portion of USAID funding was decreased to $19.6 million and in October 1989, the grant portion was increased to $15.8 million. A predominant share of USAID funding, $20.3 million, remained committed to RD&E activities. Sizeable shares were also allocated for industrial development support activities and to strengthening existing RD&E institutions.

2. Delays in project implementation

A mid-term evaluation of the project conducted in mid-1989 noted that the STDB had encountered delays in getting organized and in getting planned activities underway. This was attributed to the "unanticipated complexities" of establishing the STDB; the difficulty of attracting qualified senior personnel to an enterprise with a limited lifespan; the delay in getting a technical assistance contractor on board; and the "complexities" of operating within an administrative environment which included oversight from three Thai government agencies.

A USAID audit conducted in late 1990 confirmed that project implementation was well behind schedule. The audit report noted that of the $30.6 million of USAID funds obligated as of March 1990, nearly five years after initiation of the project, only $8.1 million had been expended.

Notwithstanding the lagging pace of project implementation, the mid-term evaluation report noted that more than 130 RD&E proposals had been received since inception of the project of which 45 had been approved for grants, mainly to universities. Of the 45 approved, 23 were in bio-science or technology, 16 were in material science or technology, and 6 in applied electronics and computer technology.

3. The effects of the military coup

The Thai military coup of February 1991 resulted in further delays in the implementation schedule of the project. The U.S. suspended its aid program to Thailand in response to the coup. The suspension lasted two years. The 7-year lifetime of the project was extended to 9 years partly because of the coup, but also because of lagging implementation.

Adjustments in funding were also made. The loan portion of USAID funding was reduced to $11.5 million, substantially below the original design budget, and the grant portion to $10.2 million.

The reduced levels of USAID funding were more than offset, however, by increases in funding provided by the RTG. Having made only modest inputs in the years leading up to the coup, the RTG was forced to pick up an increased share of STDP costs following the suspension of USAID assistance. The increased funding was provided by the RTG in conjunction with its establishment of the National Science and Technology Development Agency (NSTDA).

4. The National Science and Technology Development Agency (NSTDA)

The NSTDA was established in December 1991 and operates autonomously under the policy guidance of the National Science and Technology Development Board (NSTDB). The NSTDB is chaired by the Minister of Science, Technology and Energy (MOSTE) and was established to take over the operations of the Science and Technology Development Board (STDB). As an autonomous agency, the NSTDA operates outside the normal framework of state enterprise regulations and civil service rules, enabling it to take a broad-based approach to managing S&T development programs. Funds provided the NSTDA under the RTG budget have increased from $12.0 million in 1992, to $14.0 million in 1993 and $16.0 million in 1994. The funding level proposed for 1995 is $40.0 million. The NSTDA is also overseeing expenditure of the remaining STDP funds being provided by the USAID, amounting to approximately $1.0 million.

The establishment of the NSTDA enabled the RTG to bring under one roof, an RD&E funding agency (NSTDA); and Thailand's three national research centers: the National Center of Genetic Engineering and Biotechnology (NCGEB); the National Metal and Materials Technology Center (MTEC); and the National Electronics and Computer Technology Center (NECTEC).

5. The U.S.-Thailand Commercialization of Science and Technology (UST/COST) Program

One of the more significant developments registered during implementation of the STDP project has been a shift toward promoting direct interaction between U.S. and Thai private firms in lieu of having a public agency or institution serve as an intermediary. This direct approach was viewed as more likely to produce suitable matches between U.S. and Thai firms; to bring about more practical, privately-driven technology commercialization activities; and to lead to substantially greater cost-sharing. The U.S. Board on Science and Technology for International Development (BOSTID), a group within the National Research Council (NRC), was instrumental in working with the NSTDA on the establishment in 1991 of the U.S.-Thailand Commercialization of Science and Technology (UST/COST) program which is aimed at promoting direct commercialization agreements between U.S. companies and Thai firms. In addition, approximately $600,000 of STDP funds have recently been allocated for "special activities" aimed at facilitating direct interaction. A like amount

of funding is being committed by private business firms and the research institutions participating in these activities.

D. FINDINGS FROM INTERVIEWS AND SITE VISITS

Most of the institutional development and RD&E support programs that had been initiated by the STDB when it was managing the STDP project, were taken over by the NSTDA and are still being implemented. Following are summaries of the status of these activities based on Study Team interviews with their current managers or directors and a review of documentation provided by the NSTDA and USAID.

1. The development of a program of policy studies directed at stimulating the development and utilization of the country's scientific and technological capabilities

Studies conducted to date under the program have dealt with the following issues or problems:

- The commercialization of RD&E results in Thailand;
- The supply and demand situation relating to the S&T manpower situation in Thailand;
- Government policies affecting the acquisition and utilization of S&T in small scale businesses;
- The development of S&T baseline data.

The 1990 USAID audit report noted that STDB staff had indicated at that time that the four studies "were not useful and did not satisfy STDB requirements". However, USAID staff told members of the Study Team recently that the studies had been "very useful", and were widely disseminated.

2. Developing S&T resources through a fellowship program

The fellowship program was aimed at increasing the availability of highly trained professionals within the RTG's three priority areas of technological development, i.e., bio-science and bio-technology, material technology, and applied electronics technology. The mid-term evaluation report noted that by mid-1989, 129 fellowships had been granted surpassing the project's goal of 105 fellowships. Of the total granted, 81 were in the area of bio-science and bio-technology, 23 were in material technology, and 25 were in applied electronics and computer technology.

3. Designated and competitive RD&E activities

Grants awarded to research institutions under the Designated Research Program, are provided primarily to enable these institutions to develop their capabilities to resolve specific and well-known high priority industrial problems. Grants under the Competitive Research Program are used to help private firms solve industrial or technological problems or to enable them to develop a new or improved process or product, including "state-of-the-art" technologies that have relevance for Thailand's economic development and growth.

At the time of the USAID audit, 65 RD&E sub-projects had been approved, and an additional 91 sub-project proposals were under review. The Study Team was not able during its brief visit to Thailand to obtain information regarding the current status of RD&E activities.

4. Providing Thai industries with consulting support from universities, private firms or public institutions: the Industrial Consultancy Services (ICS) Program

The major objective of the Industrial Consultancy Services (ICS) Program currently being operated by the NSTDA is to stimulate the further development of technical and industrial engineering consulting services in Thailand, and to promote the utilization of these services by Thailand's productive industries. It is expected that the increased use of technical and industrial engineers by private sector firms will accelerate the rate at which Thai industries can become internationally more competitive. It also provides a means of getting Thai manufacturers to realize that many production problems do not require procuring new technologies but can be solved less expensively by applying technical or managerial knowledge already available.

The Study Team was informed that the range of industrial sectors on which the ICS will focus has not yet been decided. The program is just getting underway. Decisions will be made over time as the consultancy needs of private sector Thai firms become clearer.

5. A program of support to firms in their efforts to acquire and assimilate technology: the Support for Technology Assessment and Mastery Program (STAMP)

STAMP was launched in 1988 in an effort to facilitate the process by which Thai firms gain greater experience in the acquisition and assimilation of technologies important for the success and growth of firms. The major objective of the STDB in establishing the program was to help Thai companies make wise decisions in purchasing new technology, and to instruct them on the effective use of the technology once it has been purchased.

STAMP does not charge a fee. It is considered to be company-directed RD&E. The focus of the program is on small and medium-scale enterprises (SMEs), very few of which are capable of doing their own RD&E. The current rate of implementation for the program is pegged at five projects per year at an estimated cost per project of $20,000. STAMP proposes to increase this level of effort to ten projects next year. STAMP also finances feasibility studies for new investments and SME attendance at industrial trade fairs.

The Study Team was provided a list of twelve projects that are currently slated for implementation under the program. All of the projects had originally been scheduled for implementation during 1990-1992. The types of technologies slated to be acquired relate to aluminum hydroxide production, sunflower oil extraction, improvement in the quality of carbon and graphite blocks, semi-automated paint production, and the processing of quick-frozen fruits and vegetables.

6. Increasing the quality of the country's industrial output with a standards, testing, and quality control (STQC) program that works through existing S&T institutions and agencies

The STQC program was designed to enhance the quality control awareness and capabilities of industrialists and workers, particularly in small and medium-scale enterprises (SMEs), to enable them to produce quality products for export. A second purpose is to establish a detection system suitable for monitoring quality control performance.

Four approaches are currently being pursued under the program to bolster the capacities of RTG institutions involved in the implementation of STQC programs. These include: (1) the acquisition of suitable instrumentation and testing equipment; (2) the provision of technical training in the U.S.; (3) the training of trainers in the food and polymer industries; and (4) public awareness activities.

The USAID audit report noted that the STQC program was considered to have been successful in part, in that technical assistance was being provided, workshops were being conducted as scheduled, and working groups had been organized to enhance coordination among selected institutions. However, Thai officials selected for U.S. short-term training were having difficulties in meeting the English language requirement.

7. Developing a national network of information centers with access to industrial, business, scientific and technological information; the Technical Information Access Center (TIAC)

TIAC is an information service organization that earns funds by charging system access and service fees. It also conducts one-week orientation visits and

workshops. TIAC has to remit 30 percent of the fees it receives to NASDA, currently its parent organization, but retains 70 percent for its own operations. Dr. Sudhiporn Patumtaewapibal, the Director of TIAC, noted that he is required to adhere to NASDA policy guidance in managing the Center, but sets his own course operationally. He noted further that one of his goals for the Center is to make it self-sustaining.

TIAC has had a problem getting situated. It has been relocated three times since being established. With suspension of the STDP in February 1991, and the loss of USAID funding following the military coup, the Center was forced to stop providing services for six months and was told to wrap up its operations. This, of course, didn't happen. TIAC is currently considered to be a UST/COST sub-project and is being subsidized by the RTG. The Center has made several attempts since being established to become an autonomous government agency or to privatize, but hasn't as yet succeeded.

TIAC's clients at present are mainly Thai R&D firms. It now serves as a consultant to the Bank of Thailand and the Research Council of Thailand. The UNDP's Private Investment and Trade Office (PITO) would like TIAC to be its Thai information systems consultant. The EEC has indicated its interest in having TIAC function as a business center for the EEC in Thailand.

The Center has set aside funds to acquire CD-ROM capabilities for use in disseminating educational materials. It also wants to acquire and sell videotapes of R&D lectures presented at major U.S. universities, such as Georgia Tech and M.I.T. Presently, it depends on the USIS to provide such materials.

8. The Aquatic Resources Research Institute (ARRI)

The Aquatic Resources Research Institute (ARRI) was established in 1991 to undertake RD&E related to technology commercialization activities in the aquatic resources sector. It also conducts research in depth on environmental problems such as marine pollution. The Center has received funding under both the USAID-funded STDP Project and the ATT Project for some of its research activities, including one aimed at improving knowledge of shrimp feed technology. It is currently in the process of getting a grant from the NSTDA to study the impact of shrimp farming on the environment.

The shrimp feed technology research program was developed by ARRI on its own. The Institute is now trying to transfer the technology to private sector firms. Twelve demonstration farms have been set up around Thailand. The process requires the use of a labor-intensive farming system. S&T training programs, conducted regularly by the Institute for farmer cooperatives and private sector firms, will also be used as a means of dissemination.

According to Dr. Piamsak Menasveta, the Director of ARRI, aquacultural and aquatic resources research in Thailand is usually funded by private sector firms under contract research arrangements and through consultancies. The Government is still a player, however, inasmuch as its extension service is generally needed to get high-tech products to the village level.

9. The National Research Centers

As noted earlier, Thailand's three national research centers have been brought under the administrative control of the NSTDA and are engaged in managing the balance of activities being funded under the STDP project.

a. The National Center for Genetic Engineering and Bio-Technology (NCGEB)

The NCGEB provides technical and financial support to both educational institutions and research institutes involved in RD&E activities in high technology areas, as well as at the basic, intermediate, and advanced levels. It also promotes cooperation among scientists at home and abroad on technical matters related to genetic engineering and bio-technology development, and coordinates transfers of technology from outside sources to both private and public sector organizations and agencies in Thailand.

The Government budget is the Center's main source of funding. It also collects fees for contract research and training programs. The Center presently receives only about one percent of its support from private sector sources. Research on tissue culture and seed technology is currently the main focus of the Center's research program. It has recently evolved a plan to bring new seed technologies into Thailand under the auspices of the UST/CCST program.

The Center will be moved to the proposed Siam Science Park once that facility has been constructed. The Park, which is to be located near Bangkok's international airport, will be a science-based industrial park patterned after a similar facility in Singapore. The Park will provide a forum for interaction between Thailand's public sector RD&E institutions, such as the NCGEB, and private commercial firms, and will serve as an incubator for the commercialization of innovative high-tech products.

b. The National Metal and Materials Technology Center (MTEC)

As its name indicates, MTEC is involved in research related to the testing and improvement of metal and materials technology. The Center's current research activities are focused on developing improved surface treatments (including hardening) for mechanical parts, tools and processing equipment; powder technology for ceramic

and metal powder products; polymer (plastics and rubber) processing and materials recycling; and the design, construction and reverse engineering of machinery.

c. The National Electronics and Computer Technology Center (NECTEC)

NECTEC was founded in 1986 as a project under MOSTE. It became a specialized national research center in 1991 following enactment of the 1991 Science and Technology Development Act. The NECTEC Board is chaired by the Director of the NSTDA. Its primary objective is to meet domestic demand through import substitution.

According to Dr. Pansak Siriruchatapong, the Deputy Director of the Center, NECTEC does very little in the way of lab-to-market R&D. Instead, it looks for opportunities to improve technology incorporated in existing products being exported by Thailand, in order to increase Thai value added. It sells improved technologies, not products. The Center also conducts in-house RD&E activities. It is presently trying to develop a commercially competitive communications switching system.

NECTEC has not as yet been very successful in interacting with foreign companies doing business in Thailand, largely because of its specialized research functions. The geographic areas targeted for export products for which Thai value added has been increased through technology improvements, are the Middle East and Africa.

E. ANALYSIS OF PROJECT IMPACT

Despite the 2-year interruption in implementation of the SDTP Project brought on by the military coup in 1991, the institutional development objectives of the Project have essentially been achieved. As it has emerged, however, the overall management structure of Thailand's RD&E institutions is now more heavily influenced by Government policies and priorities than had been envisaged at the onset of the project. As a result, less emphasis is being directed to the commercialization phases of the technology commercialization process and except for the modestly-funded UST/COST program, private sector participation in STDP-funded programs to the extent needed has not been achieved.

Nevertheless, considerable progress has been made in a number of areas, specifically with respect to STDP projects aimed at:

- increasing the quality of the country's industrial output with a standards, testing, and quality control program that operates through existing S&T institutions and agencies.

- developing industrial RD&E institutional capabilities by way of institution building grants. The NECTEC approach to enhancing the value added of Thai exports is a brilliant scheme and highly suited to the country's competitive situation.

- solving specific industry problems by stimulating targeted research through grants to universities, public and private research institutions, and private firms. This approach has worked particularly well in the case of ARRI and the work that it has done in conducting research on environmental problems such as marine pollution, and on improving knowledge of shrimp feed technology.

Less progress has been achieved in other promising areas, such as:

- developing a national network of information centers with access to industrial, business, scientific and technological information. TIAC has made progress but it has been plagued by not being allowed to set its own institutional development policies and goals, by location problems, a lack of cooperation from Thailand's other information centers, and by a lack of funding.

- initiating a program supporting firms in their efforts to acquire technology. An excellent idea but thinly applied at present due largely to insufficient demand among Thailand's many small and medium-scale industrial firms

Programs that appeared ill-conceived or ineffectual:

- providing consulting support to industries with consultants from Thai universities, private firms or public institutions. The idea behind the program, of using consultants to get Thai manufacturers to realize that many production problems do not require procuring new technologies but can be solved less expensively by applying technical or managerial knowledge already available is a very sound one, but it is not being put into practice effectively. There is low private sector investment in RD&E in Thailand and it may be that overcoming this general problem is a pre-requisite to getting private firms to understand the importance of acquiring technology wisely.

- developing a program of policy studies directed at influencing policies and practices to stimulate the development and utilization of the country's scientific and technological capabilities. After an auspicious start, the program has not been aggressively pursued.

The loss of USAID support and funding during a critical period of project implementation was clearly costly to the success of some elements of the STDP project and, in terms of building stronger business ties and institutional relationships

between two countries, has been detrimental to the interests of the U.S. as well as Thailand. Nevertheless, the technological and economic soundness of the basic approach to technology commercialization that was built into the design of the STDP project is impressive, particularly as it reflects full recognition of the fact that for Thailand, as for other advanced developing countries, especially in the Asia region, joint partnership between the public and private sectors of these countries is essential if they are to compete successfully against global competition. Secondly, they must establish close links with developed countries like the U.S., if they are to maintain access to the innovative technologies they need to compete effectively.

1. The impact of project-funded activities on economic growth

Primarily because of lagging implementation prior to the military coup in 1991, the two-year hiatus in project activity since the coup, and the current winding down of project activities, it is difficult to assess the impact of project-funded activities on Thailand's economic growth. If there has been impact, it has been minimal.

2. Project impact on job creation and skills levels

The Team received virtually no information concerning the impact of project-funded activities on job creation and skills levels. This is understandable in that, except for their own staffs, research institutions are generally one step removed from the job creation process. Moreover, a large share of the funds expended under the project was directed to research activities. Information made available to the Team indicates that very few of these activities reached the stage of commercialization.

The NECTEC approach of looking for opportunities to improve technology incorporated in existing products clearly has the potential of increasing Thai exports and, if effectively pursued, would likely have a positive impact on job creation.

3. Impact on secondary beneficiaries

The Team had no occasion to evaluate project impact at site level. From information obtained through interviews, however, the following two projects are viewed as likely to have positive and measurable impact on secondary beneficiaries, as indicated.

Research on tissue culture and seed technology is currently the main focus of research being done at the National Center for Genetic Engineering and Bio-Technology (NCGEB). The Center has recently evolved a plan to bring new seed technologies into Thailand under the auspices of the U.S.-Thailand Commercialization of Science and Technology (UST/COST) Program. The introduction of new disease-

resistant and higher-yielding seeds would be of considerable benefit to the country's farmers.

The Aquatic Resources Research Institute (ARRI) is now trying to transfer to private sector firms the shrimp feed technology that it has pioneered. Twelve demonstration farms have been set up around Thailand. The process requires the use of a labor-intensive farming system. S&T training programs, conducted regularly by the Institute for farmer cooperatives and private sector firms, will be used as a means of dissemination. Shrimp farmers would be the main beneficiaries of the spread of this technology. Consumers would be the principal secondary beneficiaries.

4. The types of technologies transferred or developed and their impact on development

The Team was not able, during its brief visit, to obtain sufficient information concerning the types of technologies transferred or developed under the project, to form a reliable judgement as to the development impact of the various types of technologies involved.

F. RECOMMENDATIONS AS TO POSSIBLE PROJECT FOLLOW-UP ACTIVITIES

If there were to be a successor project to the STDP project, the Support for Technology Assessment and Mastery Program (STAMP) should be included as a key component of the project. The Program enables Thai private sector firms to utilize the expertise of the country's leading technologists to help them in procuring new technologies and to instruct them on the effective use of the technologies once they have been procured. This facilitates the participation of private sector firms in technology R&D activities in Thailand, and would contribute to the commercial success of these activities. The TIPS Project in Sri Lanka has used U.S. consultants for this purpose. A combination of the two approaches would be very effective in Thailand.

Also, as noted earlier, one of the more significant developments registered during implementation of the STDP project was a shift toward promoting direct interaction between U.S. and Thai private firms in lieu of having a public agency or institution serve as an intermediary. This direct approach is viewed as more likely to produce suitable matches between U.S. and Thai firms, and should be incorporated as a key element in the design of any proposed follow-up activity.

V. THAILAND: THE AGRICULTURAL TECHNOLOGY TRANSFER (ATT) PROJECT

A. THE BASELINE SITUATION

Through the late 1970s, Thailand ranked as one of only six nations in the world, and the only one in Asia, which had consistently been a net food and feed exporting country. Agricultural exports generally accounted for around two-thirds of the total value of exports. About 70 percent of total Thai agricultural growth was attributable to the opening up of new arable land areas, and 20 percent related to government infrastructure investment, particularly irrigation works. Only 10 percent was attributable to the introduction or adaptation of new productive technologies.

By 1984, however, just prior to startup of the ATT Project, the growth rate of agriculture had dropped below 2 percent. Relatively little arable land remained to be opened. Soil erosion had become a serious problem. Use of organic and chemical fertilizers was minimal. Soil fertility was decreasing. Average yields of most crops were well below world and regional averages, and were declining. A shift from the existing relatively low level of agricultural technology to a much higher level was needed in order to contribute to overall economic growth, export earnings, and to the alleviation of rural poverty.

Among the major constraints to increasing production were: (a) the low level of technology then being used by Thai farmers; (b) managerial deficiencies in research, extension and other MOAC functions related to reaching and persuading farmers to utilize more modern methods; and (c) a shortage of the skilled program and project managers needed to strengthen public-private sector collaboration.

B. THE MAIN FEATURES OF PROJECT DESIGN

The ATT Project was designed to bring "state of the art" agricultural production and processing technology to Thailand, provide for it to be adapted to Thai conditions and then transferred to farmers and small and medium-scale food processors. A key objective of the project was to assure the maintenance of adequate food supplies for the country's growing population taking account of its disappearing arable land frontier.

It was anticipated that implementing the project would increase the MOAC'S capacity and that of other Thai institutions, including the private sector, to locate or generate, introduce, transfer and manage the new technologies needed by Thailand's farmers to increase yields, overall farm production, and farm incomes, thereby

maintaining Thailand's agricultural exports at planned levels while meeting increasing domestic demand for food, feed and fiber.

Initial funding contributed by USAID to the project amounted to $5.0 million, of which $4.5 million was provided as soft loans and $0.5 million as grants. RTG budgetary support commitments and contributions in-kind were estimated at $1.7 million. Approximately $5.5 million, or over 80 percent of the total $6.7 million committed to the project was used to finance sub-project activities. The balance of $1.2 million was used to cover project management and operations expenses. Additional contributions brought the total of USAID funding to approximately $13.9 million, as of September 1991.

C. SUMMARY OF PROJECT IMPLEMENTATION EXPERIENCE

The ATT is an "umbrella" project, being implemented by officials from different line agencies of the MOAC. The project has funded applied research, training and subproject operating expenses in a wide variety of existing agricultural, dairy and fish products activities, as well as in small emerging agro-industries like seaweed, artificial crab (surimi), fresh fruit and vegetable contract farming. It has also funded a range of innovations, including new techniques of farm production, processing, post-harvest care, and marketing, as well as disease control. Loan funds have been used for the procurement of necessary equipment and operating expenses. Grant funds have been used for training, including study tours and short-term technical assistance, mostly from the United States.

Over the five-year period 1984-1989, 45 sub-projects were approved and financed. Twenty-five workshops with private sector involvement were held, attended by an estimated 3,750 private and public sector representatives. The total number of individual farmers involved in training and extension programs reached 10,000 with evidence of some of the technologies introduced subsequently spreading by themselves.

D. FINDINGS FROM INTERVIEWS AND SITE VISITS

1. Seaweed production and agar processing; the establishment of a Development Center for Phycololoids; and the development of shrimp scale processing

Beginning with the Seaweed Production and Agar Processing sub-project in 1986, the Chemistry Department of Srinakarintrvirot University in Bangkok obtained three sub-projects under ATT auspices and a fourth related sub-project funded through the STDP program.

Seaweeds have been used for many purposes: as food, fertilizer, fodder for animals and as a source of valuable chemicals for genetic engineering, bio-technology and the cosmetics industry. The objectives of the initial sub-project were to promote the development of the seaweed industry and to substitute domestically processed high-grade agar for imports which amount to about $7 million annually. Another objective was to provide an additional source of income for coastal villagers. The research and development of the first sub-project led to two follow-on sub-projects designed to develop new products: high-value agarose from seaweed, and chitin and chitosan-based applications from shrimp shell waste.

This set of sub-projects has been regarded as one of the most successful activities funded under the ATT project and has received outstanding evaluation reports from the U.S. Department of Agriculture and from a private sector firm in Thailand. Data on import-substitution and increased incomes of villagers were not available; however, these activities developed cutting-edge technology considered to be among the most modern in the world. High-grade agarose has been developed for use as a filter medium in bio-technology applications and in genetic engineering. One Thai company was established, and at least one U.S. firm has been involved in production of this product.

Perhaps of greater long-term significance are the "spread effects" which these sub-projects have generated. A wide variety of products have been developed from chitin and chitosan made from the processing of shrimp wastes. A Bio-polymer Unit has been established at Srinakarintrvirot University which has developed a range of innovative products for Thailand's environmental, bio-medical, bio-technological, food processing and cosmetics industries. This has led the Massachusetts Institute of Technology to submit a proposal to USAID for support to collaborate with Srinakarintrvirot University under USAID's University Development Linkages Project.

Several private companies in Thailand and in the United States have shown interest in investing in the production of chitin and chitosan. The lead scientist at Srinakarintrvirot University has established a private training and consulting organization, i.e., Women in Science & Engineering - Thailand (WISE-T), to provide training programs in these technologies.

With regard to issues concerning women in development, it is noteworthy that women have spearheaded these efforts which have developed international linkages for women in the field of science and technology especially through the Asian Alliance of Appropriate Technology Practitioners (APPROTECH - ASIA), an international NGO sponsoring the Women in Science, Technology, Training and Consultancy Program (WIDTECH) which presently collaborates with WISE-T in offering training and technical services.

2. The establishment of the Center for Export Inspection and Certification of Agricultural Products (CEICAP)

In 1989, when this sub-project was initiated, Thai exports of food and processed agricultural products were constrained because quality control practices did not meet international standards. Consequently, a number of importing countries imposed automatic port-of-entry detention and extensive inspection measures.

In response to this problem, the ATT project assisted the Department of Agriculture in establishing and equipping the Center for Export Inspection and Certification of Agricultural Products (CEICAP), and in training its staff of 35 scientists located in 10 laboratories in Bangkok as well as in an Inspection Branch with four regional offices. In order to promote the export of food and agricultural products, CEICAP established a system for both the quality analysis and certification of food and agricultural products.

CEICAP offers low cost pre-export inspection and certificates to manufacturers in the areas of plant environment, sanitary conditions, production processes and quality control. It assists food processors in identifying problems and in overcoming existing deficiencies which could exclude them from meeting the sanitary and health requirements of importing countries. Over 50 Thai companies presently avail themselves of CEICAP's services.

CEICAP's certificates approving food products for export are presently accepted by the U.S., Canada, Japan, Australia, Sweden, and Finland. This means that exported food products bearing these certificates can enter these countries without additional inspection or with considerable less checking at ports of entry. Economic benefits accrue from savings on storage charges and expenses for rejection, and loss of foreign exchange earnings. The image of Thai commodities for potential importers has also improved. During 1990-1993, more than 6,000 certificates were issued covering more than $24 million of exported food products.

3. Controlling aflatoxin contamination in agricultural products.

Prior to the inauguration of this sub-project, there was a serious problem with aflatoxin contamination in corn grain which has posed a serious barrier to corn exports as well as posing a serious hazard to domestic farm animals and people. Post-harvest drying technology was improved with the adoption of a variety of techniques for farmers, traders, feed mills, and export silos. A trainer of trainers program was conducted by MOAC's Plant Pathology and Microbiology Division for agricultural extension workers, farmers cooperatives, and trader associations. The Division's laboratories are equipped with the latest equipment including a recent acquisition through USAID of a large Enzyme-Linked Immunosorbent Assay (ELISA) unit which

has expanded CEICAP's processing capability to 96 simultaneous samples and has considerably reduced the time required for analysis of samples.

Sample contamination levels have been reduced from an average of 100 parts per billion at the beginning of the sub-project in 1989 to less than 50 in 1992. In addition, completely uncontaminated samples increased from 26 percent to 85 percent during this period. In addition to avoiding foreign exchange losses through importing country rejection and/or imposition of severe price cuts, this has impacted on the health of the Thai population since contamination being passed on to consumers of meat and milk products has been significantly lowered.

4. The creation of new fishery products for export: surimi and artificial king crab legs

The goal of this sub-project was to identify technology appropriate for the development of fishery exports. Instead of exporting unprocessed frozen products, processing only 10 percent of these frozen products would increase sector foreign exchange earnings by at least 25 percent. The sub-project was implemented by the Fishery Technological Development Institute (FTDP), Department of Fisheries at Yannawa which is located just south of Bangkok.

A major component of the sub-project was focused on processing low priced minced fish meat to higher value products such as surimi and imitation king crab meat. A $68,000 pilot plant was set up to demonstrate the processing and quality control technology which had been developed.

The number of surimi processors increased from only two before initiation of the sub-project in 1985 to twelve in 1988. Two of these firms succeeded in producing artificial crab meat for exports. By 1993, four years after ATT funding had ended, the FTDP pilot plant continued to demonstrate sustainability by transferring its technology to more private sector firms and even offering training to other Asian and even African counties including China, India, Indonesia, Singapore, Malaysia, Philippines, Brunei and Tanzania. The number of surimi factories increased to 15 and crab meat processing plants increased to seven with capital investments ranging from $1.2 to $2.4 million for each processing facility. Export of surimi increased from 3,000 tons in 1985 to 45,000 tons by 1992. About 90 percent of production is exported.

In terms of job creation, the sub-project was a clear success. Approximately 20,000 jobs were created in the surimi plants and 600 jobs in the crab meat processing plants. Over 80 percent of the persons employed in the surimi and crab meat processing plants are women. Approximately 80 percent have only a primary school education. This suggests that low-income urban groups have been the major beneficiaries of these additional jobs.

5. **Dairy herd management improvement (hybrid Holstein dairy cattle, feeding and livestock management)**

The goal of this sub-project was to improve the overall system of dairy herd management in Thailand. The sub-project was conducted at the Thai National Dairy Training and Applied Research Institute (NDTARI) in Chieng Mai, which is attached to the Department of Livestock Development's (DOLD) Animal Husbandry Division. The sub-project included research, technical assistance, training and the acquisition of laboratory equipment, milking machinery, computer hardware and specialized herd management software.

Through the research program, hybrid cattle were bred with different levels of Holstein and Brahman combinations and improved feeding practices were developed. Training was provided for dairy cooperatives to strengthen their negotiating relationships with banks and private milk processing plants. Cooperative members received training in modern milking procedures, farm management, and livestock breeding improvement. During this process, computers and specialized software were provided to ten of the fifty dairy cooperatives existing in Thailand. A mobile training team was established and a training of trainers program was also initiated for extension workers throughout the country.

Specific skills involved in this technology transfer to dairy farmers included new combinations of feed for use through sequential milking cycles, U.S. housing designs were used to keep cows in farm sheds rather than in fields to avoid tick fever. Overhead water spraying systems were used to keep cows cool. Fans were used for this purpose in the larger cooperatives.

Regarding dairy products, an ongoing research program focussed on the production of several kinds of cheese, yogurt and ice-cream, was funded. The results of these experiments have been included in training programs for milk processing plant managers and personnel, in order to make the products commercially feasible as the domestic supply of raw milk catches up with demand.

Of the 15,000 farmers involved in dairy farming in the country, to date NDTARI has trained 2,000 farmers in different regions reaching out through its mobile team. NDTARI's training of trainers program for extension workers of the Department of Livestock Development has strengthened DOLD's capability so that 2,000 farmers are now scheduled to be trained annually. Milk yields of participating farmers have increased from 7-8 liters per cow per day during the rainy season and 3 liters per day during the dry season to 12 liters per day throughout the year.

The ATT experience has played a catalytic role in moving the Thai population toward increased consumption of milk and milk products. Over a five-year period domestic production of milk has risen from 20 percent of domestic demand to 30

percent, representing significant foreign exchange savings. This is significant in view of the fact that during this period the amount of milk consumed in Thailand had increased three times. The Thai government has also introduced a milk program in all public primary schools. In Chieng Mai alone, incomes for members of the dairy farmers cooperative increased by 15-20 percent per year during the period 1987-1989.

6. Arabica coffee development in northern Thailand; the production of black pepper for export; developing macadamia nuts as a new tree crop; and inaugurating straw mushroom, shitake, and button mushroom cultivation in Thailand

This set of sub-projects was developed at MOAC research stations in the northern highland region of Thailand. Sites for testing macadamia cultivation were also located in the northeastern, southeastern and southern regions. The sub-projects are aimed at implanting and/or speeding up commercial cultivation of crops for export as well as domestic consumption. Given the long-term time requirements for introducing and thoroughly testing new disease resistant horticultural crops, only two of the sub-projects have been commercialized. These are the macadamia nut and the mushroom sub-projects.

Macadamia nut trees have been commercially planted at several locations and have provided employment for approximately 5,700 persons. A small canning factory with an annual output of about 20 tons has been established to process the mushrooms produced in the Chaing Rai area. About 30 rural families which have benefitted thus far from the project have increased their net incomes by $500-$1,500 per year. One outstanding success story is that of a farmer in Chaing Rai who was able to increase production to large scale amounts and, through direct sales to exporters, to increase his annual income to a reported level of $25,000.

Local hill tribes living in the area adjacent to the Wawi Highland Agricultural Research Station have benefitted both through direct employment and indirectly through selling produce and services to this large project site, as well as being recipients of the health and educational services offered through it.

7. Control of the papaya ringspot virus disease

Papaya is grown throughout Northeast Thailand as a staple food for the rural population and is the most important subsistence crop in the region, after rice. The disease caused by the ringspot virus was first reported in 1975 and since then has destroyed the majority of the papaya trees planted in the Northeast. By 1985, the virus had spread to the large commercial papaya areas of Central Thailand and has subsequently spread to other commercial growing regions of the country. Given the increasing difficulty over the years of obtaining papaya from other parts of the

country, poor rural households in the Northeast have been losing their dietary mainstay.

In order to overcome this severe threat to the nutritional base of farm communities in the Northeast, MOAC's Northeast Regional Office of Agriculture (NEROA), with ATT support, developed two virus control measures with technical assistance from Cornell University. One has involved the development of a cross-protection mild-strain vaccine of the Thai virulent ringspot virus and inoculation of seedlings through a high speed sprayer. The other approach has been the breeding of a resistant hybrid variety papaya. Advanced bio-technology has played a major role in the development of tissue culture facilities and capabilities using recurrent gene selection techniques. A portable version of the Enzyme-Linked Immunosorbent Assay (ELISA) Unit was provided through the sub-project to apply a rapid diagnostic technique for monitoring virus infection and severity, and to assess inoculation results upon new plants.

Under the vaccine approach, a mild strain virus has been developed which offers temporary protection against the disease. Thai authorities are using this technique to distribute 40,000 fresh papaya plants to farming households until a new resistant variety becomes available. Although breeding programs are typically long-term, the payoff is significant. ATT funding ended before both approaches were completed; however, Thai officials have carried on the sub-project with resources from the MOAC. At present, NEROA officials report that they expect to have enough seed stock of a fifth generation virus resistant variety to provide a definitive solution to farmers by the end of 1994.

Under the sub-project 8,000 farming households in 18 villages in the area near Khon Kaen have benefitted from the inoculated plants. Since the disease has spread throughout the country, it now represents a national problem and tissue culture multiplication of the new resistant variety will require resources for new greenhouses and equipment which reportedly exceeds MOAC's funding capabilities.

8. Promoting integrated agro-production and marketing in the dry season

The Lam Nam Oon (LNO) Integrated Agro-Production and Marketing Program is a community development sub-project covering irrigated areas of three districts of Sakon Nakhon Province in Northeast Thailand, which is inhabited by approximately 15,000 farm families.

In 1986, the sub-project instituted a commercial agricultural development effort in an area which had been designated by the RTG as being one of the poorest rural regions in the country. The effort was aimed at transferring to government officials at the local level the knowledge and techniques necessary to promote integrated agro-industrial crop technology which would be led by the private sector.

It was also aimed at creating appropriate linkages and cooperation among agro-industrial firms, banks and farmers to produce and process crops such as vegetable seeds, tomatoes, black pepper and baby corn.

A final objective was to replicate the Lam Nam Oon crop production and marketing model in other rural areas. Technology transfer involved the introduction of new crop varieties, training in the use of fertilizers, disease and insect control for commercial crops and farmer training in understanding cost-benefits of changing crop patterns and dealing with private firms and banks.

Farmers and businessmen have mutually benefitted from the Lam Nam Oon sub-project. Farmers successfully adopted the technology to produce new crops for which a strong demand existed. Farmers learned to use their judgement in assessing which crops are in demand by the market and achieved the skill and confidence to deal with private firms and banks. Firms profited through the increased export of agricultural products.

The number of contract farmers shifting from subsistence to cash crop farming, increased from 171 at the start of the sub-project in 1986 to a peak of 8,311 in 1991. Crop yields per rai increased by 6.5 times during the first two years of the sub-project with higher yield levels being maintained through 1993. The incomes of affected farmers increased by 30 percent from sub-project start-up. Reported additional net income in the 1992/93 season was approximately $1,000 per farmer.

Using new products and methods, losses caused by disease and insects in commercial tomato production, the region's largest cash crop, were reduced from 30 percent in 1986/87 to less than 5 percent at present with a consequent increase in farmers' incomes.

One study indicated that by 1988 the equivalent of 4,900 full-time, year-round jobs had been created as a result of 4,200 rai being cultivated with cash crops and over one million persondays worked. By contrast, in order to create the same amount of employment by growing rice, 20 times the area and 40 times the amount of water would have been necessary, though water is not available in the Lam Nam Oon area.

Additional labor was also required to assist families in cultivating their cash crops. Part of this labor involved the use of mechanized plows. At present, approximately 50 farmers in Lam Nam Oon have acquired this equipment and provide their services to the area. The sub-project has also resulted in additional jobs being created by private sector processing plants. Beginning in 1987, a special effort was made to train youth from various Sakon Nakhon districts for employment in the private sector.

E. ANALYSIS OF PROJECT IMPACT

1. The impact of project-funded activities on economic growth

The set of bio-technology sub-projects involving seaweed production, agar processing and the production of chitin and chitosan made from shrimp wastes is regarded as one of the ATT Project's most successful activities, particularly in terms of the "spread effects" which these sub-projects have generated. As discussed earlier, a wide variety of innovative products have been developed using state-of-the-art technology for the environmental, bio-medical, bio-technological, food processing and cosmetics industries. The Lam Nam Oon cash crop project has been singled out for replication in both the sixth and seventh national plans as a model of public-private sector cooperation for income generation in rural areas.

By 1989, significant increases in Thai agricultural exports could be traced directly to fruit and vegetable farming, integrated agro-production and marketing (hybrid seeds and canned products), and fish product sub-projects. These trends continued through 1993. Economic benefits accruing through CEICAP's certification process for food product exports are reflected in savings on storage charges and on expenses for rejected shipments with subsequent loss of foreign exchange earnings. During 1990-1993, more than 6,000 certificates were issued on more than $24 million of exported food products.

2. Project impact on job creation and skills levels

In terms of direct job creation, several of the sub-projects were clear successes. An example of this is the surimi and imitation king crab meat sub-project. Approximately 20,600 direct jobs were created in the 22 plants established as a result of the sub-project. Under the Lam Nam Oon sub-project, one study reports that the equivalent of 4,900 full time year round jobs were created. The macadamia nut tree sub-project has provided direct employment for approximately 5,700 persons at several rural locations.

3. Impact on secondary beneficiaries

Farmers and businessmen have mutually benefitted. Farmers have adopted technology to produce new crops for which a strong demand exists, they have learned to use their judgement to assess which crops are in demand by the market, and they have achieved the skill and confidence to deal with private firms (Lam Nam Oon). Business firms have profited through increased exports of agricultural and fish products.

The poorer segments of Thailand's population also benefitted, as consumers, from the increased production of fresh fruits and vegetables and from a 25 percent increase in milk yields obtained through the introduction of new milk cow breeds and feeding programs.

An appropriate transfer of job skills and know-how occurred along with the transfer of technology as sub-project leaders were found to have increased their understanding of how to import needed technology and how to transfer it on to end-users. In one case (the Lam Nam Oon integrated agro-production and marketing sub-project), appropriate linkages and cooperation were established among investors, farmers and government agencies. An integrated cultivation, production and marketing system was thereby structured. Throughout this process RTG officials gained experience in the promotion of production of high-value export and specialty crops.

Women have benefitted substantially from a number of the ATT sub-projects. Clear examples include the surimi and crab meat processing industry where over 80 percent of the jobs created are held by women coming from lower urban income groups. A rapid assessment approach involving field interviews with farmers in the Lam Nam Oon sub-project indicates that women farmers were highly represented among the beneficiaries of this sub-project. As mentioned earlier, women have spearheaded efforts in the chitin and chitosan sub-project areas. They have developed international linkages for women in the field of science and technology both through a national as well as an international network of professional collaborators currently disseminating the results of their cutting-edge work through training and technical assistance activities.

4. The types of technologies transferred or developed and their impact on development

The types of technologies transferred or developed under the ATT project were a mix of "high-tech" and "low-tech", and depended upon the circumstances and requirements of individual sub-projects. The technology applied in the case of the set of projects involving seaweed production and agar processing, and the development of shrimp scale processing, has been described as "cutting-edge" and among the most modern in the world.

Advanced bio-technology played a major role under the papaya ringspot virus disease control project, in the development of tissue culture facilities and capabilities using recurrent gene selection techniques. A portable version of an Enzyme-Linked Immunosorbent Assay (ELISA) Unit was provided through the sub-project to apply a rapid diagnostic technique for monitoring virus infection and severity, and to assess inoculation results upon new plants. The goal of the sub-project involving the creation

of new fishery products for export, e.g., surimi and artificial king crab legs, was to identify technology "appropriate" for the development of such products.

An important lesson to be learned from the ATT project is that, in developing countries and particularly in the rural agricultural areas of these countries, the types of technologies used and their development impact are heavily conditioned by the circumstances and needs of the communities in which they are being applied. In those instances in which "high-tech" activities are being implemented, however, it is essential that well-qualified intermediaries be involved in the implementation process.

F. RECOMMENDATIONS AS TO POSSIBLE PROJECT FOLLOW-UP ACTIVITIES

In view of the closure of the U.S. bilateral aid mission in Thailand, the incorporation of ATT-type sub-projects under a USAID regional project would seem warranted. The Team recommends that any such follow-up activities be linked to relevant research efforts currently being pursued by Thailand's National Center for Genetic Engineering and Bio-Technology (NCGEB) and the Aquatic Resources Research Institute (ARRI), to avoid possible overlaps and to take advantage of findings beneficial to agricultural development in the Southeast Asian region.

VI. THE PHILIPPINES: APPROPRIATE TECHNOLOGY INTERNATIONAL (ATI) PROJECT FOR SMALL-SCALE RURAL PRODUCERS

A. THE BASELINE SITUATION

It is estimated that 12 million Filipinos or 20 percent of the population are involved in coconut farming. Within the coconut industry, small-scale coconut farmers, i.e., landholders and tenants cultivating less than 4 hectares, are the most disadvantaged sector of the industry. The small-scale farmers traditionally cultivate the coconuts and process copra, the oil-yielding kernel of the coconut. Few other coconut-based products are made by the vast majority of rural-based communities. Approximately 70 percent of the coconut farmers live in poverty with an average annual income of less than $400.

Despite the low incomes derived from copra sales, most small-scale coconut farmers have not diversified their products, even though a number of these could be produced at the village level. Rural families still need and purchase locally, cooking oil, soap, charcoal and snack foods, all of which could be profitably produced on a small-scale basis in the communities where the coconuts are grown. In addition, promising exports based on coconut waste materials exist. These products could result in significant value-added, and include using coco dust as a peat substitute and coir fiber for mats, planter liners and mattress backings. The lack of coconut product diversification has several causes including lack of technology dissemination, financing constraints, and lack of market information as to which products have sales potential in local and foreign markets.

The majority of coconut farmers process copra using a traditional method involving smoke kilns called "tapahan" that dry the copra with both heat and smoke. The copra produced is generally of poor quality, usually has a high moisture content, and is smoke-contaminated and unevenly cooked. Due to the high moisture content, molds easily develop in the copra when it is stored and high levels of aflatoxin contamination are common.

B. THE MAIN FEATURES OF PROJECT DESIGN

The project, which is still in the early stages of implementation, is being managed by Appropriate Technology International (ATI), a private voluntary organization (PVO) headquartered in Washington, D.C. The organization, which has field offices in Bolivia, Senegal and the Philippines, was founded by the U.S. Congress in 1976 to respond to the needs of low-income micro and small-scale producers in developing

countries, for appropriate technologies that will enable them to increase their incomes through increased value added activities.

ATI identifies technology packages that match the local needs of small producers. It links these packages up with local organizations and helps them develop strategies for demonstrating the use and benefits of the technology to be adopted. ATI provides management, technical, marketing and financial assistance to its local partners and helps leverage project funds. After the demonstration stage, the extension and dissemination of commercially viable technologies are accomplished by establishing small-scale private enterprises that will assure the sustained availability and use of the technology.

The focus of the ATI project in the Philippines is on enabling community-based non-governmental organizations (NGOs) to transfer to low-income coconut farming communities, processing technologies that are commercially viable and that can be readily assimilated into community development programs. The goal of this effort is to work gradually toward introducing technologies that are technically more sophisticated and more costly, but that will enable the communities to gain a greater share of the value added derived from coconut processing and marketing activities. Three locations have been targeted for coconut enterprise activities: Boac, Marinduque; Arbolan, Palawan; and Southern Leyte. These locations were chosen based on the presence of an established and experienced NGO in the area that shares ATI's approach; the existence of a market for coconut products; and the potential for replicating the approach among enterprises in the region.

Total funding contributed to the project by USAID under a grant agreement with Appropriate Technology International (ATI), has amounted to $200,000. In addition, counterpart and other funds valued at approximately $299,000, are being contributed by ATI, the Philippines project partners, and the Royal Tropical Institute.

C. SUMMARY OF PROJECT IMPLEMENTATION EXPERIENCE

The project is being implemented through Memoranda of Agreements between Appropriate Technology International (ATI) and indigenous PVOs in the three regions involved. ATI's target is to establish a minimum of nine micro- or small-scale coconut processing enterprises which are expected to benefit up to 500 people. Before entering into the actual enterprise establishment stage, ATI will have conducted an extensive series of studies in the three regions including a baseline study, a gender analysis study, and studies on technical and marketing parameters. The Coconut Processing and Training Plant located at Los Banos in Southern Luzon, is being used to test the technology package and market acceptance of a series of products which can be produced at project sites as well as to train interested NGOs, extension agents and members of farmers cooperatives.

D. FINDINGS FROM INTERVIEWS AND SITE VISITS

The Study Team met with ATI and USAID staff involved in managing implementation of the project. Meetings were also held with Mr. Victor H. Rodriguez, Chairman of the Board of Marinducare Foundation, Inc., the non-governmental organization (NGO) that is implementing the Marinduque sub-project; Mr. Francisco Soriano, President of the Soriano Multi-Purpose Fiber Corporation, located in Southern Luzon; and with Dr. Ernesto P. Lozada, a Research Professor at the University of the Philippines in Southern Luzon, and the developer of the Los Banos Multi-Crop Dryer.

Mr. Rodriguez informed the Team regarding the plight of low-income coconut farmers on typhoon-prone Marinduque Island, and the difficulties organizations like his face in trying to improve the situation.

Mr. Soriano, whose firm has pioneered in developing and marketing coconut-based products, provided insights into both the technological and commercial ends of the process by which coconut products are produced and marketed. Soriano Fiber is the major exporter in the Philippines of high value-added coconut products such as coco peat, coco soil, coconut planter liners, mats and mattress backings. His principal markets are in the United States, Australia, Europe and Taiwan.

Negotiations are underway between Soriano Fiber and ATI, acting as an intermediary, regarding the manufacture by Soriano Fiber of up to ten fiber processing machines which are to be sold to farmer cooperatives in Southern Leyte and other areas of the Philippines, and used to extract coir fiber and coco dust from coconut waste. Soriano Fiber would then buy the dust and fiber from the farmers as raw material for its line of export products. This venture will provide an opportunity for participating farmers to move up the value-added chain in a rapidly expanding export market, through processing shell and husk waste. A matter for future consideration concerns the extent to which farmer cooperatives can produce the final products themselves and obtain an even greater share of higher value-added export products.

The Team's visit to Los Banos and its interview with Dr. Lozada regarding the process by which he developed a new technology for copra drying, was one of the highlights of the Team's 6-week visit to Asia as it illustrated how extended "high-tech" R&D can make a direct contribution to improving the commercial value of a crop or product produced through labor-intensive "low-tech" farming and processing methods by low-income farmers.

Coconut farmers are accustomed to using traditional kiln-drying methods which require up to three days to dry copra properly; more often they dry for much shorter periods, which results in a low-quality product. The Los Banos Multi-Crop Dryer involves a continuous 24-hour method. The dryer was designed to be as similar as

possible in appearance to the traditional "tapahan" to ensure better farmer acceptance.

The major technological component of Los Banos dryer is a unique burner that generates clean, near smokeless combustion from a variety of agricultural wastes, such as coconut shells, charcoal from coconuts, or peanut shells. At the heart of the burner is a castable refractory material which is the result of years of laboratory research, testing and model refinements by Dr. Lozada. The burner operates for up to six hours without needing to be tended. This allows a farmer to do other farm chores during the day or to rest at night, while the copra drying process is continued.

E. ANALYSIS OF PROJECT IMPACT

The ATI project has been underway for only 18 months, a comparatively short period, and it is too early in the implementation stages to assess the impact the project is having on economic growth and development, on job creation, and on the beneficiary communities and farmers involved. It is significant that the approach being used by ATI is a highly participatory one, involving farming communities at the early stages of the implementation process for baseline data gathering and planning activities. Also, in the wake of project activities completed to date, copra traders in the communities being impacted have begun to offer higher prices, from 10 to 40 percent higher, for better quality copra.

F. RECOMMENDATIONS AS TO POSSIBLE PROJECT FOLLOW-UP ACTIVITIES

The Study Team considers the scale of the project to be too modest compared to the vast number of potential beneficiaries resident in the Philippines and recommends that, in addition to expanding the scale of the project, any follow-up activities include funding for the procurement of the processing equipment needed to enable low-income communities to gain a greater share of the value added derived from coconut processing and marketing activities, the principal goal of the project.

VII. SUMMARY OF FINDINGS RELATED TO PROJECT DESIGN AND IMPLEMENTATION

A. PROJECT GOALS AND OBJECTIVES

While technology commercialization, as such, was the common purpose of the five projects reviewed, the Study Team found that each project has been focused on the achievement of economic and social goals or objectives specific to the development situation of the country in which it is being implemented. Accordingly, a large part of the project design effort in each case has involved establishing approaches that could effectively lead to the achievement of these goals or objectives. This, in turn, has largely determined who would be involved in project-funded activities, the nature and scale of these activities, and the primary beneficiaries.

B. THE LEVEL AND SCOPE OF PROJECT ACTIVITIES

Except for the ATI Project, which has just gotten started, the projects have all to some degree reached the goals which they set out to accomplish, including the STDP Project, despite the 2-year moratorium imposed on its implementation as a result of the military coup in Thailand in 1991. The Team believes, however, that in several cases the level and scope of project activities have not been totally conducive to the achievement of project goals and objectives.

In the case of the STDP project, for example, implementation experience has shown that the project's predominant focus on strengthening Thailand's institutional R&D capabilities did not contribute appreciably toward achieving the commercialization objectives of the project. Similarly, the modest level of funding being provided under the ATI project is basically incompatible with the project's goal of introducing technologies that are technically more sophisticated and more costly. In the case of the TIPS project, the narrow set of business services that are actually being utilized by client firms is incongruent with the broad array of services that have been provided for under the design of the project. Dislocations of this kind are, of course, to be expected in projects that are "experimental" in nature and to some extent "risky"; nevertheless, they do serve to hinder the achievement of project goals and objectives.

C. OTHER FACTORS AFFECTING PROJECT DESIGN AND IMPLEMENTATION

During Team interviews and site visits, a number of factors external or ancillary to the technology commercialization process were identified which affected the design and implementation of the projects reviewed. These factors will need to be taken into account in the design of future technology commercialization projects. They are discussed below.

1. **The countries involved feel a need to develop or acquire innovative technologies to be able to compete for global markets.**

The need to acquire innovative technologies to enhance the ability of local enterprises to compete effectively for global markets was a key element in the design of the PACT, TIPS and STDP projects, and one that has taken on increased importance as global competition for markets has heightened in recent years. The rapid export expansion taking place in East Asian countries was viewed by exporters in India as a matter of particular concern.

2. **The countries involved believe that improving technologies will lead to increases in local value added.**

The acquisition and application of improved processing technologies to increase local value added from domestic production was a key factor in the design of the ATT and ATI projects and was directed to increasing income levels in low-income farm communities. Expanding Thailand's ability to modify existing technologies to increase local value added and foreign exchange earnings from exports emerged as a focus of R&D efforts during implementation of the STDP project.

3. **Cultural resistance to change served in some cases to impede the achievement of project objectives.**

Cultural resistance to change was generally taken into account during project design; however, its potential for impeding the achievement of project objectives was not fully appreciated in some cases. For example, Thai firms were known to rely traditionally on foreign firms to introduce needed technological innovations. Thus, RTG efforts under the STDP project to bolster the R&D capacities of local research institutions, while successful, did not predictably lead to the level of interaction between Thailand's R&D institutions and private industrial firms that was needed to ensure the successful commercialization of innovative locally-generated technological improvements.

Despite the low incomes which they derive from copra sales, most small-scale coconut farmers in the Philippines have not moved to diversify their line of products, even though a number of these could be profitably produced at the village level. The lack of product diversification has several causes including inadequate capacity for technology dissemination and financing constraints, but inertia or cultural resistance to change has also been a contributing factor.

The need to overcome cultural resistance was recognized early on in the design of the PACT project. Human resource development through industry training and broad exposure to the U.S. way of doing things is a key objective of the project.

PACT-funded activities are seen as vehicles for upgrading managerial and technical skills by providing exposure to U.S. companies.

4. **Targetted approaches are needed to reach low-income beneficiaries such as the rural poor.**

The ATT Project, which was designed to introduce and adapt innovative agricultural production and processing technologies to the rural provinces of Thailand, has had considerable success in achieving this objective. The use of well-trained extension agents to serve as technical intermediaries was key to the success of the project; however, the role played by Thailand's Ministry of Agriculture and Cooperatives (MOAC) in targetting low-income farmers in selected geographic areas as project beneficiaries was also a major contributing factor.

The approach being taken under the ATI Project, of using community-based NGOs as intermediaries to introduce technological improvements to low-income coconut farming communities, further illustrates country recognition of the need for using targetted approaches in situations where low-income groups, such as the rural poor, are the intended beneficiaries of technology modernization or commercialization programs.

The Study Team devoted a considerable share of the time spent during interviews and site visits, trying to elicit credible information as to the nature and magnitude of the impact that the five technology commercialization projects were having on secondary beneficiaries. It appears that a significant number were being impacted, but that there would have been a greater number had all of the projects been designed with that objective in mind. The Study Team believes that the design teams for future projects will need to be more strategic about how secondary beneficiaries are to be reached under such projects.

5. **Adequate financing is key to the successful commercialization of innovative technologies**

The importance of finance was particularly evident in the case of several PACT sub-projects which showed considerable market potential but which required drawn-out gestation or prototype testing periods. ICICI took steps to fill this need through the establishment of matching fund contributions and reflow use arrangements. Under the latter, reflows from quick-return activities such as information technology sub-projects are used to sustain other activities with longer-term pay-off prospects, such as bio-technical research activities.

The overall availability of funding and the level of funding per activity were also significant factors under the TIPS and ATI projects in that they conditioned the kinds of assistance that could be provided. TIPS activities were limited to low-cost

consultancies, industry training visits, and visits to trade fairs. Activities under the ATI project were confined primarily to short-term consultancies and community training programs. In both cases, the availability of project funding to procure needed equipment would have greatly facilitated the achievement of project objectives, but overall funding levels and activity caps precluded such procurements.

6. Technology commercialization activities contribute significantly to the achievement of USAID development assistance objectives.

Activities financed under the PACT, TIPS and ATT projects have demonstrated that technology commercialization projects contribute significantly to broad-based economic growth through job creation and spread effects, and to environmental preservation objectives. Various activities financed under the PACT, ATT and ATI projects have addressed particular problems in traditional areas of USAID concern such as health and agricultural development.

7. The bilateral nature of U.S. assistance is a desirable feature of USAID technology commercialization programs.

The bilateral nature of U.S. assistance was singled out as a highly desirable feature of USAID technology commercialization programs by the heads of business firms involved in the PACT and TIPS projects. The specific advantages cited were the direct access which the bilateral approach provided to U.S. sources of technology and U.S. markets, and the management know-how generally offered under bilateral arrangements.

VIII. SUMMARY OF FINDINGS AND CONCLUSIONS RELATING TO THE DEVELOPMENT IMPACT OF PROJECT-FUNDED ACTIVITIES

A. IMPACT ON ECONOMIC GROWTH

The Study has provided clear indications of the effects of technology commercialization on economic growth. The technology commercialization activities being financed under the projects generally involve the development or expansion of institutional R&D capacities, capital investment, or the application or adaptation of new or improved technologies to productive processes. As noted throughout the report, these intermediate activities have, in turn, contributed to increased industrial production and productivity, job creation and expanded trade, i.e., economic activities which form the basis for economic growth. The Team did not attempt to measure in macro-economic terms the impact being registered on the economies of the countries involved, such as contribution to GDP, because of the comparatively small scale of the projects relative to the size of the economies.

The magnitude of impact is measurable, however, at the sub-project activity or firm level. The TIPS project, for example, has been encouraging individual small and medium-scale Sri Lankan manufacturing firms to establish links with suppliers and sources of technology in developed countries in order to obtain the technologies needed to capitalize on export opportunities. For the firms involved, this approach has resulted in an approximate doubling of export sales. Recent increases in the export of selected Thai agricultural products exports can be traced directly to technology activities funded under the ATT Project.

1. The links between technology commercialization and economic growth

As noted earlier, technology commercialization brings about changes in the various intermediary activities which form the basis for economic growth. There are periods when such growth is driven by technological innovation, as is the case in India and Thailand at present, as well as periods when it is retarded because of the failure of an economy to keep up with technological developments, as was the case in India and Sri Lanka during the 1980s.

Direct links between the two processes are clearly evident at the micro-economic or industrial firm level, which is where technology transfer, development and commercialization activities generally take place. At this level, joint venture as well as country-based undertakings aimed at technology transfers and commercialization contribute directly to increased production, job creation, and trade, in ways that are measurable.

The efforts of the SPIC Science Foundation to produce seedlings of improved varieties of coffee and roses, in order to lower the cost of seeds to coffee farmers and increase local coffee production and rose cultivation for exports, illustrate perhaps most vividly the micro-level links between technology commercialization and the economic growth process.

2. **The "componentry" characteristic of modern technology helps to ensure the sustainability of economic growth.**

The ease with which modern technologies can be broken down into discrete components, "packaged" and transferred, coupled with the considerable "spread effects" inherent in the technology commercialization process, help to ensure that economic growth resulting from technology commercialization projects is broad-based and sustainable. This "componentry" feature facilitates the local procurement of supplies as indicated under the PACT, TIPS, ATT, and ATI projects, and illustrates the manner in which the economic impact of technology commercialization projects is extended to a wide range of ancillary industries, and through them to a broad array of indirect or secondary beneficiaries.

3. **The "spread effects" characteristic of the technology commercialization process and the broad sectoral or geographic reach of USAID-funded projects also contribute to ensuring sustainable growth.**

The "spread effects" feature of the technology commercialization process emanates primarily from the establishment by primary beneficiaries of procurement and supply linkages with ancillary firms, and to the need for competing firms to make comparable technological improvements in their productive processes in order to remain competitive. The net effect of the "spread effects" feature as it applies to a country's economic growth process is to enhance the sustainability of the growth process because of the broader underlying impact and support structure that has been established.

A number of the project-funded activities visited by the Study Team have capitalized on these two key attributes of the technology commercialization process. The set of bio-technology sub-projects included under the ATT project in Thailand, which involve seaweed production, agar processing, and the production of chitin and chitosan made from shrimp wastes, is regarded as one of the more successful ATT activities being implemented, particularly because of the "spread effects" which they have generated. A wide variety of innovative products have been developed under the project using state-of-the-art technology for the environmental, biomedical, biotechnological, food processing and cosmetics industries.

When the Globe Active permanent magnet alternator enters its marketing phase, which is to begin shortly, it is expected to have wide-ranging output and

employment effects on the approximately one hundred ancillary small and medium-scale industrial firms currently being contracted by Globe to provide machine parts and castings for production of the alternators. This ability to sub-contract work out to ancillary industries also stems from a second "componentry" characteristic of modern technology i.e., the ease with which material, technological or design inputs from ancillary suppliers, can be blended into the production of a marketable product.

The broad sectoral reach built into four of the five projects reviewed (the Appropriate Technology Project in the Philippines was by design focused on one sector) also helps to ensure that the economic growth resulting from technology commercialization projects is sustainable.

Activities funded under the PACT project are spread over various "high-growth" industries , e.g., information technology and related software development activities, and at least one comparatively "slow-growth" industry, i.e., bio-technology activities involving plant genetic engineering and the production of bio-pesticides and hybrid seeds. This sectoral spread has permitted fund reflows generated from quick-return "high-growth" activities to be used to sustain "slow-growth" activities with longer-term gestation and pay-off periods.

The TIPS project in Sri Lanka has provided technology sourcing and business development services to a vast number of small and medium-scale firms arrayed across eighteen different industrial classifications or sectors. These firms account for a major share of overall industrial output in Sri Lanka and are playing a key role in the development of the economy. The TIPS Project was designed with this broad-based sectoral approach in mind.

The STDP project in Thailand is focused on the establishment and strengthening of R&D institutions that cover some fourteen different technology development and commercialization functions or support services. The comprehensive nature of the support structure has provided the country with the capability to accelerate technological innovations in a number of sectors, and will help to ensure that the economic growth achieved through investment in these sectors is sustainable, once Thailand's own country-based R&D and commercialization processes begin to take hold.

Though limited to three major sectors, i.e, agriculture, aquaculture, and agribusiness, the ATT project in Thailand has funded a sizable number of activities directed toward the development, adaptation and commercialization of technology. The ATT is an "umbrella" project which covers a variety of agricultural, dairy and fish production activities as well as small emerging agro-industries and a range of bio-technological and marketing innovations. The new techniques of farm production, processing, post-harvest care, marketing, and disease control introduced under ATT-funded activities have been instrumental in arresting the decline in Thailand's

agricultural growth rate in recent years and in establishing a sound basis for sustainable broad-based future growth.

4. Economic benefits derived through the local procurement of supplies and raw materials

The emphasis given to the local procurement of supplies and raw materials under projects like PACT, TIPS, the ATT project in Thailand, and the ATI project in the Philippines, has contributed substantially to extending the economic impact of these projects to a wide range of ancillary industries, and through them to a broad array of indirect or secondary beneficiaries.

The production by Globe Scott of a miniature alternator provides a good example of what is involved in this process. Production of the alternator will require inputs of machine parts and castings from approximately one hundred small firms in the Bombay area. The demand for specialized glass and plastic ware from local companies that are ancillary to the tissue culture industry spawned by SPIC's tissue culture experiments in Madras, and the input of Computer Aided Design (CAD) drawings for Laxmi's co-generation system, also represent good examples.

B. IMPACT ON JOB CREATION AND SKILLS LEVELS

The Team's assessment of the impact of project-funded technology commercialization activities on job creation has been focused on determining the extent to which job creation has occurred in the four countries involved as well as in the U.S., directly, as a result of the projects, and indirectly, as ancillary or support businesses have grown up around the firms being aided through the projects. The assessment has also included identifying the social groups that are the main recipients of newly-created jobs, and determining whether significant transfers of job skills and know-how have taken place along with the transfers of technology.

1. Job creation in the four implementing countries resulting from project-funded activities

a. Direct job creation

The Study showed job creation resulting directly from technology commercialization projects to be uneven from project to project. The number of jobs generated to date under PACT-funded sub-projects on average has not been very large. However, a high proportion of the PACT portfolio consists of sub-projects in the information technology, chemical process, pharmaceutical and biotechnology sectors, which have high levels of R&D. These sectors have provided jobs for approximately 200 highly skilled professionals, many of whom have graduate degrees.

For the 48 client companies surveyed during a recent mid-term evaluation of the TIPS Project, full-time jobs roughly doubled within two years of project inception. There has also been a substantial increase in the number of contracted piece-rate workers.

Except for their own staffs, research institutions like those funded under the STDP project are one step removed from the job creation process. Moreover, the adoption by private firms of improved technologies generated by high-tech research institutions is likely to have adverse job retention impact. At the same time, the research approach applied by NECTEC which involves looking for opportunities to improve technology incorporated in existing products to increase Thai exports, will likely have positive impact on job creation in industries that operate well downstream of the R&D stage of technology commercialization; however, this will be difficult to measure.

b. Indirect job creation

Several PACT-funded projects have had job creation impact that has extended well beyond the immediate impact registered on the beneficiary firm itself. The Georgio Foods/Ponds mushroom growing project, for example, in addition to the 400 new jobs created at the site of the processing plant, also generated employment for another 400 to 600 temporary workers in rural areas surrounding the site, as well as contributing to the creation of uncounted jobs in ancillary support plants located near the site.

The impact of PACT-funded activities on the development or expansion of ancillary and downstream industries has had important effects for job creation in both high-tech and low-tech industries. Of particular note is the considerable potential that the LAXMI boiler project has, to create downstream linkages to rural agro-industries (including cooperatives) and to small and medium-scale urban enterprises in industries such as textiles, paper, pharmaceutical, sugar distillery and rubber products.

Globe Active's "state-of-the-art" alternator, which is about to enter its marketing phase, is expected to have wide-ranging employment effects on the approximately one hundred ancillary small and medium-scale industrial firms that are being contracted by Globe to provide machine parts and castings for production of the alternators. Zandu Pharmaceutical Works, Ltd., believes that successful marketing of its product will result in increased employment for low-income farmers growing herbs.

The ancillary manufacturing industries that benefitted when the SPIC Foundation localized its procurement of laboratory glassware and plasticware will

experience even greater benefits with the rapid spread of the tissue culture industry in India. Employment at these firms is expected to increase accordingly.

A key point that emerged from Team interviews with TIPS clients during site visits, was that the sub-projects in which they were participating largely involved small and medium-scale firms whose plants were located in suburban or semi-suburban communities. When the business activities of these firms picked up, they generally hired inhabitants of the communities in which they were located. Secondly, because many of the firms were small or medium scale, the persons hired to fill the jobs created were generally semi-skilled and low-wage workers.

2. Jobs created in the U.S. as a result of project activities

A report prepared by a U.S. consulting firm concerning the impact of the PACT Project on the U.S. economy, noted that U.S. firms participating in 25 of the PACT-funded projects had reported the number of U.S. jobs supported as a result of the successful implementation of PACT-funded sub-projects, at 169. Combining the projected export sales of these firms with a factor used by the Department of Commerce to estimate U.S. jobs supported by U.S. trade, the consulting firm calculated a lower estimate of 115 jobs. Using this same factor, the estimated number of jobs that will be supported from 1993-95 is 277 and for the period 1993-99 is 1,554.

Comparable data regarding jobs created in the U.S. as a result of activities financed by the four projects other than the PACT project were not made available to the Study Team. Inasmuch as these activities did not involve joint venture arrangements with U.S. firms, it is unlikely that they have had appreciable effects on employment in the U.S. Moreover, the STDP project was focused primarily on strengthening in-country research capabilities, and the ATT and ATI projects on raising domestic production and income levels for low-income farmers. The TIPS project was export-oriented, but project-funded activities were very modest in scale and involved primarily the delivery of business development support services through industry visits and visits to trade fairs.

3. Social groups that have been the main recipients of newly-created jobs

a. Semi-skilled urban workers

The interim evaluation of the TIPS project, conducted in August 1993, reported that over 2,800 new jobs were created as a direct result of project-funded activities. A relatively large number of the jobs created were filled by semi-skilled urban workers. A substantial increase in the number of semi-skilled urban workers contracted on a piece-rate basis, was also reported.

The Tea House, also a TIPS beneficiary, currently employs 25 semi-skilled urban workers, most of whom are women. Kelani Cable's expanded ability to produce ballast for fluorescent lamps has created 25 new jobs, with total employment projected at 70 workers. Almost all are semi-skilled urban workers who have been trained on the job.

b. Low-income farmers

Job creation and enhancement for low-income farmers has been achieved in particular through activities funded under the ATT and ATI projects which, as noted earlier, have targetted low-income farmers as project beneficiaries.

c. Workers in home-based or cottage industries

Low-income urban groups are benefitting from the creation of short-term "piece-work" jobs resulting from TIPS sub-contracting to cottage industries. Such groups are also benefitting from similar sub-contracting practices and the expansion of ancillary industries taking place under the PACT project, although such "trickle-down" effects take time.

While aggregate data are not available, an illustration of how significant home-based employment generation may be was provided by one USAID/Colombo official who visited a large toy manufacturer involved in the TIPS program. He noted that the toy-making firm was sub-contracting work to approximately 1,500 home-based workers.

4. The transfer of job skills and know-how along with the transfer of technology

Skills upgrading through industry visits and training was a key feature of virtually all of the PACT-funded sub-projects visited by the Study Team. In several instances the PACT project was credited with contributing to a "reverse brain drain" by creating high-tech jobs and skills upgrading opportunities that had heightened professional and technical staff interest in remaining in India. DCM Limited and SR Associates, for example both saw their joint ventures with U.S. firms under the PACT Project, as vehicles for retaining skilled manpower in India.

The transfer of job skills was a particularly important element in PACT-funded sub-projects in the information technology industries. DCM/Aspect included training and industry visits in their joint venture arrangement as a means of introducing DCM staff to the complexities of a high quality electronic design automation and manufacturing process. SR Associates sent four of its key staff to the U.S. to gain an initial understanding of the technology application process involved in its PACT-funded project.

The Graduate Fellowship Program supported under the STDP project represented a concerted effort to increase the availability of trained professional staff in the three high-tech areas targetted for technology development under that project. Skills enhancement through on-site training was an integral feature of the ATT and ATI projects. Under the ATT project, RTG extension agents gained experience in the technologies needed to produce high-value export and specialty crops, which was then transferred to end-users.

C. IMPACT ON SECONDARY BENEFICIARIES AND THE STANDARD OF LIVING AT COMMUNITY LEVEL

In assessing project impact on secondary beneficiaries and on the standard of living at community level, the Study Team focused in particular on identifying low-income social groups that have benefitted from project-funded activities; on determining the extent to which benefits have affected the standard of living at the community level; and on evaluating the impact of project-funded activities on pluralism and democratic institutions at the community level

1. Low-income social groups that have benefitted from project-funded activities

a. The rural poor

The rural poor have been targetted as beneficiaries under both the ATT project in Thailand and the ATI project in the Philippines. Improvements in the standard of living of the poorest rural groups involved in the ATT project were confirmed through site visits and interviews in North and Northeast Thailand. The incomes of the 8,000 plus farm families who had shifted from subsistence to cash crop farming under the Lam Nam Oon contract vegetable sub-project were reported to have increased by 30 percent from the income levels prevailing at the start of the project. The farmers involved also noted that they had acquired the know-how needed to successfully cultivate new crops, learned to assess and respond appropriately to market conditions, and had achieved the skill and confidence needed to deal with representatives of processing plants and banks.

Members of dairy farmer cooperatives participating in the ATT-funded Dairy Herd Management Improvement sub-project experienced income increases of approximately 15-20 percent per year. Gross incomes were reported to have doubled over a four-year period for the mangosteen farmers of Southeast Thailand, who had participated in an ATT-funded disease-control activity.

A small though representative segment of the 12 million people involved in small-scale coconut farming in the Philippines will benefit from activities being implemented under the ATI project. As noted earlier, approximately 70 percent of the

country's coconut farmers live in poverty with an average annual income of less than $400. The ATI project is focused on increasing the value-added accruing to low-income coconut farmers by spreading the application of improved production and processing technologies for coconut-based products with export potential.

b. Low-income urban groups

Low-income urban groups have benefitted from TIPS sub-contracting to cottage industries, mainly through the higher family incomes that have resulted from short-term jobs. Increased incomes for small-scale urban entrepreneurs, arising from their role as ancillary or supporting industries, were particularly notable in the cases of the PACT and TIPS projects.

c. The "poorest of the poor"

The rural poor groups who are benefitting directly from activities financed under the ATT and ATI projects, and to some extent the urban cottage workers who are being benefitted indirectly by activities financed under the TIPS project, can be characterized as being among the "poorest of the poor" in the countries in which they reside.

Generating impact on specific social groups was not among the original objectives of the PACT, TIPS, or STDP projects. The Team believes, however, based on site visits, that a number of the activities funded under these projects have had substantial impact in terms of jobs, increased incomes, and improved health care on low-income rural and urban groups that might be characterized as being among the "poorest of the poor". Compiling the information needed to assess the extent of such impact, however, would require an extended and more exhaustive research effort than that allowed under the time constraints of the present study.

2. The extent to which project-funded activities have impacted on the standard of living at the local community level

The Study Team found project-funded activities to have impacted on the standard of living at the local community level in essentially three ways: (1) through the employment, increased income and training opportunities afforded workers who are members of communities in which such activities are located; (2) through the subcontracting, local materials procurement, and home-based "piece work" arrangements instituted by primary beneficiary firms with other local community-based firms and workers; and (3) through the impact on local communities of the innovative, lower-cost and improved products and processes that emerge from project-funded activities.

As indicated in the assessment of project-funded activities in Sections II through VI, all five projects have to some extent afforded workers or firms from local communities opportunities for employment, materials procurement and training. The STDP project to a lesser degree than the others because of its R&D and institution-building orientation. PACT and TIPS-funded activities have been sited primarily in urban or semi-urban communities and have impacted primarily on the members of these communities. Similarly, the ATT and ATI projects have impacted almost entirely on the members of rural communities. Sub-contracting, local materials procurement, and home-based "piece work" arrangements with local community-based firms have been a feature primarily of PACT and TIPS-funded activities, mainly because of the predominant fabrication and manufacturing orientation of these activities.

With respect to the impact on local communities of the innovative, lower-cost and improved products and processes that emerge from project-funded activities, the effects in terms of standard of living have in some cases been almost immediate, while in others, they are foreseeable but long-range in nature. The PACT-funded Georgio/Ponds mushroom growing project, for example, has literally transformed the rural community in which it is located within a few years. On the other hand, many innovative PACT-funded projects have the potential to make vast and lasting changes in the standard of living in most of the country's rural and urban communities, but it will take at least a decade for the full impact of these activities to be felt.

The LAXMI co-generation unit, for example, can bring low-cost energy within the reach of even remote rural communities. The Esvin thermal-chemical conversion reactor will improve environmental conditions in the mill towns in which it is installed. Similarly, Four Eyes' efforts to develop a system for the treatment of spentwash will improve environmental conditions in the many communities that are located downstream from distilleries.

The success of efforts by PACT-funded pharmaceutical firms to develop low-cost medicines and drugs for the treatment of debilitating diseases such as cancer and Parkinson's will have important implications for those members of India's communities afflicted with these diseases, particularly the elderly and low-income groups.

Largely because of the $25,000 cap on funds that can be allotted per client (although consecutive multiple grants are allowed), the scale of the technologies transferred under the TIPS project have generally been too modest (lab equipment, etc.) to have had significant direct effects on incomes or the standard of living at community level.

The demonstration effect implicit in the business and trade development activities promoted by the TIPS Project can, however, and often has had considerable impact on local communities. The project has literally plucked small-scale entrepreneurs from closely-knit communities in suburban and semi-suburban areas

(and from delimited communities in urban areas) and transported them to trade fairs in New York and Las Vegas or to factories in industrial cities like Akron, Ohio. TIPS clients visited by the Study Team have noted that such experiences have greatly influenced the way that they conduct their businesses and the way they treat their local employees.

The Managing Director of Midland Tire, for example, upon his return from a TIPS-funded industry visit to tire firms in the U.S., re-designed the layout of his plant floor to improve worker safety and working conditions. He also installed an experimental solar-based energy unit which reduced the plant's energy costs. He told the members of the Study Team that shortly after these improvements were made, he had noted that the productivity of his workers, who were recruited from the small semi-urban community in which the Midland tire plant is located, had noticeably increased.

The Team had no occasion to evaluate the impact of the STDP project at site level. However, the environmental thrust of project-funded research conducted by ARRI, an aquatic research institution, appears to be having considerable and beneficial social and community development impact in areas where it is being applied. As noted earlier, the ATT and ATI projects are targetted on rural communities, and project-funded activities in both cases are having virtually direct impact on the standard of living at community level. The Team saw no need to try to assess the indirect or "trickle-down" effects of these activities.

3. The impact on pluralism and democratic institutions at the community level

The extent to which technology commercialization projects have promoted the empowerment of the poorer disenfranchised sectors of affected societies, particularly the rural sector, can be seen clearly in the ATI project in the Philippines which employed a highly participatory approach, and in the integration of poor subsistence farmers in Northeastern Thailand into the formal sectors of the economy through contract farming. As noted earlier, these farmers now participate more fully in community activities and are generally capable of making their own decisions regarding product marketing and pricing, thanks to the skills and confidence they have achieved in learning how to negotiate effectively with representatives of processing plants and banks.

Yet another example of how workers acquire and strengthen the skills needed to function meaningfully in a pluralistic society is given in the case of Ponds India. Formerly employed as seasonal manual workers in the rural areas of the state of Tamil Nadu, the employees of the mushroom processing plant established by Ponds actively participate in the "quality circle" approach that is being applied to solving employee-related production and productivity problems.

D. THE TYPES OF TECHNOLOGIES TRANSFERRED OR DEVELOPED AND THEIR IMPACT ON DEVELOPMENT

The types of technologies being transferred or developed under the five Asian technology commercialization projects are basically "high-tech" in the case of the PACT and STDP projects and "low-tech" in the case of the TIPS, ATT and ATI projects. The Study Team found elements of both types of technologies being utilized, however, in activities funded under all five projects. This finding has complicated the task of determining the nature and magnitude of the impact on development that can be ascribed individually to the two types of technologies on the basis of the experience gained in implementing the five projects, including the extent to which the technologies and their impact have been "labor-saving" or "labor-intensive".

1. The types of technologies transferred or developed

The types of technologies transferred or developed under the PACT project have been predominantly "high-tech" in nature, inasmuch as they have involved the use or development of a broad range of complex techniques and products including computer-assisted design (CAD) activities, the development of a permanent magnet alternator, high-efficiency miniature motors, robot assembly technologies, sophisticated gear-boxes, thermal-chemical conversion reactors, bio-chemical reactors, and ceramic membrane technologies. The technologies were basically "labor-saving" to the primary beneficiaries of the projects, except to the extent that they generated a need to hire additional staff with requisite "high tech" skills, which was the case in most of the project-funded activities visited by the Study Team.

Technologies transferred under the TIPS project have been characterized by the project's managers as being "hard-tech" or "soft-tech", as opposed to "high-tech" or "low-tech". "Hard-tech" is defined as referring to the transfer of capital goods or machinery and equipment, and "soft-tech", as the provision of business and market development services. Activities funded under the project have been directed toward helping export-oriented labor-intensive small and medium-scale enterprises, and to some extent micro-enterprises, acquire new technologies from U.S. or other developed country sources primarily through industry visits or by attending trade fairs. Actual transactions under the project, however, have generally involved the provision of business and market development services, and have not included transfers of machinery and equipment. The Study Team has, accordingly, classified the project as basically a "low-tech" activity.

The STDP project has involved mainly technology research, development and adaptation activities and is predominantly a "high-tech"-oriented project. The ultimate purpose of the project is to help Thai small and medium-scale enterprises compete globally through the adaptation and assimilation of modern technologies. An important emerging objective of the project is to increase the value-added derived

locally from the production of domestic as well as export goods, by acquiring and adapting "labor-saving" as well as "labor-intensive" technologies.

The ATT project in Thailand was designed to bring "state of the art" agricultural technologies to Thailand, to adapt these technologies to Thai farm conditions, and transfer them to farmers. In its implementation, the project has provided funding mainly for the development and implementation of "low-tech" demonstration and training activities aimed primarily at adapting the innovative technologies to local farm conditions and at assuring that Thai farmers are able to effectively utilize them. The demonstration and training activities, as well as the ensuing farming activities, have been generally "labor-intensive".

The focus of the ATI project is on enabling community-based NGOs to transfer to low-income coconut farming communities, "appropriate technologies" for small-scale coconut processing that are commercially viable and that can be readily assimilated into community development programs. ATI project managers define "appropriate technologies" as including both "high-tech" and "low-tech" technologies. The Team found, as in the case of the ATT project, that the main thrust of the ATI project is to provide funding for the development and implementation of "labor-intensive" demonstration and training activities related to the application of primarily "low-tech" coconut processing technologies. In this case however, as in the case of the ATT project, attention is also being given to adapting innovative and "state of the art" technologies to local conditions and at assuring that Filipino coconut farmers and processors are able to effectively utilize such technologies.

2. The development impact of the types of technologies transferred or developed

On balance, the development impact of the five projects has been a function of both the types of technologies transferred or developed, and the principal economic and social objectives of the projects. In those instances, such as under the PACT and TIPS projects, where obtaining the technologies needed to compete for global markets has been a primary objective, the tendency has been toward acquiring "high-tech" types of technologies to bolster the competitive capabilities of local firms, and the development impact has been essentially economic.

In the case of the ATT and ATI projects, where broad-based rural income generation and increased agricultural production have been major objectives, the general tendency has been toward acquiring "appropriate" or "state-of-the-art" technologies and adapting them to basically "low-tech" farming conditions. The development impact has been reflected in increased social welfare and improved standards of living at the community level. This is not to overlook those occasions, discussed earlier with respect to the two projects, where the "state of the art" technologies have been "high-tech' in design. Generally, in these cases, the effect

has been to accelerate the achievement of project objectives and to enhance development impact.

3. The comparative impact on development of "low-tech" vs. "high-tech" types of technologies

The Study Team found it difficult to assess the comparative impact on development of "low-tech" vs. "high-tech" types of technologies, except in the general terms cited above. Such an assessment is difficult largely because of the modifying effects on development impact that result from cross-cutting factors such as those discussed immediately above; namely, the economic and social objectives of the project being implemented; the mode of technology transfer; the absorptive capacity of the beneficiaries involved; and the approach being taking to utilize, adapt and disseminate the technology. To put it more directly, the implementation experience of the five Asian projects has shown that innovative technologies will have appreciable and desired impact on development, whether they are "high-tech" or "low-tech" or a combination thereof, if they are appropriate to the situation to which they are being applied and can be effectively utilized by the beneficiaries involved in their application.

4. The effects of alternative approaches to technology transfer or development

The varied approaches to technology transfer and development that are being utilized under the five projects have also played a role in determining the extent of development impact registered by the different types of technology, primarily by assuring that appropriate channels or capacities for transferring or developing needed technologies are established Each approach has certain advantages and disadvantages. The varied approaches that have been employed under the PACT project illustrate this point quite well.

a. The effects of the varied approaches employed under the PACT project

Implementation experience under the PACT project has shown that the approach whereby Indian and U.S. companies each perform about half the technical work, and share relatively equally in the expected benefits of commercialization, is the one most likely to lead to a lasting relationship between U.S. and Indian partners. It is also the one most likely to attract an overseas Indian technology expert to repatriate, inasmuch as he retains access to the latest in technological innovations in his field, while also being in a position to capitalize on marketing opportunities in both the U.S. and India. The Globe Auto/Active Technologies joint venture best illustrates the advantages of this approach.

The most problematic of the four approaches has been the one whereby an Indian company implements an R&D program largely on its own, while a U.S. firm

provides technical and research assistance and assists in marketing the product in the U.S. The marketer in the U.S. has on occasion been an Indian transplant whose contacts and knowledge of U.S. market operation are limited. Secondly, there have been several instances in which unforeseen and disruptive changes have been made in management on the U.S. side, essentially subverting the purpose of the joint venture. This approach normally facilitates technology sourcing and market access, however, and is beneficial to the development in-country of ancillary enterprises.

In undertaking research into innovative techniques of tissue culture, the SPIC Science Foundation has used the PACT approach whereby a U.S. company transfers key intellectual property to a private Indian research institution or company. The Indian institution, in turn, develops commercial applications for India. This approach appears well-suited to longer-term research efforts, and has good spread effects and downstream linkage potential, but low immediate impact on job creation.

PACT has funded a large number of activities, particularly in the information technology sector, whereby a U.S. company provides a single high-tech component to its Indian partner who then undertakes R&D incorporating the high-tech component into a locally-made product and implements a domestic and overseas commercialization program largely on its own. This approach leads to immediate high-tech job creation and holds longer-term promise of job creation for secondary beneficiaries. The downside of the approach as it has been applied to date is that there have been instances where the U.S. partner hasn't delivered promised technology. Further, the Indian firm involved has not been able on occasion to deliver on domestic marketing prospects.

b. The more concerted approaches being applied under the other four projects

As noted earlier, under the TIPS project Sri Lankan firms are encouraged to acquire new technologies directly from U.S. or other developed countries through industry visits and by attending trade fairs.

While the project generally has not financed transfers of machinery and equipment from the U.S., almost all of the firms involved have been able to procure needed machinery and equipment from their own resources. As a result, the project has effectively accomplished its goal of increasing the international competitiveness of Sri Lanka's small and medium-scale private sector industries. The sizeable increases in sales registered among participating firms and in project-related exports, indicate that the approach has also had significant and beneficial impact on Sri Lanka's development efforts.

The main thrust of the STDP Project in Thailand has been to acquire needed technologies by bolstering the scientific research and technology development

capacities of the country's universities, public and private research institutions, and private sector business firms. Despite a 2-year interruption in implementation of the project brought on by a military coup in 1991, the institutional development objectives of the project have essentially been achieved. As it has emerged, however, the overall management structure of Thai R&D institutions is more heavily influenced by Government policies and priorities than had been envisaged at the inception of the project. Secondly, private sector interest in participating in STDP programs has been considerably less than anticipated. As a consequence, less emphasis has been directed to the commercialization phases of the technology commercialization process, and the expected impact of the project on Thailand's development process has not been fully realized.

ATT-funded sub-projects were found to have had a substantial impact on the recent resuscitation of Thailand's agricultural economy, following years of decline. Clear evidence of this is reflected in the increased farrner incomes, increased exports, and reduced losses from livestock and crop diseases that have resulted from the implementation of project-funded activities. To a great extent, the success of these activities has been due to the sound and purposeful approach to technology transfer and development pursued under the project.

The approach to technology transfer and adaptation being taken under the ATI project in the Philippines is geared to the comparatively low income status and low absorptive capacity of the coconut farming communities which are the targetted beneficiaries of the project. ATI identifies technology packages with the potential to increase production and processing value added and matches them to the needs of small producers. It then engages local community organizations to help in the development of strategies for demonstrating the use and benefits of the technology. Dissemination of the technologies is accomplished by establishing sustainable private, small-scale enterprises capable of using them to the benefit of the community. An important objective of the ATI approach is to work gradually toward introducing technologies that are more sophisticated and more costly, but that will enable the communities to gain a greater share of the value added derived from coconut processing and marketing activities. It is still too early in the implementation stages of the project to assess the impact that it will have on development in the three low-income rural communities which are involved in implementing the project.

5. The profitability of sub-projects

For activities in which development impact is a key objective, profitability is normally not a suitable measure to use in assessing the success of the activities. It is, however, perhaps the only way to determine the commercial viability of the various innovative, risk-oriented, grant-funded sub-projects being implemented under the five Asian technology commercialization projects. Among the firms visited by the Team under the PACT, TIPS and ATT projects, several were either expanding plant size,

buying non-grant-funded machinery or equipment, or projecting huge increases in sales over the next several years, indicating that they had either already or were expecting at some point to reach a stage of sustained profitability. It is too early in the implementation of the ATI project to determine whether the small-scale coconut processing enterprises to be established under that project will be profitable. It is unlikely at this stage in the implementation of the STDP project, that profitability would be a useful measure to apply in assessing the success of technology commercialization activities under that project, given its focus on strengthening institutional R&D capabilities.

E. THE EFFECTS OF PROJECT-FUNDED ACTIVITIES IN AREAS OF TRADITIONAL USAID CONCERN

1. Agriculture

Technology research, development and adaptation in the agricultural and food development sectors has become essential in some Asian countries. There is a need to get more production from less land, and an urgent need to create new foods and new methods of producing foods to feed rapidly growing populations. This has been the key objective of the ATT project in Thailand. The contribution of activities funded under the ATT project toward achieving this objective have been substantial.

As noted earlier, prior to project start-up in the mid-1980s Thailand's agricultural growth rate had dropped significantly. The average yields of most crops were well below world and regional averages, and were declining.

During the first two years of the ATT-funded Lam Nam Oon sub-project, crop yields per rai increased by 6.5 times. These higher yield levels were maintained through 1993. Milk yields for dairy farmers participating in the Dairy Herd Management Improvement sub-project increased from 7-8 liters per cow per day during the rainy season and 3 liters per day during the dry season, to 12 liters per day throughout the year.

Using new products and methods, losses caused by disease and insects were substantially reduced through the implementation of other ATT-funded sub-projects with a consequent increase in farmers' incomes. Under the Control of Papaya Ringspot Virus Disease sub-project, 8,000 farming households in 18 villages located near the sub-project's center have received disease resistant plants. A definitive solution using a new resistant papaya variety developed under the sub-project is expected to be made available to farmers by the end of 1994.

Increasing food production through technology innovations has been a prime focus of the research activities funded under the STDP project. As indicated in the

mid-term evaluation report for the project, a large proportion of the research proposals approved under the project have involved bio-scientific or bio-technological research in areas related to agriculture and food production.

Product diversification and increasing the value-added accruing to low-income farmers from coconut processing, are the primary objectives of the ATI project. And, as indicated in Attachment H, approximately one-fourth of the business clients being assisted under the TIPS project are engaged in agriculture, food processing and packaging enterprises.

Working under a PACT grant, the SPIC Foundation has attempted to develop improved varieties of coffee and roses that are disease-free through a process called somatic embryogenesis, and to apply existing spin-filter bioreactor technology obtained from a U.S. firm for the mass production of mature embryos. The goal of the project is to produce larger numbers of seedlings of improved varieties of coffee and roses, in order to lower the cost of seeds to coffee farmers and increase local coffee production, and to increase the cultivation of roses for export purposes.

The adaptation of high-yielding mushroom growing technologies to Indian agricultural conditions was one of the major successes registered among the many sub-projects funded under the PACT project. The undertaking has had significant impact on India's agricultural sector, in terms of the jobs created in the rural community in which it is located, through its extensive effects on ancillary support industries, and through market development and increased exports.

2. Health, nutrition and population

Several of the activities funded under the ATT and PACT projects have had positive effects on the health and nutrition of both urban and rural population groups. Similar effects for coconut producing communities are expected to be achieved through the ATI project.

A number of ATT-funded sub-projects have been focussed on eliminating focal points of bacterial and viral infections in livestock, crops and fish products. One of the more significant efforts has involved the control of aflatoxin contamination in agricultural products. The success achieved in reducing the levels of aflatoxin contamination has not only achieved foreign exchange savings by eliminating a major constraint to feed exports, but has impacted on the health of Thai consumers of agricultural, meat and milk products. Papaya, the mainstay of the diet of rural households throughout the northeast of Thailand has been rescued from the spread of a viral disease, primarily as a result of an ATT-funded sub-project that was aimed at controlling and reducing the spread of the disease.

The contamination by aflatoxin of food and feed products in the Philippines is also expected to fall as coconut farmers adopt the improved copra drying process being introduced under the ATI project.

Zandu Pharmaceutical Works, Ltd., a firm based in Bombay, has been provided assistance under the PACT project to facilitate the laboratory research it is conducting aimed at producing low-cost herbal drugs that can be used in the treatment of Parkinson's disease. Trials conducted to date have shown one of the herbal drugs to be effective in the treatment of Parkinson's, with little evidence of disturbing side-effects from usage. According to Zandu, its drug will be from 30 to 40 percent cheaper than conventional formulations presently being used by Indian consumers.

Cipla, Ltd., a pharmaceutical firm based in Bangalore that is also being assisted under the PACT project, is engaged in developing processes that enable it to extract alkaloids, which form the basis for the production of anti-cancer drugs, from indigenous plants using methods that assure greater yields. These more efficient processes are thereby lowering the cost of producing the drugs as well as their cost to Indian consumers.

3. Community development

Project impact on community development has occurred directly under the ATT and ATI projects, given that these projects are targetted on low-income rural farm communities. Except in a few instances, the community development impact of the various types of technologies that have been transferred or developed under PACT and TIPS-funded projects has been indirect. The environmental research mentioned earlier that is being conducted by ARRI under an STDP-funded activity, represents perhaps the only activity being funded under that project that is having significant and direct community development impact.

For PACT and TIPS-funded activities that are having indirect impact, this comes mainly by way of increased incomes for community members that are employed under these activities; through sub-contracts for materials supply, services or piece-work; through improvements in environmental conditions and the establishment of low-cost sources of energy; and through increased community access to sources of outside information for business, educational and recreational purposes.

4. Impact on women

The improvements in production technology and new marketing opportunities brought about through activities funded under the five Asian projects have benefitted both urban and rural women in several ways, e.g., in terms of job creation, income,

control of resources, and division of labor. As might be expected, benefits related to women varied by social group and by technological sector.

Women from poorer urban groups benefitted from new jobs in industries related to the production of consumer goods; in new industries stimulated through technological innovations and access to new markets; and in sectors where they normally represent a high proportion of the work force. Several projects financed under the TIPS Project were particularly beneficial. Women comprise a majority of the skilled workers in gem cutting in Sri Lanka and are important in sectors such as the toy industry where sub-contracting piece work to households is a common practice.

Women in rural households benefitted from opportunities in both the agricultural and non-agricultural sectors. The ATT and ATI projects, for example, have provided a variety of opportunities to increase both household and personal income. Female workers and heads of households are well represented as participants and beneficiaries in the ATT-funded integrated agro-production and marketing, dairy farming, and papaya cultivation projects, and represent a majority of the coconut farmers participating in the ATI project.

Jobs created in the food processing and light manufacturing industries have been claimed primarily by women in the cases of the ATT-supported surimi processing plants, the TIPS-supported flavored tea and plastic bag factories, and the PACT-supported mushroom processing plant.

In the bio-technology and information technology sectors, middle-class women with university degrees have benefitted from job creation and from opportunities for professional advancement through the PACT and ATT projects. In several of the sub-projects visited, such as the SPIC Science Foundation project in Madras, CEICAP's pre-export certification program in Thailand, and the Biopolymer Unit at Srinakarintrvirot University and its spin-off Women in Science & Engineering (WISE-Thailand) training and consulting organization, female scientists constitute a majority of the employees and hold senior level management positions.

In the final analysis, however, the projects have not had an appreciable catalytic impact on women's status in the manufacturing or business firms engaged in implementing project-funded activities nor, except for the ATI project and selected activities under the ATT project, did the Study Team encounter instances in which women as a group were singled out for special treatment or identified as primary beneficiaries. In brief, the projects were not designed to promote a shift upward in the role of women in the technology commercialization process as it is being played out in the traditional societies in which the projects are being implemented. This is unfortunate, given the innovative nature and development orientation of the projects.

5. Environmental preservation and energy conservation

Industrial and agricultural practices are being affected by project-funded technology commercialization programs in ways which were designed to produce results that do contribute to solutions for environmental problems. Among the more significant innovations supported through project-funded activities are the development of integrated waste management and recycling processes for both industry and agriculture; the introduction and increased use of environmentally-friendly manufacturing techniques; and the development and application of energy-efficient technologies which both reduce energy use and promote the use of new and renewable energy sources.

As implementation of the PACT project has proceeded, environmental concerns have steadily been given increased attention. These concerns led to an increased focus on bio-technical projects, specifically those that address environmental problems such as the substitution of biologically-produced pesticides and fungicides for chemically-produced ones; on horticultural and seed improvement projects; and on projects that foster the development of chemical process technologies that use agro-waste materials to generate electrical power in low-income agricultural areas, thereby reducing the country's need to import energy resources.

F. THE EFFECTS OF THE TRANSFER OF U.S. TECHNOLOGIES ON U.S. COMPETITIVENESS IN THE REGION

The Study Team's assessment of the impact of the transfer and adaptation of U.S. technologies on U.S. competitiveness was aimed at determining whether project-funded activities have been beneficial or detrimental to U.S. competitiveness, and whether the impact is problematic only in certain sectors or technologies.

The Study Team did not attempt to measure the effects on U.S. competitiveness of the transfer of U.S. technologies under the PACT project inasmuch as such an effort would require extensive additional research time and effort. The Team did note, however, that the effects appear to vary from sector to sector depending upon U.S. competitive strengths in each sector. The extent of the effects also depends heavily on whether and the extent to which transfers have led to the establishment of close, mutually rewarding relationships between U.S. and Indian business firms that will lead to continued future collaboration.

The comparatively small scale of the Sri Lankan economy and of the industrial and business firms that operate within it, indicate that the transfer of U.S. technologies to these firms is not likely to have serious effects on U.S. competitiveness in any sector. There is some basis for concern, however, that a project like TIPS is providing funding resources to help promote Sri Lanka's access to export markets, including

U.S. markets, while for their part many of the firms being benefitted are buying the technology they need to compete in these markets, from sources other than the U.S.

The thrusts of ATT sub-projects have been directed almost entirely towards alleviating problems affecting low-income farmers in remote rural areas of Thailand and of raising the living standards of the farm population living in these areas. The technologies transferred under the ATT Project have clearly contributed to the success of these efforts. However, the U.S. is clearly not in competition with Thai business firms as regards these efforts.

None of the activities funded under the STDP project have as yet reached the point of commmercialization. An attempt to assess their effect on U.S. competitiveness would be largely speculative. The ATI project involves the production and export of coconut-based products, an area in which the U.S. is not competitive.

Based on its review of project implementation experience, the Team found the information technology sector to be the one sector where the transfer of U.S. technologies might be problematic in terms of its effects on U.S. competitiveness. U.S. competitiveness in the South Asian region, at least, has certainly been eroded to some extent by the transfer of U.S. software development techniques and computer assisted design technologies to India. At the same time, in a sector in which there is at present a comparatively free flow of talent, and where linkages and alliances among information-oriented research institutions and business firms are being formed almost daily in efforts to gain an inside track on the construction of "information superhighways", some degree of erosion is to be expected.

IX. RECOMMENDATIONS AS TO POSSIBLE FOLLOW-ON ACTIVITIES

The Study Team's recommendations as presented below concern both activities that might be pursued to follow up on the implementation experience of the five projects reviewed, as well as actions that might be taken by the ASIA Bureau of USAID pursuant to the Team's discussion of technology commercialization activities with businessmen and government officials involved in the design and implementation of the five projects and related activities.

1. **The PACT Project would benefit greatly by adding to its portfolio of assistance, a range of business services comparable to those being provided under the TIPS Project in Sri Lanka.**

Technology sourcing and market access support services, in particular, are needed to facilitate the process by which small and medium-scale firms in India find suitable business partners in the U.S., and by which they attempt to gain access to U.S. markets. The current process of finding suitable partners appears to be based primarily on personal business connections; relationships established through attendance at U.S. universities or employment at U.S. research institutions; or through the intermediary services of the project's Indian and U.S. advisory councils. While this approach has worked well in selected cases, there is a general need among India's small and medium-scale industrial firms for a more systematic approach to technology sourcing and to the "marketing" end of the technology commercialization process.

2. **It would be beneficial to convert the TIPS Project into a "for-profit" activity.**

The Team endorses the recommendation cited in the recent mid-term evaluation, which suggested that a "for-profit" TIPS-type activity be established in Sri Lanka, with initial support from World Bank and USAID grants and loans, and with the idea that this "private" TIPS would become financially self-sufficient in due course.

The Study Team believes that it would be useful to have a prominent Sri Lankan businessman head up such an enterprise. The objective of the undertaking from the U.S. perspective should be to gain an export advantage for small and medium-scale U.S. firms. The Team believes that World Bank participation might preclude U.S. efforts to establish such an advantage and should, accordingly, be reconsidered.

3. **If there were to be a successor project to the STDP project, it would be useful to incorporate the Support for Technology Assessment and Mastery Program (STAMP) as a key component of the project.**

The Program enables Thai private sector firms to utilize the expertise of the country's leading technologists to help them in procuring new technologies and to instruct them on the effective use of the technologies once they have been procured. This facilitates the participation of private sector firms in technology commercialization activities in Thailand, and enhances the prospects for the commercial success of these activities.

Also, as noted earlier, one of the more significant developments registered during implementation of the STDP project was a shift toward promoting direct interaction between U.S. and Thai private firms in lieu of having a public agency or institution serve as an intermediary. This direct approach is viewed as more likely to produce suitable matches between U.S. and Thai firms, and should be incorporated as a key element in the design of any proposed follow-up activity.

4. **In view of the closure of the U.S. bilateral aid mission in Thailand, the incorporation of ATT-type sub-projects under a USAID regional project would seem warranted.**

The Team recommends that any such follow-up activities be linked to relevant research efforts currently being pursued by Thailand's National Center for Genetic Engineering and Bio-Technology (NCGEB) and the Aquatic Resources Research Institute (ARRI), to avoid possible overlaps and to take advantage of findings beneficial to agricultural development in the Southeast Asian region.

5. **The scale of the ATI project is too modest compared to the vast number of potential beneficiaries and should be expanded.**

Project documents indicate that 12 million Filipinos or 20 percent of the population are involved in coconut farming, and that approximately 70 percent of the coconut farmers live in poverty with an average annual income of less than $400.

The Team recommends that an expanded activity include funding for the procurement of the processing equipment needed to enable low-income rural communities to gain a greater share of the value added derived from coconut processing and marketing activities, the principal goal of the current ATI project.

6. **The Team recommends that the Asia Bureau consider conducting a roundtable conference to discuss beneficiary concerns regarding certain adverse world and local development trends and the extent to which continued USAID support for technology development and commercialization activities might help to reverse these trends.**

Businessmen and agency officials interviewed by the Study Team seem acutely aware of the current state of world development trends, e.g., the rapid technological change, fierce competition for stagnating global markets, rapid population growth, widespread environmental degradation, and diminishing agricultural land frontiers. Their paramount concerns appear to be the heightened competition for global markets, and the fear that population growth in their countries is beginning to outstrip the growth of food supplies. There is also a growing expectation among these officials that the introduction and spread of more efficient and productive technologies can ameliorate the impact that these trends will have on economic and social development prospects in their countries.

Topics for discussion might include the need to create new kinds of food products to offset diminishing agricultural land frontiers; promoting the increased use of agro-waste materials for environmentally-safe energy generation; accelerating programs to neutralize toxic chemicals; steps that might be taken by developing countries to realize greater value added from exports through increased in-country technology modifications and improvements; and the prospects of inventing and distributing really effective low-cost methods of contraception.

7. **In the event that such a conference results in a decision to undertake follow-on or future technology commercialization projects, it is recommended that the Bureau take steps to:**

   a. **Combine the best design features of the technology commercialization models or approaches that have been applied to date.** Inasmuch as the approaches used for the five projects reviewed were necessarily limited and selective, and no one project covered the broad range of activities incorporated in the overall technology commercialization process, gaps in implementation did occur. There were mismatches of joint venture partners under the PACT project; TIPS clients went elsewhere to sources other than the U.S., to purchase needed machinery and equipment; and high-tech research experts again became lab-bound in Thailand while the downstream linkages with local private firms needed to effectively commercialize innovations were never effectively established. An approach based on the combined experience of the five project would enable a design team to head off the recurrence of similar gaps.

b. **Link future projects more closely to current USAID development assistance strategies.** The areas of concentration currently at the center of the Agency's strategies for assisting development include promoting programs to preserve the global environment, strengthening democracy and pluralism where needed in developing countries, encouraging broad-based economic growth, and stabilizing world population growth. As indicated earlier, technology commercial projects can contribute substantially to the achievement of objectives related to environmental preservation and broad-based economic growth.

c. **Build into project design stronger links to the private sector to enhance commercialization prospects.** As noted earlier, Thai government efforts to commercialize locally-generated technological improvements under the STDP project were not particularly successful, primarily because of the lack of effective interaction between domestic R&D institutions and private industrial firms.

d. **Provide for a greater share of the benefits of technology commercialization to be directed to secondary beneficiaries.** The Study indicated that technology commercialization projects need to be more strategic about how secondary beneficiaries are to be reached. The ATT and ATI projects illustrate how this might be accomplished.

e. **Utilize "state of the art" technologies where feasible.** The ATT Project has demonstrated that "state of the art" technologies can be successfully applied to the benefit of low-income beneficiaries.

f. **Encourage community-based NGOs to become more involved in technology commercialization efforts.** The gainful role played by community-based NGOs in introducing technological improvements to low-income coconut-producing communities under the ATI project, indicates that such organizations are well placed to perform a similar function in connection with the implementation of other community-oriented technology commercialization activities.

APPENDIX A

APPENDIX A

ASIA TECHNOLOGY COMMERCIALIZATION STUDY

SCOPE OF WORK

BACKGROUND

The Asia Bureau has invested approximately $150 million in a number of bilateral projects that fall under the broad heading of technology commercialization. These bilateral projects were prompted in part by an Agency-wide strategy for research and technology development initiated in 1983. The strategy reflected the conviction that research and technology development were critical for industrial growth and economic development which would ultimately facilitate social progress in the developing countries. However, due to shrinking development resources and emerging issues such as U.S. competitiveness in Asian markets, there has been an increased need to document the development impact of technology commercialization programming and to identify the specific social groups that have benefitted from these projects.

The study will examine these issues in greater detail to determine the ultimate development impact of such projects on economic growth, job creation, and standard of living at the community level. The study also will examine the types of technologies that have been transferred through projects and the positive and negative effects of such transfers on U.S. competitiveness in the region or in third markets.

STATEMENT OF WORK

The contractor shall prepare a report based on a study of the following bilateral and USAID/W projects in Asia:

India: Program for the Advancement of Commercial Technologies (PACT)

Sri Lanka: Technology Initiative for the Private Sector (TIPS)

Thailand: Science and Technology for Development Project (STDP) , and Agricultural Technology Transfer (ATT)

Bangladesh, Indonesia or Philippines: HealthTech (HT) or Appropriate Technology International (ATI)

I. SPECIFIC AREAS OF STUDY FOCUS

A. **Beneficiaries:** The primary beneficiaries of technology projects are often technology users in the public and private sectors. The current study will attempt to identify additional or secondary beneficiaries by answering the following questions:

- Have project activities directly or indirectly resulted in improved living standards for the poorest of the poor?

- Can "trickle down" of benefits from firms or institutions participating in projects to community members be established and documented?

- Which social groups have benefitted from projects and how have they benefitted?

- What have been the direct or indirect effects of project activities on traditional development sectors such as health, agriculture and population?

B. **Job creation:** Firms utilize technology development and acquisition to meet new market demands domestically and abroad. The current study will ask the following questions regarding job creation due to technology driven growth of firms:

- What is the extent of job creation that has occurred in the host country as a direct or indirect result of the project?

- Which social groups have been the recipients of jobs created in the host country?

- Have jobs been created in the U.S. as a result of project activities?

- Has there been an increase in jobs in the community as support businesses grow up around larger firms that have been aided through projects?

- Has there been an appropriate transfer of job skills and know-how along with the transfer of technology?

C. **Economic growth:** It is a widely held view that research and technology development are critical for economic growth. The Agency is currently reviewing economic growth issues and options which will form the basis

for the development of policy guidelines and an Agency-wide strategy in this area. The following questions explore the links between technology development and commercialization and economic growth:

- Are there clear examples of project effects on economic growth?

- What are the direct and indirect effects of technology projects on economic growth and how are these effects measured?

- Is economic growth attributed to technology commercialization project sustainable?

D. **The types of technologies transferred or developed:** The technologies developed or transferred through projects range from low to high tech. The following questions address the development impact of technologies in varying categories:

- What is the ratio of high-tech to low-tech technologies transferred or developed through each project?

- What is the comparative development impact of low versus high technology transfers through projects?

- What is the ratio of labor saving to labor intensive technologies that have been transferred through projects?

E. **Effects on U.S. competitiveness in the region:** Policy makers have recently begun to question the wisdom of transferring U.S. technologies into advanced developing countries that are potential U.S. competitors. This study will address these concerns by answering the following:

- Are technology commercialization projects largely beneficial or detrimental to U.S. competitiveness in the region?

- Have projects resulted in conflict with U.S. business in third markets?

- Is competitiveness problematic only in certain sectors or technologies (e.g., high technologies)?

- Can technology commercialization projects have a significant development impact at a low-tech level that clearly does not conflict with U.S. competitiveness?

- Would it be practical to develop a "low-tech criteria" as a screen which would eliminate transfer of high technologies in bilateral or regional projects?

F. **Project design and measurable development impact:** Each project was designed to work within the specific economic, regulatory, financial, and social conditions of the host country. Thus, the projects include several distinct approaches or models for technology commercialization, which are discussed in the Proceedings of the Technology commercialization Workshop, Singapore 1991. To explore the utility of each model and future project design the report shall include:

- a description of the rationale for the technology commercialization model implemented in each country;

- a discussion of the success of each model in achieving the original objectives as well as the types of broader development impacts outlined above;

- a general analysis of the advantages and disadvantages of each model for achieving the development benefits outlined above;

- recommendations for follow-on activities that might be implemented in each case in an effort to enhance project impacts particularly in the specific areas outlined above; and

- recommendations on the advantages and disadvantages of augmenting technology commercialization efforts through regional versus bilateral activities.

II. PREPARATORY WORK IN THE U.S.

During the first two weeks of the contract in Washington, DC the contractor shall use the general questions outlined above to develop a workplan that will include the development of appropriate study methodology(s) with input from, and subject to approval by Asia/DR/TR. This shall include the development of questionnaires appropriate for interviews with various groups involved in each project including: project managers, government officials, universities, NGOs, U.S. and host country firms, employees, community members, and any other potential beneficiaries.

During the two week preparation period the contractors shall identify the appropriate contacts in each country that will facilitate efficient collection of relevant information during TDYS. Asia/DR/TR will assist the contractors in the identification of such

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contacts. Additional preparatory work shall include the collection and review of all relevant materials as well as consultations with government agencies and NGOs that may have relevant information particularly on the U.S. competitiveness issue.

Each of the projects has been formally evaluated at the midterm and/or end of the project (the midterm evaluation of TIPS is scheduled for July, 1993). Additional informal studies aimed at measuring the development impact and ultimate benefits of projects have also be conducted by some of the missions. The contractor shall obtain and review these documents as part of the design of the study methodology(s) in an effort to avoid embarking on analyses that previously have been performed by the missions.

III. REPORT FORMAT

The Final Report shall follow the standard A.I.D. format and include an Executive Summary, List of Acronyms, Table of Contents, Body of Report and Appendices.

The Body of the Report should provide information (evidence and analysis) on a project by project and aggregate level. The report should end with a full statement of conclusions and recommendations. Conclusions should be identified by a short sub-heading corresponding to the questions posed in the Scope of Work. Recommendations should correspond to the conclusions.

The Appendices should at a minimum include:

a. The study scope of work;

b. A description of the methodology used for the study;

c. A bibliography of the documents consulted; and

d. A list of the agencies, firms and individuals consulted.

APPENDIX B

APPENDIX B

STUDY METHODOLOGY

ASIA TECHNOLOGY COMMERCIALIZATION STUDY

PREPARATORY WORK IN THE U.S.

During the first two weeks of the Contract, the Study Team reviewed documents provided by ASIA/DR/TR related to the design, implementation and evaluation of the five projects being analyzed. On the basis of this review and consultation with the Director of ASIA/DR/TR, the Team developed a comprehensive workplan for carrying out the proposed study, including a schedule of travel, project interviews, and site visits. USAID and Indian counterpart staff who had been involved in project design and implementation activities, and who were to serve as principal contacts in each of the four countries to be visited, were also identified.

In addition, the Team developed general profiles of the design characteristics of each project, such as the models or approaches being used to develop, transfer and commercialize innovative technologies. The Team also formulated questionnaires for use during interviews and site visits regarding the development impact of the five projects as measured in terms of their effects on economic growth, the extent to which job creation had occurred, their impact on community development efforts and low-income beneficiaries, and the extent to which the projects had affected U.S. competitiveness in the sector or country being assisted.

INTERVIEWS AND SITE VISITS ABROAD

Upon arrival in each of the four countries involved in the review, the Study Team was given a finalized schedule of interviews and site visits, briefed on the progress of project implementation and project impact by USAID staff, and escorted to interviews and site visits by representatives of the implementing agencies. The country visits were normally capped by Study Team debriefing sessions attended by USAID and implementing agency staff.

THE DRAFT AND FINAL REPORTS

A draft report was prepared upon completion of the overseas travel, and submitted to ASIA/DR/TR for review and comment. The Study Team then prepared a final report taking account of the comments that had been received from ASIA/DR/TR and from USAID project officers in the four countries visited.

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APPENDIX C

APPENDIX C

ASIA TECHNOLOGY COMMERCIALIZATION STUDY

SITE VISITS AND PERSONS INTERVIEWED

MEETINGS IN THE UNITED STATES

Washington, D.C.

Appropriate Technology International
Ann Koontz
Program Development Officer/Asia

DynCorp Meridian Corporation
Gerard Helfrich
Senior Scientist

USAID/ASIA/SA
Thomas H. (Tobey) Pierce
Nepal/Sri Lanka Desk Officer

MEETINGS IN INDIA

Bombay

Frontier Software Development (India) Pvt. Ltd.
Shirish Deodhar
Director

Globe Active Technologies Ltd./Globe Scott Motors Pvt. Ltd.
Rajan Zatakia
Managing Director/Director

The Industrial Credit & Investment Corporation of India Ltd., Scindia House
P. D. Shedde
Assistant General Manager, PACT Division

U. A. Deshpande
Deputy Manager, PACT Division

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Somak Ghosh
PACT Division

Zandu Pharmaceutical Works Ltd.
D. M. Parikh

Bangalore

Aspect-DCM Pvt. Ltd.
C. H. Sakharwade
Project Manager

B. R. Satyanarayan
Manager Data Production

Laxmi Boilers (South) Pvt. Ltd.
S. B. Iyer
Technical Director

Dr. A. Jaganmohan

Pond's (India) Limited
Balu S. Iyer
Chief General Manager, Mushroom Division

SAN Engineering & Locomotive Co. Ltd.
K. N. Vadirajachar
Vice-President, Marketing

S. Krishnan
Works Manager

Technology Development and Information Company of India Limited (TDICI)
K. S. Nadkarni
President

Turbo Tech Precision Engineering (P) Ltd.
B. R. Krishna Kumar
Managing Director

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Madras

Esvin Advanced Technologies Limited
S. Viswanathan
Chairman

T. S. Venkataraman
Managing Director

G. Ramanathan
General Manager (Sugar Group)

Dr. S. Narender Sivaswamy
Group Leader (Bioprocessing)

Fuller K.C.P. Limited
S. S. Sidhu
Director and President

SPB Projects and Consultancy Limited
U. Gururaja Bhat
President

SR Associates (Software) P Ltd.
S. Srinivasan
Managing Director

T.V. Sriram
General Manager, Commercial

New Delhi

USAID Mission/New Delhi
R.K. Berry
Project Officer

MEETINGS IN SRI LANKA

Colombo

Asian Toy Company (Pvt) Ltd.
Mahendra Soysa
Managing Director

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International Executive Services Corps
Karen Muir
Project Officer

Jaya Hastha Toy Company
Jayantha Fernando
Designer Wooden Handicrafts

Kelani Cables Ltd.
J. M. S. Jayasinghe
Director Technical

Midland Retreads (Pvt) Ltd.
Palitha Jayatissa
Managing Director

Gamini Herath
General Manager

Proplanka (PVT) Limited
Mahinda Suraweera
Director

Technology Initiative for the Private Sector (TIPS)
Lorne G. Olsen
Chief Executive Officer

Keith Bernard
Director, Monitoring & Evaluation

Sujeewa De Alwis
Deputy Director, Projects Development

USAID Mission/Colombo
William Foerderer
Environment & Natural Resources Officer

Nissanka Weerasekera
Project Management Specialist
Office of Private Sector Development

MEETINGS IN THAILAND

Bangkok

Agricultural Development Research Center
Dr. Waewchak Kongpolprom
Director

Aquatic Resources Research Institute
Dr. Piamsak Menasveta
Director

Center for Export Inspection and Certification of Agricultural Products (CEICAP)
Pornpimol Leiangsuthi-Sakon
Chief

Chulalongkorn University
Dr. Manuwadi Hungspreugs
Professor, Department of Marine Science

Department of Livestock Development
Siriwat Sarobol
Director, Animal Husbandry Division

Division of Plant Pathology and Microbiology
Prawat Tanboon-Ek
Department of Agriculture, Kasetsart Campus

Fishery Technological Development Institute
Pongpen Rattagool
Director, Department of Fisheries

Horticultural Research Institute
Sermsak Raktham
Medicinal Plants and Spices Specialist
Department of Agriculture

Ministry of Agriculture and Cooperatives
Thana Thongton
Planning and Special Projects Division
Office of the Permanent Secretary

Mycology Branch Division of Plant Pathology and Microbiology
Prapaisri Pitakpaivan
Department of Agriculture

National Center for Genetic Engineering and Biotechnology
Dr. Sutat Sriwatanapongse
Deputy Director, Plant Breeding

Kruawan Potisombat
National Science and Technology Development Agency

National Electronics and Computer Technology Center
Dr. Pansak Siriruchatapong
Deputy Director

National Metal and Materials Technology Center
Dr. Krisda Suchiva
Deputy Director

Dr. Anucha Euapermkiati
Research Associate, Polymer Science

National Science and Technology Development Agency
Professor Naksitte Coovattanachai
Deputy Director

Dr. Sudhiporn Patumtaewapibal
Director of TIAC

Dr. Sumol Pavittranon
Coordinator

Dr. Wantanee Chongkum
Industrial Consultancy Services Coordinator

Northeast Regional Office of Agriculture
Vilai Prasartsee
Plant Pathologist

Srinakarintrvirot University
Suwalee Chandrkrachang
Assistant Professor, Department of Chemistry
Biopolymer Research Unit

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Thailand Development Research Institute Foundation
Dr. Nit Chantramonklasri
Director, Science and Technology Development Program

USAID Mission/Bangkok
Thongkorn Hiranraks
Project Management Specialist

Karoon Rugvanichje
Project Officer, Office of Technical Resources

Chiang Mai

Chiang Mai Livestock Breeding and Research Center
Tawatchai Indratula
Director

National Dairy Training and Applied Research Institute (NDTARI)
Dr. Somkid Promma
Dairy Cattle Nutritionist

Chiang Rai

Chiangrai Horticulture Research Center
Montri Dasananda

Lam Nam Oon

Royal Irrigation Department
Vichal Sngaunpaiboon

Contract farmers

Khon Kaen

Agriculture Development Research Center in Northeast Thailand
Dr. Waewchak Kongpolprom
Director

Northeast Regional Office of Agriculture
Vilai Prasartsee
Plant Pathologist

MEETINGS IN THE PHILIPPINES

Manila

Appropriate Technology International (Philippines)
Angelito Lim
Accounting & Operations Officer

Francisco Tolentino
Project Officer

Marinduque Foundation, Inc.
Victor H. Rodriguez
Chairman

Soriano Multi-Purpose Fiber Corporation
Francisco Soriano
President & General Manager

University of the Philippines at Los Banos
College of Agriculture and Agro-Industrial Technology
Ernest P. Lozada, Ph.D.
Professor

USAID Mission/Manila
Sibel Berzeg
Project Officer

APPENDIX D

APPENDIX D

ASIA TECHNOLOGY COMMERCIALIZATION STUDY

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APPENDIX E

APPENDIX E

ASIA TECHNOLOGY COMMERCIALIZATION STUDY

LIST OF PACT PROJECTS VISITED BY TYPE OF TECHNOLOGY COMMERCIALIZATION MODEL EMPLOYED

The four models or approaches to technology commercialization employed under the PACT Project are cited below, along with a listing of the Indian/U.S. firms involved in the joint venture and the Indian firms visited by the Study Team for each of the four approaches.

1) An Indian company implements an R&D program largely on its own. Its joint venture U.S. partner provides technical and research assistance and assists in marketing the product in the U.S.

   Pennwalt India Ltd./Pennwalt Corporation in Bombay
   Development of a process to dewax rice bran oil.

   Cipla Ltd./Byron Chemicals in Bangalore
   Development of a process for manufacturing anti-cancer agents.

   Zandu Pharmaceutical Works, Ltd./Zandu U.S. in Bombay
   Development of herbal drugs for the treatment of Parkinson's disease.

   Globe Scott Motors/Ecoair Corporation in Bombay
   Development of an environmentally safe air conditioning system.

2) Indian and U.S. companies each perform about half the technical work, and share relatively equally in the expected benefits of commercialization.

   Globe Auto Ltd./Active Technologies Inc. in Bombay
   Development of a permanent magnet alternator and allied electronic controls.

   Ponds India/Georgio Foods in Madras
   Production of high-grade button mushrooms using unconventional materials.

3) A U.S. company transfers key intellectual property to an Indian company; the Indian company develops commercial applications for India.

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SPIC Science Foundation/DNA Plant Technology in Madras
Development of improved varieties of seeds by tissue culture, using a bio-reactor.

4) A U.S. company provides a single high-tech component. The Indian partner undertakes R&D incorporating the high-tech component and implements a domestic and or overseas commercialization program largely on its own.

Frontier Software Development/Frontier Software in Bombay
Development of a LAN management system.

Four Eyes Research/Alcoa in Pune
Spent-wash treatment using membrane extraction technology.

Precision Automation & Robotics/Comutech Robotics in Pune
Development of low-cost high-performance industrial robots.

Laxmi Boilers/Barber-Nichols Engineering in Bangalore
Development of an energy co-generation system.

Esvin Advanced Technology Ltd./Manufacturing & Technology Conversion, Inc. in Madras
Development of an indirect gasification (thermal-chemical conversion) reactor.

SR Associates/CyberMedia in Madras
Development of computer disk and file management systems.

APPENDIX F

APPENDIX F

ASIA TECHNOLOGY COMMERCIALIZATION STUDY

CLIENT SERVICES PROVIDED UNDER THE TIPS PROJECT
(Arranged by Client Class and by Type of Service)

No.	Client Class	Code	Type of Service
1.	Agriculture, Food Processing & Packaging	SI	Statistical Information
2.	Machinery & Metal Prods, Elec. & Transport Equipment	SS	Supplier Search
3.	Construction, Development & Building Materials	TA	Technical Assistance
4.	Textile & Apparel Manufacturing	TSA	Trade Show Assistance
5.	Communication, Transportation, & Utility Services	TE	Technology Exposure
6.	Wholesale & Retail Merchandizing	CP	Commodity Purchases
7.	Chemical & Petroleum Products	COL	Collaborations
8.	Mining & Metal Refining	COMS	Communications Support
9.	Banking & Finance	CONS	Consultancy Assistance
10.	Paper, Printing & Publishing	MA	Marketing Assistance
11.	Health, Education & Insurance	RTA	Reconnaissance Trip Assistance
12.	Governmental Administration	SA	Sampling Assistance
13.	Miscellaneous Industries and Services		
14.	Gems & Jewelry Manufacture		
15.	Rubber Products		
16.	Ceramic & Clay Products		
17.	Wooden Products		
18.	Plastic Products		

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