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Summary
Study Tour from Pakistan
COMMERCIALIZATION OF RESEARCH

Board on Science and Technology
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STUDY TOUR IN THE UNITED STATES BY AGRICULTURAL LEADERS FROM PAKISTAN

COOPERATION BETWEEN PUBLIC RESEARCH AND THE PRIVATE SECTOR

Introduction

This report presents the initial findings of a study tour in the United States by agricultural leaders from Pakistan, to review technology transfer and cooperation between researchers and the private sector. The tour was motivated by the concern that addressing the food needs of Pakistan's rapidly increasing population will require a strong research program focused on national needs and coupled to a motivated private sector for practical applications, and to public or private extension for farming techniques and methodologies. In this way research can address national needs and the findings can be effectively transferred to agribusinesses and the farmer. The study tour, and this report, are intended to provide a framework or context for a later discussion on actual changes that may be desirable in Pakistan in order to make agricultural research and its transfer more effective.

One of the most important processes in social and economic development over the last fifty years has been scientific discovery, development of the discovery to a technology that can be transferred, and finally acceptance and use of the technology by an end user. This process is not a one-way street but a continuous interaction between those developing the technology and those familiar with markets for the technology.

Governments typically recognize the importance of technical innovation and provide state support to scientific research and technical development. Goals and investments in R&D are high, but the final results in terms of measurable effects on output, are variable across countries. Conversion of scientific discoveries into innovative products and processes is a key step in development. Pakistan has a well-established agricultural research system but a slower rate of application and adoption of research discoveries by the agricultural industry and by farmers.

Agriculture is the largest sector in the economy of Pakistan and is a source of both capital and labor for industrialization in the country. Agriculture accounts for 28 percent of GDP and employs over 50 percent of the labor force. Agriculture-based products account for 80 percent of export earnings. But agriculture in Pakistan has developed slowly and a strong private sector of agro-industries, servicing farmers and processing farm products, has not evolved as rapidly as might be expected. Agricultural research has yielded high returns in several areas, including cotton production.[1] Thus, Pakistan is in a position to build on its investments in agricultural science, and the basic building blocks are in place:

- a strong agricultural research tradition and the physical infrastructure to support it

[1] See "High Economic Returns from Investment in Agricultural Research", PARC, Islamabad, 1991.

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- a central coordinating body for agricultural research, PARC
- provincial research centers supported by provincial funding
- a private sector with interest in commercializing new technologies
- an extension service in place to introduce new techniques and applications to farmers, and
- a group of progressive farmers looking for ways to make farming more productive and rewarding

The question is how can the existing complex for research and development be modified with new processes and vehicles so that innovations and discoveries in agricultural science get converted as quickly as possible into applications useful to agribusiness and the farmer. The study tour was organized to learn from the U.S. experience in agricultural technology transfer and discuss how the models and mechanisms could be adapted to enhance agricultural productivity in Pakistan. Of special interest is how the process of agricultural technology transfer could be made attractive to the private sector.

The report is organized in the following way: First, the components of the study tour are described. Second, a summary of findings is presented. Third, appendices provide a summary of the orientation meeting, the study tour meetings, and the final panel meeting.

Components of the Study Tour

Orientation

The study tour began with an orientation meeting in Washington, DC in which leaders from U.S. Department of Agriculture (USDA), U.S. Department of Commerce, National Science Foundation, World Bank, and National Research Council introduced the way science and technology is carried out in the U.S. and in their institutions, and how public research cooperates with the private sector to make use of research findings.

Visits to Agricultural Institutions

The second part of the study tour involved half- to full-day visits to the following public and private institutions:

- USDA, Beltsville
- National Institute of Standards and Technology (NIST), Department of Commerce
- Agricultural Products Division, E.I. Du Pont de Nemours & Company, Wilmington, Delaware
- Iowa State University and agribusinesses in the Ames, Des Moines, Iowa area

- University of Florida
- North Carolina State University and Research Triangle Park

These institutions were selected for their accomplishments in technology transfer involving agriculture, for variety in their technology transfer programs and for their different stages of development, also for locations that would allow the tour to be completed within two weeks.

Panel Meeting

The Pakistani members returned to Washington for a two-day panel meeting to review their findings from the tour, establish the strengths and weaknesses in the current interaction of public research and the private sector in Pakistan, record the gaps in knowledge of the system for which papers would be commissioned, and begin to establish the framework for a strategy that would enable Pakistan to establish a strong and effective collaboration between public research and the private sector in agriculture.

Summary of Findings

The goal of many countries is to increase agricultural productivity through more private sector activity in the application of research findings. The following policy suggestions for Pakistan appear to be justified on the basis of experience from the study tour in the United States and what is known of other countries.

Policy Framework for Technology Transfer

1. There is no single law, action, or model that is correct for Pakistan, or for any country, when attempting to encourage technology transfer. Rather, a framework is needed that provides a consistent and stable set of laws, rules, incentives and institutions, tailored to the particular cultural and socio-economic conditions of Pakistan. Some of those attributes are already in place. Some may need to be modified. And some may need to be added.

2. For successful technology transfer, the policy emphasis of government evolves with levels of development. During the early stages of development, governments concentrate on development of the physical and institutional infrastructure for modernization--establishing universities and research capabilities. As development progresses, political effort moves to emphasize policies that encourage private research and technology transfer. Governments in this stage still need to invest in the infrastructure for development and in a broad range of applied and adaptive research. Finally, when countries reach the stage in development where infrastructure and policies are no longer major constraints to private research, the government will move its emphasis to developing policies that encourage the private sector to invest more in research. Applying research findings then becomes part of that process for the private sector. The process of technology transfer is then completely integrated into the national research effort.

3. Agricultural policy has an important impact on investment in research and on adoption of any technologies from it. When governments intervene in the pricing, trade, marketing, or storage of agricultural products, they reduce the profitability of farming, and those policies will also lower the

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domestic profitability of research and technology, and its transfer to agribusiness and farmers.

4. Research leads to knowledge that can provide production possibilities for agricultural products. But the fact that a new technology is discovered does not mean that it will be adopted. First, the innovation must be developed into a product or commercial practice, and then the process of adoption and diffussion takes place. Companies must be free to commercialize the products they develop through research. For companies to profit from transfering their technology into a commercial product or practice, the innovation must be "shielded" or protected from infringement so that the seller can capture the profits and recover the high costs of development. A key for successful commercialization is to have in place laws that protect intellectual property rights through patents and a legal system that strictly enforces patents.

5. Where an innovation cannot be protected by a patent, the private sector is unlikely to invest significantly in it. If this innovation is likely to benefit the Pakistan economy, the value of public investment in that R&D might be weighed in terms of costs and benefits to the society. In agriculture, mechanical and chemical innovations tend to be shielded, and therefore fall into the domain of the private sector. Agronomic innovations are generally not shielded and are usually undertaken by the public sector. Public research has provided most of the new seed varieties, while seed companies prefer to develop hybrids where the technique of hybridization provides them with shielding. The advent of biotechnology makes biological innovations more shieldable.

6. Laws or regulations should be reviewed to ensure they encourage private research. Many countries provide tax incentives for firms undertaking R&D.

7. Even when innovations are patented and the private sector is supporting research, there is still a role for public support of R&D. Private companies seldom capture the full value of their innovations and do not have the incentive to support the optimal level of R&D. An explicit public policy encouraging private research and technology transfer is key to establishing a strong interaction between private and public sectors. Typical interventions include strict protection of property rights, tax incentives for R&D, cost sharing of private R&D activities, and provision of public R&D facilities and faculty for collaboration on a contractual basis. In the U.S. more than half of the research on food and agriculture is funded by the private sector, and much of this is undertaken in private sector laboratories.

8. The allocation of public funding to applied versus basic research changes with the level of development of technology transfer. Initially it is efficient to undertake mainly applied and adaptive research, relying on industrial countries to provide ideas and opportunities from their basic research. As markets and the private sector mature, it becomes appropriate for the public sector to withdraw from some applied research, allowing the private sector to take over or share the cost. At this stage public funding is better invested in long-term, high-payoff, high-risk research or on nonshielded applied research. Given the long and uncertain payoffs of basic research, some high-income industrial countries have chosen to undertake only applied research. The public sector must also concern itself with issues broader than commercial agriculture. It must be concerned with the consumer side--food safety, health and nutrition, and environment. But the basic point is that research and the development of new technologies brings new benefits to society at a cost. It can, therefore, be subjected to economic analysis to determine whether the benefits of certain research activities justify the costs.

Management of Technology Transfer

9. Research and its application is an orderly procedure by which society increases its knowledge. It is not serendipitous but systematic and is therefore amenable to management just as a business is managed. A central group, such as PARC in Pakistan, is needed to coordinate and guide the agricultural research findings of the nation. It is the locus for discussion of research priorities and inclusion of the private sector (agribusiness and representatives of farm organizations) in identifying national, agricultural research priorities and allocating funding. Technology transfer is like a body-contact sport. It requires the simultaneous interaction of all players in the system--scientists, extension staff, agribusiness, and farmers. PARC's role is critical for bringing these players together and assisting them in developing an effective research strategy. PARC could reward progress and require accountability from scientists.

10. Research and the development of new technologies undertaken at public institutions should be protected with patents as would be done at private research laboratories. The rewards to research should also mimic those found in the private sector. That is, both the institution and the individual researcher (or team) should share the financial rewards of innovation and discovery and should be rewarded according to established measures of productivity. Projects undertaken jointly between the private sector and a university or government facility can be highly effective for both groups. Outstanding scientific or technological achievements must be rewarded with salary supplements or license-fee sharing to provide the incentives needed for long term successful collaboration. The emphasis should be on the potential commercial usefulness of the work.

11. Research in the private sector is not a luxury nor an academic exercise. It must contribute profit to the company that finances or undertakes it. Research, therefore, must be organized like a business--teams must be formed, strategic plans set, intermediate goals established--and each step needs to be monitored and the scientists held responsible for their results. The ultimate goal is for the scientific findings to be commercialized and marketed. Each step on the way needs to be part of a team effort. Frequent communication of findings among the research teams responsible for different aspects of a project can provide a strong team and productive challenge. Reward discoveries, breakthroughs, and other forms of productivity. Teamwork has been demonstrated to be superior to individual research.

12. Countries need to define the role in society of scientists who are funded by the public sector. Most countries cannot afford the luxury of having scientists work on their own research interests without concern for applications. Society has a right to require that publicly-funded researchers be accountable for the value of their output, just as their farmers and other workers are accountable. At the same time the public must be educated to understand that not all research is successful and necessarily leads to a profitable outcome. A further complication is that research and its transfer to useful applications is often slow. A period of fifteen years is common between the discovery and the adoption of the technology developed from that discovery. Requiring the private sector to pay a fee for the use of technologies they will commercialize does not hinder but, in fact, speeds up the transfer of that technology. Of course the company must be provided a specified exclusivity to the technology (shielding) if it is to commit its finances for development and marketing.

13. Strong links between the clients and the suppliers of innovations are another key to success. The clients of a for-profit research laboratory are the end-users of the product, also the manufacturers and distributors of it. These linkages form the upward and downward information channels needed for

optimal product development. Researchers must be in contact with their end-users. End-users or market experts need to know current findings, possibilities, and problems, as these may lead to different products or different markets.

14. Successful technology transfer requires communications back and forth between the researcher and the user. Scientists must be comfortable "selling" their ideas in discussions with users of ideas. They must also be prepared to listen to the problems and concerns of end-users and formulate those concerns into researchable topics. An active dialogue among the various players will help ensure that opportunities for commercialization of a discovery will not be missed but will be developed and utilized by some members of the group.

15. Many private companies in the U.S. provide targeted grants to university laboratories. The company benefits from the findings and from access to the best scientists. The scientists benefit by the opportunity to do research that is more likely to be used; in some cases, an increased opportunity to produce a patentable discovery; and the opportunity to involve students in an industry that might hire them on graduation. Other firms establish formal contractual relationships with universities where the firm and the university will jointly work on an applied problem and share the costs and benefits of the collaboration.

Orientation Meeting for Study Tour from Pakistan
COMMERCIALIZATION OF RESEARCH

1055 Thomas Jefferson Street, Room 2004
Washington, DC
Monday, April 19, 1993

SUMMARY OF DISCUSSION

Introduction

Chairman Dr. Jordan Baruch opened the meeting by asking the members of the study tour what specific problem(s) they wished to solve. In reply, Dr. Mumtaz Ahmad, Tour Leader, said that most members want to see how research-based findings could be put to use, how to build linkages with the private sector, and how to identify and solve problems. Tour members do not want to see Pakistan re-invent the wheel, but rather to leap ahead, building on what has been learned in the United States.

Dr. Baruch asked about the personal focus of each traveller:

- Dr. Mumtaz Ahmad noted that in Pakistan there were numerous problems in linking public and private sectors, such as transport and storage difficulties.
- Mr. Abid Farooq found that small-scale manufacturers (the majority in Pakistan) were not aware of the benefits of research or how to apply mechanization.
- Dr. A. S. Alvi mentioned the denuded, arid lands in Baluchistan and the problem of transferring technology to the farmers there.
- Mr. Mian Mahmood emphasized the application of mechanization, especially in sugarcane farming.
- Dr. A. S. Khan mentioned the promotion of mechanization through introduction of appropriate farm machines; how can researchers interact with the private sector?
- Dr. S. M. Khan saw his role as facilitating technology transfer and wanted to learn U.S. methods of doing so.
- Dr. Muhammad Khalid saw this group as a catalytic agent for helping Pakistan meet its food and fiber needs and making research responsive to the needs of the private sector.
- Dr. Shaheena Mashkoor looked forward to seeing U.S. models of collaboration between private and research sectors. How can research benefit the end-users?

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Welcome

Dr. E. William Colglazier, Executive Director of the Office of International Affairs of the National Research Council (NRC), gave a brief description of the NRC's mission as a private, independent (nongovernmental) organization, chartered in 1863 to recognize scientific accomplishments and to advise the government on difficult or controversial problems. He distributed copies of the NRC *1992 Report to Congress*, pointing out the emphasis on public-private linkages listed under "New R&D Role for Government" on page 3 of the *Report*. (See Appendix C)

Dr. Ahmad asked whether studies had been conducted for foreign governments on R&D, and Dr. Colglazier mentioned Indonesia, among others. Dr. Baruch described this program as one that helped the Indonesian government in building new infrastructure, establishing an Indonesian National Research Council, evolving a protocol for research proposals, and developing a policy for technology generation.

Dr. Khalid asked what percentage of funding for research in government institutions comes from the private sector. Dr. Baruch replied that almost no money flows from the private to the public sector, although the private sector does fund research at universities.

How Science and Technology works in the U.S. The roles of government, research institutions, and the private sector--Dr. Stephen A. Merrill, Executive Director, Office of Government and External Affairs, National Research Council

Dr. Merrill is Director of the Academy Industry Program and Executive Director of the Board on Science, Technology and Economic Policy. He distributed statistics on R&D from the National Science Foundation (NSF), pointing out that although federal R&D expenditures have gone up in constant dollars over the years, their share as a percentage of total federal expenditures has not risen. Federal expenditures for R&D fall into three broad categories:

- Basic research in universities through NSF and other federal agencies with the purpose of promoting technology transfer; and including the licensing of rights by universities to private companies. This program has been successful, but Congress is somewhat ambivalent about it due to the general feeling that government should not be assisting specific companies.

- Applied R&D in pursuit of broad government objectives, such as computers, civil aviation, and--the oldest success story--agriculture.

- Federal R&D contributions intended to promote U.S. competitiveness based on cooperation and pooling of expertise, with government funding to encourage specific R&D on technology. This sector is expected to grow in the future.

The federal R&D budget will be $76 billion next year: 5% of GDP.

Dr. Khalid asked how much respect government scientists commanded in the private sector. Drs. Baruch and Ahmad found this an interesting question, pointing up the discrepancy between university

scientists (who think poorly of those who make money) and industrial scientists (who are required to produce results). Dr. Baruch described the two reward structures: university scientists respond well to publications, awards, and honors, while industrial scientists get paid better. Each scientist picks the award system that suits him best.

Dr. A. S. Khan asked about the unemployment level among highly trained U.S. scientists; Dr. Merrill reported it was very small, between 1 and 2 percent.

Dr. Baruch pointed out that scientists in the U.S. generally identify their own research problem and work on it. Fifty percent of General Electric research projects that were successfully completed were later discarded; as a result, there is more training now about what the company really needs. Scientists and market experts are working in two different cultures--the problem should be defined by the marketing person then presented to the scientist. It would be useful for government scientists to study industry for half a day a week, to bring a problem back from industry and solve it--and have this solution determine some share of his/her pay.

The role of the government-university-industry roundtable in commercialization of research--Dr. Don I. Phillips, Executive Director, The Government-University-Industry Research Roundtable, National Academy of Sciences

Dr. Phillips described the roundtable as a small, unique unit founded nine years ago to facilitate interaction between senior government officials, industry, and universities on major R&D policy issues. The contribution of research to private industry depends on factors beyond science and technology, therefore the roundtable is a valuable communication device. Dr. Merrill prefers the term "teamwork" to "technology transfer"; he sees laboratories as possessing capacities which, combined with R&D in companies, can lead to new discoveries and improvements. Companies require long-term collaborative relationships. Collaboration at the roundtable leads to changes in public policy. *New Alliances and Partnerships in American Science and Engineering* has an appendix on collaborative relationships (in addition to this booklet, Dr. Phillips also shared copies of the Roundtable's *Annual Report* and *Simplified and Standardized Model Agreements for University-Industry Cooperative Research*. See Appendix E for list of Roundtable publications).

The Council for the roundtable has about 22 members, who meet three times a year; university and industry members are appointed for three years. It is composed of company leaders, heads of federal R&D agencies, and university officials; there are only a few working scientists among them. The group cannot define or implement federal policy, but R&D leaders can develop and influence the government through ideas brought back from the roundtable. The roundtable publishes occasionally, but the most important interchange occurs at the Council meetings, not through its reports.

"How do you know what the user needs?" asked Dr. Baruch. The roundtable is user-driven; the customer always sets the problem. If industry did this, results would be astounding. No matter how brilliant the scientist, he may still not realize what is important to the user. Dr. Baruch suggested the members of the study tour visit supermarkets in this country to see if there was any produce in Pakistan that could be marketed here. How could such products be introduced?

How does National Science Foundation assist the private sector?--Dr. Donald Senich, Division Director, Industrial Innovation Interface, National Science Foundation

Dr. Senich described his university colleagues as having taken a vow of poverty, while he felt motivated to create wealth, since wealth pays for research. He described four NSF programs designed to build science infrastructure:

- The Young Investigators program funds the researcher with $25,000 for one year, but if the researcher gets industry to work with him, the amount can grow to $500,000 over 5 years. This encourages the researcher to identify a problem in industry, bring it to to the university, and find a solution to take back to the company. The researcher is able to stay on the university tenure track while at the same time working on a problem of industry.

- Science and Technology Centers are built at universities but involved with industry; they do fundamental research.

- Engineering Research Centers (ERCs). This is an older program; there are 18 of these centers in the U.S.

- Industry/University Cooperative Research Centers are smaller than ERCs. Funding is initially 50% from NSF and 50% from industry. After five years, 100% of the funding is from industry. This program started in 1977; there are now 54 centers, and 46 of them are self-supporting.

- The Small Business Innovation Research (SBIR) program, begun in 1977, is designed to increase the incentive and opportunity for small businesses to undertake cutting-edge, high-risk, high quality research that has potential for a high payoff if the research is successful. No award is given without a commitment for follow-on funding from the private sector. SBIR projects have three phases: six-month feasibility study (up to $65,000 in federal funds can be committed), two-year research project (up to $300,000), and product development (no SBIR funds given for this phase--small business pays the cost). Eleven government agencies and 20 major corporations cooperate in this program. It is expected to grow from $650 million in fiscal 1993 to $1 billion by 1997. See Appendix F for detailed description.

Dr. Baruch suggested that the best way to motivate employees was to change the ratio of rewards/punishments by imagining the employee's viewpoint and build in rewards for trying new methods, so that workers are not paralyzed by the fear of making a mistake. It is a combination of science, art, and craft that makes the new products that will be highly sought.

Technology transfer in the U.S. Department of Agriculture--Dr. William H. Tallent, Assistant Administrator, Office of Technology Transfer, Agricultural Research Service, U.S. Department of Agriculture

Dr. Tallent described the mandate of the U.S. Department of Agriculture (USDA) in extension work, soil conservation, and provision of nutrition information. USDA's Agricultural Research Service (ARS) has 122 laboratories throughout the United States; the largest of these is in Beltsville, Maryland.

The Federal Technology Transfer Act of 1986 initiated the establishment of CRADAs (Cooperative Research and Development Agreements) between industry and federal agencies, such as the ARS (see Appendix G for descriptive brochures). CRADAs include a commitment to collaborate and give patent rights to a company, with the USDA scientist cooperating in many ways to accomplish the research, including working on site at the company and interacting directly with the factory manager. USDA has initiated over 300 CRADAs. The incentives to the scientists are threefold: money awards, a share of patent revenue (25% goes to the scientist), and promotion--which is dependent on technology transfer and use of the research findings. It is as important to get science used, as it is to get it done.

The two most important forces driving agriculture in the next decade will be computers and biotechnology. ARS is promoting the message that agriculture is a high-tech field.

The role of the Commerce Department in commercialization of science and technology--Dr. Joseph Clark, Senior Science Advisor, Technology Administration, Department of Commerce

Dr. Clark distributed a one-page description of the Commerce Department's ten administrations (see Appendix H) and the text of *Technology for America's Economic Growth, A New Direction to Build Economic Strength*, the Clinton-Gore technology policy published in February 1993. The thrust of this document is a belief in the government's role in accelerating technology to provide:

- long-term economic growth that creates jobs and protects the environment
- government that is more productive and more responsive to the needs of its citizens
- world leadership in basic science, mathematics, and engineering.

The focus is on infrastructure, manufacturing, and the partnership between industry and government. Seven criteria are listed for determining funding:

1. accelerating the development of technologies inadequately supported by private firms;
2. encouraging a pattern of business development that will likely result in stable, rewarding jobs for large numbers of workers;
3. accelerating the development of technologies that could increase productivity while reducing the burden of economic activity on the environment;
4. improving American workers' skills through education and training;
5. reflecting the real needs of American businesses as demonstrated by their willingness to share

the cost of research;

6. supporting communities or disadvantaged groups, in the U.S. or abroad, who have not enjoyed the benefits of technology-based economic growth;
7. enhancing cooperation on global problems.

Dr. Clark noted that the three generic areas getting the most attention and government support are in advanced materials technology, biotechnology, and information technologies. He emphasized that it is critical that developing countries have a modern information infrastructure.

How does commercialization of research and participation of the private sector fit into development in Pakistan?--Dr. Ridwan Ali, Division Chief, South Asia Department, The World Bank

There was considerable discussion on this subject, and some of the points that emerged were as follows.

Political uncertainty and security in Sindh are critical to investment by the private sector. While the government has made good progress in deregulating the economy and privatizing certain key sectors, direct foreign investments continue to be low.

In Pakistan, agriculture continues to dominate the economy, employing the bulk of the workforce. However, productivity is not high. The gap between actual and potential yields is one of the biggest challenges that can be addressed by technology transfer. Sectorial performance looks good overall, but not when examined closely. Cotton production is good because of tremendous technological improvements and investment in R&D. However, wheat is less impressive.

In the past, Pakistan has pursued a costly policy of self-sufficiency. Recently, however, there has been recognition of the need to change the objective to one of food security with more emphasis on trade. Pricing policy is key, and on this Pakistan's performance is mixed. Prices of cotton and wheat, for example, should be increased to international prices, while subsidies on sugar are removed. Overall, there should be less government involvement in purchasing and more participation from the private sector.

If research is funded only by the government, which has many other priorities, research will be underfunded. The more funding there is outside the government, the less pressure there is on government, so achieving commercialization of research results to make research privately profitable is very important. Dr. Ali noted the lack of appropriate incentives for this.

Dr. Ahmad commented that improved technology has not percolated down to the farmers. The private sector will not plant wheat, as it is too bulky to transport. They have preferred crops such as sunflower.

Dr. Ali closed by stating that an environment for commercialization does exist, and it is important for the country to move toward a private system and away from dependency on the government.

BOSTID programs in commercialization of science and technology in Indonesia and Thailand--Mrs. Rose Bannigan, Director, BOSTID Indonesia and Thailand Programs

Mrs. Bannigan described the BOSTID programs in Thailand and Indonesia as examples of how science and technology can be applied and how government can help (see Appendices I and J).

The U.S. Agency for International Development (USAID) in Thailand and the Thai Ministry of Science, Technology, and Environment (MOSTE) designed a seven-year project to help Thailand increase its capability to identify, develop, and/or produce the scientific knowledge and technology it requires to strengthen its industrial and agricultural development.

The project aims at assisting Thailand's higher education institutions and government and private research organizations undertake research, development and engineering (RD&E) focused on problems facing agriculture and industry. The project's three main areas of scientific emphasis are: (1) biosciences/biotechnology; (2) materials technology; and (3) applied electronic technology. A Thai agency, the Science and Technology Development Board (STDB), was created in 1986 to carry out the project. In 1991, it became the National Science and Technology Development Agency (NSTDA), a permanent body.

The U.S. National Academy of Sciences, through its Board on Science and Technology for International Development (BOSTID), was asked to provide the technical assistance for the implementation and management of this program. BOSTID provided experts to assist with the design and review of grants, as well as to participate in scientific workshops, symposia, and training programs. Standards testing and quality control were important parts of this program; in addition, a technical information center was established. In the commercialization of science and technology, BOSTID served as a broker between U.S. and Thai companies, helping U.S. companies realize the potential of investing in Thailand. In order to promote technology transfer through the private sector, the U.S.-Thai Commercialization of Science and Technology (UST/COST) program was established to stimulate the adoption by Thai firms of new technologies with significant potential for enhancing productivity and profitability.

The Indonesian Agency for the Assessment and Application of Technology (BPPT) requested that BOSTID provide technical assistance aimed at improving policy making and implementation of science and technology in the following areas:

- give technical assistance to strengthen the Indonesian National Research Council
- design a science and technology information network
- study governmental policies that seek to identify constraints on the effective application of S&T in both public and private sectors
- study technology management and utilization in Indonesian industry
- design and implement an S&T decision support information system
- develop a system of procedures for establishing S&T project analysis capability at the national level.

Dr. Baruch closed the meeting with a short discussion of the significance of Internet, the network of networks, which gives access to the internal networks of 140 countries.

VISITS TO AGRICULTURAL INSTITUTIONS

U.S. DEPARTMENT OF AGRICULTURE, BELTSVILLE

Overview of the Beltsville Agricultural Research Center and the Agricultural Research Service

Dr Gordon Martin
Associate Director, Beltsville Area

In the United States about 10% of the research on food and agriculture is undertaken by the Agricultural Research Service (ARS). Another 53% is done by private companies, 22% by other federal agencies, and 16% by state agencies. As the in-house research arm of the U.S. Department of Agriculture (USDA), ARS has a mission to develop the knowledge and technology needed to solve agricultural problems in order to ensure adequate production of high quality food and agricultural products to meet the nutritional needs of the American consumer, to sustain a viable food and agricultural economy, and to maintain a quality environment and natural resource base.

The primary responsibilities of ARS are to:

. Provide initiative and leadership in agricultural research.

. Conduct research on broad regional and national agricultural problems.

. Conduct research in support of Federal action and regulations.

. Provide technical expertise to meet national food, food safety, and environmental emergencies.

. Serve as resource on agriculture to the executive and legislative branches of government.

ARS manages activities in 129 laboratories in the United States and overseas. Supported by appropriated funds, ARS provides:

. Ability to perform long-term, high-risk research.

. Ability to respond to stable and changing technical goals.

. An organizational structure ensuring research program accountability and coordination.

. Ability to focus research on gaps in knowledge that are barriers to problem solution.

. Capability to coordinate, as needed, interdisciplinary research teams from its 2,600 research scientists.

The challenges that ARS faces in the 1990's include:

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Environment: the effects of air and water pollution on the environment, depletion of nonrenewable resources, waste management, and potential effects of global warming. The agricultural sector is challenged to sustain supplies of agricultural products for domestic consumption and export and at the same time to solve (not contribute to) environmental problems.

Food Safety, Human Nutrition, and Health. Protect the food supply from contamination during production and processing and maintain safety of biotechnology products. Address and educate on the relationship between diet and health, and provide information on the nutritional content of foods.

National Economy. Lower costs, add value, and improve the quality of U.S. agricultural products to reduce the trade deficit, boost U.S. market share, and otherwise enhance U.S. agricultural competitiveness.

Scientific and Technical Approaches. Scientific research is being driven by major trends:

- Increased use of biotechnology, interdisciplinary teams, and computer automation.
- Increased dependence of the private sector on public research capabilities, particularly for fundamental and pre-market research, although public research may be privately financed.
- More effective transfer of new knowledge and technologies to users or further developers, expansion of public/private sector research collaboration.

ARS has a staff equivalent to 8,200 full time employees, about 2,600 of whom are permanent or visiting scientists. The cost of conducting science is currently $250,000 per scientist year. At Beltsville alone, the budget is $88 million from the federal government and $4 to $5 million from the private sector. There are 450 Ph.D. scientists, 350 of whom are permanent staff, while the remaining 100 are post doctoral students and visiting scientists from more than 21 countries.

The ARS program is divided into six areas with the relative levels of support shown.

1. Soil, water, and air (8%)
2. Plant productivity (48%)
3. Animal productivity (24%)
4. Commodity conversion and delivery (6%)
5. Human nutrition (10%)
6. Integration of system including modelling (4%)

The agency encourages and rewards scientists for successful commercialization of their research findings. USDA considers that unless research findings reach users, they are failures.

Dynamics of the Emerging Liaisons of Government and Industry

Dr J.J. Menn
Associate Director, Plant Science Institute

Public Law 96-517 enacted in 1981 was a catalyst for greater interaction between public research and the private sector. Following that law, USDA was given authority to grant a third party an exclusive

license for an invention. Later laws paved the way for USDA to enter broad variety of cooperative R & D agreements. USDA can accept several forms of assistance--personnel, materials, facilities, or financing--toward cooperative research and development endeavors when those projects have already been approved by the agency. Other federal laboratories may also cooperate.

These mechanisms for cooperative research have energized the interaction between the government and the private sector. Science has become an attractive area for entrepreneurs, with opportunities to develop products, processes, or methods in agriculture. Those with successful patents receive both monetary rewards and professional recognition.

Mechanisms of Technology Transfer

Dr R.H. Villett
Deputy Assistant Administrator

Development of high technology products requires considerable time, funding, and hard work. Several systems have been used for motivation. Technologies can be transferred by several funding mechanisms:

- the research and development organization may license out the technology- the organization and the inventor both receive a portion of the royalties
- an industrial company may purchase the technology
- the research and development organization may consider the applicants for a technology and make the selection and the contract, functioning as the deal maker
- a private corporation may be hired to review proposed patents, make patent applications, sell patents, and receive part of the royalty
- the research and development organization may set up a venture capital fund, and hire a professional to manage it.

About fifty companies have set up production units, some in rural areas, using new technologies from ARS. Examples of these companies are American Cyanamide, Hewlett Packard, Amoco, and Ecogen.

In Peoria, Illinois, ARS has set up a consortium to support commercialization of agricultural research in Illinois. The U.S. government contributes $2 million, Dow Chemical $200,000, and the state of Illinois also contributes.

In the United States a patent becomes open to the public 17 years after the application was filed. At USDA, a minimum of 15% of royalties go to the scientist, 45% goes to the agency, and the remainder covers patent costs.

The Federal-Maryland Industrial Partnership Program

Dr. H.R. Gamble
Helminthic Diseases Laboratory

In last twelve years, cooperation between the government and the private sector on research and development of new products and processes has gone from zero to interaction on several projects and considerable flexibility in the types of interaction.

There are currently 54 CRADAS worth $4.5m. Since the introduction of CRADAS, 300 have been supported. CRADAS are supported for up to two years by private as well as state & local government funding.

The Federal-Maryland Industrial Partnerships Program was established by the Maryland State Department of Economics and Employment Development to make strategic partnerships between Maryland companies wanting to commercialize new technologies and federal laboratories developing new technologies.

Predators to Control Garden Insects

Dr Jeffrey Aldrich
Ecology and Insect Chemistry

This laboratory has recently produced the fungus Gliocadium, which is effective against several pathogens. The product is named Gliogard and is a biological/microbial fungicide which is aimed at the $1.4 billion U.S. market for pesticides.

The company was responsible for registration and marketing of the product and USDA provided expertise to facilitate the many steps in that process that included the environmental use permit for testing a genetically engineered organism, EPA registration, microbial pesticide toxicology, soil inoculant registration, and toxicity categories for the product label. The work from this laboratory was recently published in U.S. News and World Report.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Overview of NIST, the Advanced Technology Program, and the Manufacturing Technologies Program

Dr. Ken Gordon
Deputy Director for International Affairs

Mission and Goals The National Institute of Standards and Technology (NIST) was established by Congress "to assist industry in the development of technologies that would improve product quality, modernize manufacturing processes, ensure product reliability, and facilitate rapid commercialization of products based on new scientific discoveries."

NIST conducts basic and applied research in the physical sciences and engineering, developing measurement techniques, test methods, standards, and related services. This includes generic and precompetitive research and development on new advanced technologies. The 1992 budget was $435 million, and the staff is 3,000 scientists, engineers, technicians, and support personnel, and about 1,000 visiting scientists each year. Research is undertaken in the following commercially important areas:

- Building and fire research
- Chemical science and technology
- Computer systems
- Computing and applied mathematics
- Electronics and electrical engineering
- Manufacturing engineering
- Materials science and engineering
- Physics

Several new NIST programs are designed to assist innovation at U.S. businesses through seed money for development of generic technologies; grants to states for support of technology transfer programs; and financial and technical assistance to help small and mid-sized companies adopt more efficient manufacturing methods. The Institute also promotes industrial innovation through more than 100 cooperative research agreements with private companies. In all, NIST researchers collaborate with more than 1,000 industrial and other researchers annually.

Advanced Technology Program NIST administers the U.S. Commerce Department's Advanced Technology Program (ATP), which assists businesses in carrying out out research and development on precompetitive, generic technologies. The ATP emphasizes high-risk technologies critical for a wide range of potential applications capable of generating significant economic benefits. The ATP provides technology development grants to single businesses or to joint ventures, with cost-sharing by the participants. Awards to individual firms are limited to $2 million for up to three years, and can be used for direct R&D costs--single applicants must agree to pay all indirect costs. Awards to joint ventures can be for up to five years and are not subject to the $2 million limit. Joint ventures must provide more than 50% matching funds. The funding requested for either type of award must be appropriate for the proposed R&D plan and commensurate with the projected benefits.

Technology Services NIST's Technology Services provides technical support and, in some cases, financial assistance, to state and local governments to facilitate the transfer of information, technology, and useful devices based on federally funded discoveries. The office has a staff of approximately 180, with expertise in chemistry, physics, materials sciences, engineering, and technical support services.

Manufacturing Technology Centers The Manufacturing Technology Centers Program offers technical support and financial assistance to regional centers created to transfer manufacturing technology to small and medium-sized firms. The program focuses on modernization of manufacturing companies in a selected industrial region, with emphasis on "hands on" experience and advanced technologies. The first three NIST Manufacturing Technology Centers were established in 1988: the Great Lakes Manufacturing Technology Center at the Cleveland Advanced Manufacturing Program in Cleveland, OH; the Northeast Manufacturing Technology Center at Rensselaer Polytechnic Institute in Troy, NY; and the Southeast Manufacturing Technology Center at the

University of South Carolina in Columbia, SC. Two additional sites were selected in March 1991 to establish technology transfer centers: the Industrial Technology Institute in Ann Arbor, MI, and the Kansas Technology Enterprise Corp. of Topeka, KS. Additional Centers serving other regions of the country will be established on a competitive basis.

Standards Services maintains liaison with domestic and international organizations concerned with standardization and measurement of weights and measures activities:

- Standards Code and Information
- Standards Management
- Weights and Measures
- Laboratory Accreditation

Measurement Services This office provides services to industry on a reimbursable basis:

- Standard Reference Data
  - Provides critically evaluated data on chemical and physical phenomena and materials properties.
  - Coordinates all data activities domestically and represents the United States in all international data matters.
- Standard Reference Materials
  - Provides Standard Reference Materials that help ensure accuracy of measurement and improved quality control.
- Physical Measurement Services
  - Assists manufacturers and users of precision instruments to achieve the highest possible levels of measurement quality and productivity for more than 500 different calibrations and tests.

Technology Commercialization provides U.S. industry and state technical extension organizations access to technologies developed by NIST and other federal laboratories, and encourages the commercial use of these technologies.

- Research and Technology Applications
  - Assists business, industry, and state programs to identify, access, and apply NIST and other federally developed technology.
  - Serves as the NIST point of contact for the Federal Laboratory Consortium, manages the State Technology Extension Program, and arranges visits to NIST for business and industry.
  - Participates in and develops workshops, conferences, and seminars that bring NIST and other federal laboratory technology to the attention of interested companies.

- Technology Development and Small Business
  - Manages and coordinates NIST's intellectual property, licensing, and commercialization activities.
  - Helps business and industry identify and use NIST's technologies, research and development capabilities, facilities, and collaborative opportunities.
  - Works with NIST management and staff to develop research and development

partnerships and consortia with industry and government.
- Manages NIST's Small Business Innovative Reserach PRogram.

Technology Evaluation and Assessment This office assesses the technical and commercial feasibility of inventions and new product technology developed by individuals and small businesses.

- Energy-Related Inventions
  - Stimulates the development of energy-related technology in the private sector through a joint program with the U.S. Department of Energy (DOE).
  - Evaluates new product ideas received and recommends those deemed promising to DOE. Over 27,000 evaluation requests have been processed, and more than 500 recommendations have been made with over $24 million in grants awarded.

- Technology Evaluation Service
  - Developing a general technology evaluation service for state seed capital and small business development programs.

- Supplementary Activities, such as a new National Technology Workshop (NTW) program to assist small businesses in strategic planning for new products development.

Information Services provides information services (both historical and current) for NIST staff; the research and development, technology, and industrial communities worldwide; and federal, state, and local governments.

E.I. DU PONT DE NEMOURS AND COMPANY
STINE-HASKELL RESEARCH CENTER
NEWARK, DELAWARE

Chemical Discovery at du Pont

Dr. Russell Bellina
Manager, Chemical Discovery

The Discovery Research department in the agricultural products division of du Pont has five technical areas: chemical discovery, biochemical discovery, weed control, field evaluation and insect control. A major challenge is to provide cost-effective pest control for crops while still maintaining a safe environment. Since preharvest losses due to weeds, insects, and plant diseases average 23% in developed countries and 37% in developing countries, pesticides will remain routine and invaluable inputs for the foreseeable future. At the same time chemical companies are under pressure to produce products that are not damaging to the environment.

For discovery of new products, du Pont and other chemical companies target their research efforts toward identification of ideal crop protection molecules--molecules that are cost effective, flexible, reliable, safe, easy to use and leave no harmful residue. The ideal molecule is also degraded quickly

on contact with soil, is highly specific to the targeted organism, has no off-target effects (if spread by wind drift or water contamination), is easily integrated with best management practices, and does not lead to pest resistance. Promising molecules are then selected for development to commercial products based on their activity, toxicity, crop safety, and compatibility with the environment. This selection is done carefully because the process of development is highly expensive. Du Pont has been very successful in its discoveries of new chemicals, such as Nustar and Asana (a pyrethriod).

The agricultural products section of du Pont invests $300,000 per year in unrestricted grants to universities (about 8-10% of earnings). The entire company donates $12 million per year to universities in unrestricted grants and a further $16 million for directed research. The total annual budget for R&D at du Pont is $1.3 billion. Corporate-wide, 3-4 % of earnings are committed to research.

Company earnings from agricultural products increased from $7 million a decade ago to $2 billion last year. This increase was due mainly to the discovery and commercialization of new products.

On the issue of how to keep scientists productive, the following points were made:

- respect the intelligence and creativity of scientists
- provide scientist broad freedom to invent and test their ideas
- hold the scientist accountable for his accomplishments.

For example, the discoverer of sulfonyl urea received special compensation -- professional recognition and monetary reward -- for his success. The award was based on the estimated net present value of product and on the extent of his contribution to the discovery.

The different groups at du Pont meet frequently to review progress, discuss promising directions, and plan target dates for completion of the specific goals within a project area. Management is closely involved with each step and experts on several aspects review findings as they become available. If an effective compound is produced, its toxicity and impact on the environment are assessed in relatively early stages. The company will promptly stop research on an otherwise promising compound if problems in these areas cannot be resolved to avoid nonproductive studies and not to risk the loss of public confidence caused by a product with harmful side effects.

Technology Transfer at du Pont

John Pierce
Research Manager, Biochemical Discovery

This division is involved in the design and characterization of agrochemicals for insect control, as well as investigation of the mode of action of agrochemicals and their behavior in the soil. The design of such chemicals involves selection of the appropriate enzyme to target.

Research at du Pont is always market driven. The search for promising biochemicals is increasingly

difficult--one compound in 20,000 became commercially successful in the mid 1980s, while now only one in 30-35,000 becomes a commercial success.

Tour of the Stine-Haskell Research Center

Mr. Kurt Sunderlin

Wherever possible, the center has controlled systems set up for the routine and large-scale activities. These include mixing soil for pot studies, spraying plants, and propagation of plants.

Du Pont has developed several kits for diagnosis of plant diseases in the field. The kit for cereal foot rot or eyespot disease is used to monitor the level of pathogens present in the crop before disease is visible. It takes the guesswork out of decisions on when to spray the crop. This kind of quantitative disease detection provides quick, accurate information on which to establish whether disease is present, whether a fungicide is needed, and which one is needed. This accurate use of therapeutants provides a substantial cost saving to the user and an environmental benefit to the public.

Another example is the Direct Dry Applicator, which is a novel approach for aerial application of Londax 60DF. This is an alternative to conventional liquid spray applications with advantages in several areas:

- environmentally safer since it is targeted resulting in less drift
- improved worker safety due to the reduced loads on the aircraft
- increased productivity since the application can be done in half the time and uses half the fuel, the spray tanks do not need to be cleaned, and less equipment and labor is needed
- applications of other pesticides can be sequential or simultaneous.

AGRIBUSINESSES IN IOWA

Iowa Cattlemen's Association

Mr. John Hinners

This association has a membership of 12,000 cattlemen, each paying annual dues of $40. There are similar associations in 45 states and these are all members of the National Cattlemen's Association. The three objectives of the association are:

- to lobby Congress on behalf of the cattlemen
- to promote the production and marketing of cattle

- to educate producers on consumer needs

Members serve on committees with specific concerns such as animal health, foreign trade, and research. Members, through their representatives on committees and the board, set industry priorities. These are communicated to the university research committee that coordinates a peer research program supported by the Cattlemen's Association.

The Iowa Cattlemen's Association performs other functions as needed, such as being the liaison between meat producers and packers. Several projects are being done in cooperation with Iowa State University:

- collection and analysis of carcass weight and other data from processing plants
- continuous monitoring and recording of cattle weights at feedlots
- continuous appraisal of cows and their offspring --number and weight of calves, longevity, etc
- evaluation of bull genetics by comparing weight gains under conditions of identical feed
- use of ultrasound to evaluate the bone, fat, and muscle composition of carcasses in order to meet consumer demand for tender (well aged and marbled) meat with minimal fat beyond good marbling

Beef Industry Council

Mark Fischer

This organization is supported by a self-imposed assessment of $1 per animal sold for processing. Nationally, $70 million is collected and $7 million of that supports research, $90,000 at Iowa State University. The remaining funds support promotion of beef in the United States.

The results of research supported by the Beef Industry Council must be publicly available. Patent rights can be negotiated, and the collaborating organization has the first option to patent the research findings. In this way the Council ensures that beef producers benefit from research they support. Patent rights will be lost if the patent finding is held but not used.

Two other organizations important in beef marketing are:

- United States Meat Export Federation which promotes meat exports, and
- Meat Export Research Center which undertakes specific market studies.

Pioneer International Seed Company

Herbert Eckhouse
David Wissink

Pioneer International began in 1926 and is the largest independent seed company in the United States. In 1992, Pioneer operated in more than 100 countries with sales of $1.3 billion. Pioneer has numerous partnerships and joint ventures. There are several divisions:

- seed products--produces seed for sorghum, sunflower, canola, soybean, alfalfa, wheat, pearl millet, and peanuts
- microbial genetics--isolates strains of beneficial bacteria, silage inoculant, animal inoculant, and hay inoculant
- specialty plant products--produces special products for the farmer, producer, and consumer, including wet millers, dry millers to create snack foods, soybean for tofu, animal feed, and high oleic sunflower oil for Kraft
- business information systems-- financial, marketing, crop insurance,interactive network, broadcast network, hardware and software for education and agribusiness items from U.S. newspapers
- environmental factors--information is collected from research stations around the world on climate, soils, disease, and insects and their impact on crop production
- production--field studies under different conditions with quality assessment including testing for genetic purity and evaluation of performance including germination
- marketing and sales--the salesmen (part-time) are 4500 farmers who use Pioneer products and have training from Pioneer in sales, while 86 full-time agronomists provide technical advice on products
- data systems--all information including sales, research, and corporate is computerized and used in the operation of the business

The company earnings of $1.3 billion resulted in a profit of $150 million. Expenditure on research was $100 million in 1993 and was focused in traditional breeding, biotechnology ($10 million of research funds), specialties such as entomology, and data management. Important projects in biotechnology are transforming crops such as soybean, canola, corn (for high oil) with new genetic material.

Pioneer International has 5000 employees worldwide, 1200 of whom are at the headquarters in Des Moines, Iowa. There are 250 scientists and 1000 hectares of research land at this site in Johnston, Iowa. The research effort is worldwide but the major emphasis is in the Midwest. About 85% of the

research is an in-house effort while 15% is completed under contracts. Research is also supported at some land grant universities. These universities produce many of the technical staff hired by Pioneer.

Pioneer has 100 scientists working on biotechnology projects. There is still considerable controversy surrounding transgenic plants, although biotechnology is simply speeding up a process that has always been underway in nature. Development of transgenic plants involves the following steps:

- identify desired traits
- identify responsible gene
- obtain responsible gene
- develop gene cassettes
- introduce gene into cells
- test transgenic material for gene presence and activity, and for trait effectiveness and other effects on plant

During the tour of Pioneer laboratories, the group showed considerable interest in the use of a particle gun, which was demonstrated. BOSTID-PARC grantees at Faisalabad and Lahore are considering the purchase of particle guns. For the use of particle guns see Box 1.

Box 1. Use of the Particle Gun

- A Petri dish with the target cells to receive new genetic material is placed on a tray in the firing chamber
- Microscopic tungsten beads coated with the gene of interest are placed on a plastic bullet. The bullet is placed in the barrel of the gun.
- A plastic stopping plate is placed between the bullet and the target cells
- When the gun is fired, a .22 calibre blank propels the plastic bullet towards the stopping plate. The microscopic gene-coated tungsten beads pass through a hole in the plate and shower the target cells with genetic material.
- Ideally, many beads land in or near the nucleus of some of the cells. If the genes of interest become a functional part of the cell's genetic code, the plant is transformed.

Pioneer has a joint venture in Pakistan with United Distributors Limited. Pioneer has experienced two difficulties in Pakistan:

- the overall market is large but the market for hybrid varieties is small
- although single and double crosses are available, the company has scaled back to providing only double crosses because of their concern to protect elite material in the absence of strict enforcement of intellectual property rights

The Pakistani participants noted that Pakistan is a large grower of cotton, maize, and sunflower, and that 100% of the seed for vegetable crops is currently imported.

Heart of Iowa Cooperative

Ron Gates
Jim Penney

The 850-900 members of this cooperative each pay $250 to join and must own at least 40 acres and produce corn or soybeans. The cooperative purchases grain from members and other growers and sells fertilizer and other inputs as well as renting equipment for the application of fertilizer. The goal is to assure members of good buying and selling prices as well as a dependable supply and market. For this reason profits are not high--about 1% of sales. Members receive a patronage dividend from that profit based on the size of their business with the cooperative that season.

The cooperative has 55 employees in 6 branches and a total storage capacity of 5 million bushels. In addition to the buildings and equipment, it owns 1 feedmill, 3 fertilizer plants, 2 refined fuel trucks, and 4 petroleum pumps. There are other cooperatives, and most farmers in the area belong to one or more of them.

Since cooperatives have not performed well in Pakistan, there was a spirited discussion of potential reasons including:

- managers of cooperatives must be paid well enough to attract and hold highly competent staff--these staff may make more money than the individual farmers
- the board of directors are farmers who must be willing to make tough decisions that are always in the best interests of the coop but possibly not in their own best interests.

Woodland Farms, Inc.

Mr. Pete Hermanson

This mixed farm is a family operation that began in 1871 and is currently operated by the third, fourth, and fifth generations of the original family. The farm produces turkeys (200,000 heavy tom

turkeys annually), milk (from a 350-cow dairy herd), and crops (1800 acres of corn, 1500 acres of soybeans, and 200 acres of alfalfa).

Most of the fertility needs are supplied by the organic nutrients from the turkey and dairy operations. Along with the alfalfa, corn silage and earlage are produced for the dairy cows. The balance of the corn is dried and stored on the farm to be used as needed in the on-farm feed mill, primarily for turkey feed. The soybeans are sold to a processor. Soybean meal and other feed ingredients are purchased to manufacture feed for farm use.

Technology Transfer at Iowa State University

Dr Steven Price
Director of Office of Technology Transfer

During the mid 1980s, Iowa State University staff recognized the need to assist researches at the University in transferring technologies, a need that became more urgent with a declining economy. At the same time there was concern to balance the need and support for basic and applied science being undertaken. The university provided researchers with two services that support technology transfer:

- obtaining patents (national and international) for inventions
- negotiating licenses or rights for patents (royalty rates, license fees etc.)

In 1987 the research park at Iowa State University was established with about twenty companies. Research parks have not been widely successful in the United States due, in part, to the lag between inventions and their commercialization -- about 15 years. A second obstacle is the enormous research base needed to generate significant activity. Iowa State University has faculty of 2000: 10 of them have made inventions and two want to start businesses based on their inventions. Stanford University generates the highest royalties in the United States with earnings of $25 to $30 million per year. However, these are not agricultural products and possibly not readily comparable with agricultural products.

Iowa State (ISU) ranks 14th in the United States for the number of patents obtained and is among the top for the number of patents per million dollars spent on research. There have been 1.5 inventions per million dollars of research compared with the national average of 0.5 patents per million dollars of research.

ISU obtains 20-35 patents a year, about half the number applied for. It costs about $10,000 to process the papers for obtaining a patent. About one patent in 100 generates earnings that cover the cost of the patent application, so an enormous research base is needed to generate significant activity. The Salmonella vaccine discovered about three years ago will probably have federal approval in one year and be making money in five years.

Inventors at ISU are rewarded with one third of the patent royalty after the patent costs have been covered. There is a close liaison between the university and many companies. In the area of meat

processing the programs in research and teaching are responsive to producer needs, which results in graduates with practical knowledge and experience in the meat industry and in support of special projects by the industry.

Center for Advanced Technology Development

Mr. Richard Gaertner

The Center for Advanced Technology Development (CATD) was formed in 1987 as a result of a $3.5 million grant from the U.S. Department of Commerce. Its mission is to develop and transfer Iowa State University technologies to the private sector so as to strengthen the competitiveness of U.S. industry and, where possible, to improve the economy of the state of Iowa.

CATD is a member of ISU's Institute for Physical Research and Technology--a federation of eleven interdisciplinary research centers that includes the U.S. Department of Energy's Ames Laboratory. Because of Ames Laboratory's size, about half of the CATD projects originate from research performed at that facility. (During the brief period CATD has been in existence, the program has involved 170 faculty and research staff members, 21 post-doctoral assistants, 78 graduate students, and 176 undergraduate students.)

A major goal is to facilitate successful university-industry technology transfer. The barrier here is industry's perception that university research is both high-risk and directed by scientists of a different culture and motivation. To address this deficiency CATD's technology transfer model was, therefore, developed to include one to three years of market-driven applied research. This work results in advanced prototypes or early product forms of the technologies, which can be evaluated in actual end-use applications. By having licensable technologies that are well characterized and understood, the business risk is greatly reduced.

CATD applied research is guided by the market studies and manufacturing cost analyses from industry and other experts. By giving companies early options to license technologies, CATD often establishes a direct dialogue with potential licensees and obtains direction from these sources as well. By the time a CATD technology is ready for licensing, it is usually protected by one or more U.S. patents and possibly by foreign patents as well.

Projects are selected for funding by a vigorous screening process that evaluates the merit and uniqueness of the technology as well as its potential for commercialization. Screening is generally provided by an Advisory Board, comprised of faculty and senior administrative personnel chosen for their breadth of technical backgrounds and industrial experience. Also individuals who represent seed venture capital firms and are willing to sign confidentiality agreements. Each member of the Board is given a uniform set of criteria on which to evaluate the proposals and the proposed projects are ranked for possible funding. Where the Board does not have the required expertise or cannot reach consensus, the proposals then are sent for a second screening at the Battelle Institute in Columbus, Ohio.

Once a project is selected for funding, the principal investigator prepares a detailed applied research plan specifying the technical approach, semi-annual milestone objectives and the project deliverables.

This constitutes a contractual agreement between the principal investigator and CATD for which the principal investigator is held accountable.

CATD markets its own technologies and negotiates the licenses. To identify potential licensees, CATD reviews market studies, networks with industry contacts, and screens companies from several sources. CATD also assists faculty inventors and other entrepreneurs where the technologies are best commercialized through new startup companies. In those cases where a broader marketing approach must be taken, it follows up contacts at trade shows and other meetings, and advertises in trade literature. After a licensee is identified and the terms are negotiated, the final license agreement is given to the Iowa State University Research Foundation for review and signature.

CATD administrative staff have industrial experience and understand the needs of both industry and the university. This significantly contributes to the success of the program. Each staff member has a broad range of industrial experience, including backgrounds in industrial research, manufacturing, corporate strategic planning, business development, technology marketing and licensing, small business assistance and venturing.

During the first two years following its startup, CATD had an administrative staff of one professional. Now, with a larger number of projects and a higher level of marketing/ licensing activity, the professional staff has grown to a total of six people who are organized into a group responsible for technology marketing and licensing and oversight management of the projects and a second group responsible for establishing research projects within the university that address specific company problems.

CATD's budget has ranged from $2.2 million to $3.5 million per year with funding primarily from the U.S. Department of Commerce. Over the past fiscal year, these federal dollars were supplemented with an additional $2 million from Iowa and industry, which resulted in the program growing to include more than 30 active projects.

A number of institutions have studied the CATD model. It has been adopted by another federal laboratory, the Idaho National Engineering Laboratory. A recent study on technology transfer by the Atlantic Council of the United States, recommended that either the CATD model or the ARCH Technologies model be considered for adoption by all Defense Programs Laboratories of the U.S. Department of Energy. ARCH is a program that is jointly operated by Argonne National Laboratory and the University of Chicago.

Since CATD and the businesses it has generated are still quite new, CATD's effectiveness cannot be measured by the number of new jobs created and the amount of royalty income generated. The only realistic measurements at this time are (1) the number of technologies that have been licensed and (2) the number of business extensions and new startup companies that have been created as a result. On this basis, CATD's accomplishments for the past five plus years of its existence (or for the three years it has been licensing) can be summarized as follows:

- the 16 technologies that have been licensed, or options given for license, resulting in
- 5 new startup companies and 7 new business extensions to existing companies.

These technologies have won four national R&D 100 Awards and in 1992 one of them received a

NIST Advanced Technology Award and was cited as a "Development to Watch" by *Business Week* magazine.

An advantage of this program over CRDAs is that it does not force companies to commit to technologies before they have a good understanding of both the technology and the market.

Engineering Animation, Inc

Mr. Jay Shannon

This company, founded in 1988, is based on computer software developed in an Iowa State University visualization laboratory. The software generates three-dimensional animations, about half of which have biomedical applications (starting with animations of the wrist and arm and moving on to other body parts each showing the muscles, nerves, and blood vessels in three dimensions) that are being used to train physicians and surgeons. The other half are animations used to support expert testimony for litigation hearings. The development began when the professor/inventor was involved in part-time consultations to create animations of accidents. He is a stock-holder of the company with 20% of the stock. The company has an exclusive licensing agreement with the Iowa State University Research Foundation.

du Pont Agricultural Products

Mr. Glen Rippke
Mr. Daniel Dyer

While basic research and development activities are carried out in Delaware, the grain quality research laboratory is located in Iowa, where Du Pont staff are in close contact with the corn breeders. When Du Pont began at Iowa State, they used some of the more advanced university equipment, but over three years, Du Pont's technical capability has outstripped the university's in this area. The laboratory works closely with its strategic partners, Holden Seed company and Asgrow, to develop and test genetically engineered corn and soybean seed products. Using nondestructive analyses, 35,000 samples can be tested in two weeks for protein, oil, starch, and energy content. This unit of Du Pont has been in this location for three years and is expected to break even in two more years.

UNIVERSITY OF FLORIDA, GAINESVILLE

Agriculture in Florida and the Role of the University

Dr James M. Davidson
Vice President for Agriculture and Natural Resources

The state of Florida ranks 8th in the U.S. in agricultural production and 2nd for plant production alone. The commodities produced in Florida are valued at $6 billion before processing (at the farmgate): $1.4 billion in vegetables, $1.4 billion in citrus, and about $1.4 billion in ornamentals. Florida ranks 4th in earnings from its own agricultural technologies and is 2nd in state funding for

research. Although agricultural production was once the overriding issue, producers and processors are now very much concerned with the environment as well.

The School of Agriculture has the following full-time staff:

- 400 in research (63% of budget)
- 150 in extension (27% of budget)
- 100 in teaching (10% of budget)

The federal government provides 4% of the funding for research at University of Florida and 20% of the funding for extension. The 67 counties in the state of Florida, through property and sales taxes, cover 40% of the cost of extension. This funding contributes to youth programs and adult education as well as research, extension, and teaching. The private sector provides up to 5% of university funding. $80-90 million goes to research, about 28% of which goes to extramural studies in the form of contracts and grants. For every box of citrus that is marketed 1/2 cent, and more recently 1 cent, is contributed to research and education on citrus. The vegetable and dairy producers each contribute $350-400,000 for research.

Agriculture and Technology Transfer

Dr York
Chancellor Emeritus
Florida State University System

In 1862 President Lincoln created the land grant colleges with grants of public land. In 1888 the Hatch Act authorized research and extension, which led to the establishment of extension services as enacted by the Smith-Lever Act in 1913. This act was legislated federally but directed by states. USDA established the Cooperative Research and Extension Service (CRES) to assist in the coordination of this. Over the years, extension programs have extended to include marketing of crops, broad rural programs to address local needs, nutrition programs, and others. The state government supports land grant colleges through programs like Florida's Institute of Food and Agriculture (IFAS). The private sector (in areas such as seed, fertilizer, farm machinery, and others) provides funding to the university from commercial sales.

In 1964, the University of Florida's food, agricultural, and natural resource programs were consolidated into Florida Institute of Food and Agriculture (IFAS) to link the academic program of the university with research and extension programs in food, agriculture, natural resources, and veterinary medicine.

IFAS conducts research, teaches students, and disseminates science-based educational information through the extension service. Its research supports the state's $40 billion food, agricultural, and natural resource industries; prepared students for careers in those industries; and delivers science-based information to consumers. Research and extension programs address issues of food and food quality, pests, plants, water quality and wuantity, solid waste disposal, energy conservation, marketing, home resource management, and youth and community development in Florida.

The not-for-profit organization provides a means by which discoveries, inventions, processes, and work products of the UF faculty, staff, and students can be transferred from the laboratory to the public. Funds generated by such discoveries are used to enhance research at the University of Florida. Research-generated inventions and copyrights that have commercial value are assigned to the Research Foundation for marketing to private industry. All income received from license fees, royalties, and equity positions is distributed by the Research FRoundation to inventors and their departments. The remaining share is used to support patent and copyright functions at the University and for the direct support of research throughout campus.

Faculty spin-off companies have been operating in the Gainesville area since the early 1950s. These companies today employ nearly 1,000 people from the Gainesville community, and their annual economic impact is estimated at approximately $60 million. The University of Florida ranks second among universities in licensing income as a percentage of sponsored research, and third in the number of patents issued per dollar of funded, sponsored research.

Private companies provide grants or contracts to support research of interest to both the company and the university. This has sometimes led to development of a product or a process that is commercialisable. The resulting patent earnings are shared between the scientist and the company. An example of this is *Gatorade*, which was developed by a physician at University of Florida who studied the loss of salts in athletes during heavy exercise. He developed and marketed fruit-based drinks that would replace electrolytes lost with water during strenuous exercise. A second generation of drinks named TQ11 or Thirst Quencher 11 is about to be marketed.

Private companies can support research through a contract to undertake defined studies of mutual interest. Commodity groups will sometimes tax themselves or their sales to provide funding for research. One group in Raleigh, North Carolina had a program, Nickels for Know-How, in which growers were assessed 5 cents per ton of fertilizer or feed. This has since been raised to 10 cents per ton. Commodity groups may have an advisory board that targets funds raised by their membership toward research on problems important to their members.

Gifts from agricultural foundations to the university may also support a university chair for an eminent scholar or research equipment. Frequently the State of Florida will provide matching funds toward construction of a new university building when outside funds have been raised. The Florida Agricultural Council represents all major agricultural groups around the state (the farm bureau, seed and commodity groups, etc) and works with them to support research at the university.

Agricultural Research at USDA

Dr Sherlie West
USDA at University of Florida, Gainesville

The agricultural research service (ARS) of the USDA takes guidelines from the USDA in Washington, DC but is also free to work with University of Florida on projects important to the state. The ARS has 2600 scientists in the United States, most of whom are associated with land grant universities. There are 125 scientists at the University of Florida, 65 of whom are at Gainesville. Their research is conducted on land given by University of Florida. Cooperation between USDA and university faculty is common:

ARS maintains a national germplasm depository with worldwide collections. It also maintains a national seed storage facility in Colorado. Here old and new varieties are maintained in viable form.

ARS supports genetic engineering programs by making available to university researchers expensive equipment in a gene expression laboratory.

As a federal agency, ARS seeks alternate ways to produce crops--for higher yields, less expensive production, and improved reliability. The agency is involved in finding solutions to emergencies such as Salmonella and E. coli outbreaks in food.

The transfer of technologies takes place in ARS in a similar way to the university. There are often joint releases of products, joint patents, and joint publications. When a patent is issued, both the university and ARS encourage use of that technology. As long as the technology is used, a company can receive exclusive rights to it. Scientists receive 15% of the royalty up to $100,000/year, and the remainder of the earnings support research.

Commercialization of a Diagnostic Test for HIV Infection

Dr Roger Clemmons
College of Veterinary Medicine

Scientists who undertake applied research are receiving acclaim and monetary awards when they make substantial contributions toward industrial production. While industrial scientists used to identify promising technologies from universities by reading the literature and participating in scientific meetings, that is now too late, since promising technologies are likely to be already patented and undergoing commercialization.

Many industries have found it more productive to support universities and use their research system to develop new technologies. It is a major expense to set up and maintain their own laboratories and difficult to establish an environment stimulating to scientists. The university has that already in place.

In order for development of a diagnostic test to be economically feasible, there must be a demand for at least 100,000 tests per year. Substantial start-up funds are needed to develop a diagnostic test, and this funding is generally not available from government sources. As a result small companies do not have the capital needed to bring such tests to the marketplace. The Wall Street Journal has noted that the challenge for high technology companies is to expand the boundaries of science and make money at the same time.

In the United States, 12-20% of the feline population is infected with a disease similar to AIDS, which is eventually fatal. Study of this disease at University of Florida has led to development of a diagnostic test for HIV infection in humans. The need for simple, reliable tests is underscored by the dramatic increase in numbers of persons infected with HIV.

The diagnostic test developed--ORACLE™-HIV--provides rapid, visual results; allows multiple testing; and has a minimal cost. Considerable testing is needed to establish the sensitivity and accuracy of the test using both saliva and blood specimens.

Raising Funds for Agricultural Research

Mrs. Melda Bassett
Special Help for Agricultural Research and Education (SHARE)
University of Florida Foundation, Inc.

The university established SHARE in 1981 to solicit, receive, and manage private support for IFAS. This foundation receives donations from a variety of sources: $1 million from a family corporation to protect the Everglades, $450,000 from the State of Florida, $300,000 from Florida Turfgrass together with matching funds from the state, $0.8 million from companies involving aquatic food products together with another $0.8 million in matching funds from the state, and $40 million raised from many donors in a campaign to raise funding for the next five years. These donors were asked to donate cash, stocks, land, endowed funds, or life income gifts of several types, or to name the agricultural foundation as the beneficiary of life insurance policies. In addition, some employers make a donation that matches that of an employee.

Funding of Agricultural Research

Dr Neal Thompson
Dean for Research

The research program of the university is conducted statewide. About half the research staff are in Gainesville and about half are in the 13 centers throughout the state. Association with industry is strongly encouraged and effective in many areas: ethanol generation, methane production, vaccines for babesiosis and anaplasmosis, and development of new plant varieties.

Development of new plant varieties involves about one third of the research resources in agriculture and involves cooperation with industry, which has the necessary market expertise. New varieties are handled by the Cultivar Release Committee then by the Florida Seed Foundation, a private auxiliary to assist in getting new varieties into use. Private companies submit proposals to obtain new, patented varieties and may pay royalties to the university's experiment station. Sometimes a variety is released to several companies. The university is focused more on getting the variety out to producers than to making profit.

Funding support to the university from the U.S. Department of Agriculture and the State of Florida is currently limited since the U.S. is in the mode of reducing public expenditures. Increasingly, research is undertaken with private industry to accomplish tasks that are defined in contracts between the two groups. Funding cannot be accepted by the University if there are associated and inappropriate expectations or requirements. Considerable research support still comes from government programs at National Science Foundation and National Institutes of Health, also from private foundations in the form of competitive grants for innovative, promising research. The key to success in the highly competitive research and development industry is to always hire the best faculty. They must be highly talented and highly motivated to be successful.

Commercialization of University Research

Dr Tom Walsh
Head, Sponsored Research

Once a discovery is patented it becomes part of public knowledge but is protected for 17 years. Licensing is the right to use the knowledge in a patent. While small companies cannot afford to pay large licensing fees, they can substitute with stock in their company. If a researcher first publishes the work in a scientific journal, he can still obtain a patent in the United States within a year of the publication. To obtain a worldwide patent, which covers a market double that of the U.S. alone, it is necessary to obtain the patent first.

Why use a system of patents? Is this not an unnecessary expense? Patents create the incentive necessary for a company to invest in development, secure in the knowledge that the new technology is protected and they can make a profit later. The company need not fear competition from a copy-cat organization. The cost of development is too high for companies if they do not have this security. The system of patents is expensive: not only in the legal preparation of the patent but to be effective the patent must be upheld by the judicial system.

Most states have a research park, each of which is operated differently. They all belong to the Association of University Research Parks. No model is perfect and that is certainly true of the research parks- there have been many failures. At the University of Florida Research Park about 40% of the projects are from the university and 60% from industry. The research park and its close association with the university offers the kind of environment important for these creative endeavors but expensive and well beyond the means of most small companies. The university does require that an inventor own no more than 5% of the stock in his company in order to maintain a faculty appointment.

The University of Florida discovery selected as being singularly significant from the first $5 million patents was one for making fuel from celluloses and hemicelluloses from a wide range of plants including sugarcane, corn, kallar grass, vetiver, cotton stems, rice husk, and citrus pulp. The first and easy step is to convert the celluloses and hemicelluloses to sugars. The second step is the important discovery, and that is to use a bacterial fermentation to make ethanol from the five and six carbon sugars. Brazil has cars and trucks running on 100% and 20% ethanol and is building an industrial plant to extract the sap from sugarcane and ferment it with yeast, then heat it with sulfuric acid to release the sugars, which are finally fermented to ethanol. This operation can operate year-round, whereas the alternative industry--production of rum--operates for only six months while the sugarcane is available.

The Interdisciplinary Center for Biotechnology Research

Director, Dr Sheldon Schuster

The university has developed a center with sophisticated laboratory capability in a wide range of biological techniques. This center is used by researchers at the university, and by other groups for specialized measurements and analyses and for educational work, all on a fee for service basis. The capabilities of this center include: biological computing, DNA sequencing, DNA synthesis,

biotechnology education and training, electron microscopy, flow cytometry, hybridoma technology, protein chemistry, transgenic animal technology, and biotechnologies for the ecological, evolutionary and conservation sciences.

NORTH CAROLINA STATE UNIVERSITY

The U.S. Land Grant System and Partnerships between the Public and Private Sectors

Dr Jon Ort
Dean, College of Agriculture and Life Sciences

North Carolina has several (16) campuses across the state, the largest of which is North Carolina State University at Raleigh with more than 27,000 students. There are also 58 community colleges--only Texas and California have bigger systems of university campuses.

The College of Life Sciences is the second largest of the colleges at North Carolina State University and accepts 3200 students each year from the 11,000 to 13,000 applicants. The faculty for this college is about 165, most of whom have appointments divided between research and teaching or, less commonly, between research and extension.

Agricultural Research Service, USDA at North Carolina State University While 55-60% of the North Carolina population is rural, less than 3% is directly employed in agriculture. In 1960, 60% of the agricultural earnings was from tobacco, while in 1993, under pressure in the United States to reduce the use of tobacco products, earnings from tobacco have dropped to 17%. The poultry, livestock, and animal product industries of North Carolina are valued at 2.6 billion annually. Horticultural crops are valued at $600 million.

The university budget for agricultural and life sciences is $140 million per year. The private sector contributes $3-4 million for extension and $24 million in grants, contracts, and memoirs of agreement. Since the national economy is weak at this time funding levels are lower than otherwise anticipated.

Environmental Biotechnology

Dr James Shih
Professor, Poultry Science

Using a thermophilic, anaerobic digestion of poultry waste, a higher reaction rate has been obtained along with a shorter retention time, a less viscous medium, mixing by effervescence, and a process adaptable to a simple digester, with improved control of pathogens, better environmental health, and more sanitary by-products.

Using Bacillus lichenoformis, the poultry feathers are also digested and the resulting feather lysate is

a feed as nutritious for chickens as soybean meal. The enzyme responsible for the digestion is a powerful protease, keratinase, which is also active on collagen, elastin, and casein. It has been patented.

Aseptic Technology in Packaging

Dr. Arthur Hansen
Professor, Department of Food Science

This is the processing technology by which a sterile product is loaded into sterile packaging:

- plate heat exchanger is used for juices
- tubular heat exchanger is used for fluids and products with particles and fibers such as eggs
- direct steam incorporation is used for apple sauce and spaghetti sauce- the quick heating time allows better retention of the flavor

This kind of technology would provide an opportunity for Pakistan to extend its markets into other countries. This is the direction of the future for food packaging. By the year 2000, half the milk in the United States will be ultrapasteurised. Multi-layered packaging can provide separate barriers to oxygen, light, and other flavors.

The Role of Extension and Research in Market Development for Small Fruits

Dr Barclay Poling
Associate Professor, Horticulture

Small fruit crops represent about $25 million in farmgate receipts, less than 1% of North Carolina's $5 billion come from farm products. All horticulture has sales of about $600 million with the largest group being vegetable crops, followed by greenhouse and nursery crops, and finally tree fruits and small fruits.

Strawberries are a high value crop and great attention is given to marketing and marketing strategies. Small fruits are becoming more important as farmers in North Carolina move away from tobacco production. In 1980 strawberry growers were in a sellers' market. The demand for strawberries was high and the crop was sold at the gate on a pick your own basis. Growers could realize a profit of $24,000 per hectare. The strawberry industry in California then moved to better varieties of strawberries and North Carolina growers lost their markets to the new varieties. To regain the strawberry markets as rapidly as possible, a market-directed research and extension program was initiated. Visits to California and Florida to meet growers and researchers and learn new technologies revealed that the matted row cultivars had a relatively poor picking performance. The harvest efficiency could be improved three- to four-fold by growing cultivars with larger berries on raised mulch-covered beds. The California cv. "Pajaro" had excellent attributes with large berries, easy fruit detachability, and a medium size plant. An intensive field investigation was launched in North

Carolina to test ideas from California and Florida. New production methods were developed, a vigorous extension program was undertaken including ten half-acre plasticulture demonstrations funded by the North Carolina Agricultural Foundation, and the farmers became convinced of the advantages of the new methods. The demonstrations continued in more areas and the adoption of the methods led to a recapturing of the lost markets. Despite later difficulties with anthracnose losses, the strawberry industry in North Carolina is rebounding. The Chandler variety brought back from California grows well in North Carolina and can be harvested with fuller flavor and color. There is now research directed at growing a September-December crop of strawberries, which would go onto the market when prices for strawberries are highest.

The university appointment split between research and extension has been an effective mechanism for becoming involved in research focused on specific industry problems. A university researcher has access to a broad range of expertise at the university and across the country and these can be used, as with strawberries, to solve industry problems. Success requires that research is directed toward products that provide the consumer with quality and convenience at a reasonable price.

RESEARCH TRIANGLE PARK, RALEIGH, NORTH CAROLINA

BASF Agricultural Research Center

Pesticides and crop protection are central to BASF's business in the United States. The company is about the eighth largest in the United States and in the world. There are 17,000 employees in the U.S. While herbicides are the most used products in the U.S., followed by insecticides, then fungicides, the order is reversed in Europe.

Research Triangle Park was established in the 1950's. BASF began construction here in the 70's and completed the facility in the mid 80's. This was an ideal location with North Carolina State University, Duke University, and University of North Carolina all within 20 miles and much land available. Many other large laboratories were also attracted to Research Triangle Park. They were followed by contract laboratories that provide support to the larger companies. The universities are good sources of highly qualified staff and have sophisticated instruments that can be made available to private sector researchers. BASF has 80 laboratories in this location. The nylon and fibers part of the company is located at Charlotte.

Without chemicals it is no longer possible to produce enough food to feed the world. The extent of losses depends on the crop, the pest, and the field conditions. Cotton can produce a zero yield without herbicides. A balance can be maintained between hard pesticides and alternate methods of pest control.

The decision on whether to commercialize a product or not is very difficult because of the massive expense involved. The regulatory work for a U.S. patent alone costs $10-20 million, requires 5 to 6 years of data, and about 2 years for the EPA to evaluate that data. Fifteen years ago the following questions were developed to assist BASF managers in the decision whether to commercialize a product:

- Does it have biological activity?

- Can the company synthesize it?
- Does it meet BASF's strategy?
- What effect would it have on current BASF products?
- Exactly how is it used? At what rates? What does it control?
- How many years to develop it?
- Registration for the year 2000?
- What is the total crop acreage?
- What is the total biological potential area?
- What are the major competitive markets
- What will the BASF market share be in five years?
- How are BASF competitors doing and how effective are they?
- What will be our sales costs?
- What is our method of distribution--will our distributors be receptive to this product?
- Is the product easy to use, handle, and store?
- What investment needs to be made in field development and registration?

The environmental costs alone are around $3.5 million, and the cost of establishing the residues is another $350,000. This is in addition to formulation costs, toxicological testing, registration, and risk assessment. The object is to achieve a return on the R&D investment within three years of marketing the product.

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Panel Meeting for Study Tour from Pakistan
COMMERCIALIZATION OF RESEARCH

1055 Thomas Jefferson Street, Room 2003
Washington, DC
Wednesday, April 28, 1993

SUMMARY OF DISCUSSION

Introduction

Dr. Michael Dow, BOSTID Acting Director, welcomed members of the Study Tour from Pakistan on behalf of the National Academy of Sciences/National Research Council, and said he was pleased to see this collaborative program expand beyond research laboratories and into the realm of implementation and the private sector. Dr. Dow expressed gratitude to the Pakistan Ministry of Agriculture and the U.S. Agency for International Development who have supported this visit and to the U.S. scientists who donated their time and expertise to host the Study Tour. As a result of their efforts, ways to continue this productive collaboration may be identified.

Noting that Pakistan already had an excellent start toward technology transfer, Dr. Mary Carter, Co-Chairperson with Dr. Mumtaz Ahmad of this panel meeting, asked members to introduce themselves:

- Dr. Mumtaz Ahmad, Co-Chairperson of this meeting and leader of the Study Tour, Director of the National Agricultural Research Centre (NARC) in Islamabad;
- Mr. James Finch, member of a New York law firm specializing in helping foreign investors in developing countries and studying mechanisms of technology transfer;
- Dr. Peter Carlson, plant geneticist with a private firm whose specialty is biological controls for crop protection and whose interest is taking research from universities to the private sector;
- Dr. Abdul Shakoor Khan, who worked in the private sector before joining the Pakistan Agricultural Research Council (PARC), has taught at the University of Agriculture, Faisalabad, and is now director of the Farm Machinery Institute in Islamabad;
- Dr. Leon Hesser, consulting agricultural economist formerly with USAID, served in Pakistan from 1966-1973 and helped set up the Agricultural Business Cell;
- Mr. Mohammad Abid Farooq, Director General of Agriculture for the

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Department of Agriculture of the Government of the Punjab, whose career has been mainly in mechanization research, combining engineering and agriculture;

- Dr. Cyrus McKell, Dean of the College of Natural Sciences at Weber State University in Ogden, Utah and Chairman of the BOSTID Pakistan Agricultural Research Program, previously with Native Plants, Inc.;
- Dr. Abdul Sattar Alvi, Director of the Arid Zone Research Institute in Quetta, formerly with the MART project, whose specialty is breeding and nutrition studies;
- Dr. Shaheena Mashkoor, microbiologist and poultry production specialist recently with agrobusiness, currently assistant liaison for BOSTID-PARC program;
- Dr. Muhammad Khalid of USAID, an agricultural engineer by training, who has worked in Saudi Arabia, at NARC's Farm Machinery Institute, as a private consultant, and for the Winrock MART project;
- Dr. Richard Goldman of the Harvard Institute for International Development whose area is research studies on food and agricultural policy in Pakistan;
- Mr. Sultan Mahmood Khan, economist formerly with the National Fertilizer Corporation who has worked at PARC since 1985, currently in research-industry linkages;
- Dr. Mary Carter, Area Director for the U.S. Department of Agriculture's (USDA) Agricultural Research Service (ARS), who worked as a chemist in the textile industry before joining USDA where she served as Associate Administrator of ARS before returning to the field--closer to science, "where the action is;"
- Dr. Judith Bale of BOSTID, director of the BOSTID Pakistan Agricultural Research Program;
- Mrs. Barbara Krause, senior assistant for the BOSTID Pakistan Agrigultural Research Program.

Dr. Carter commented briefly on technology transfer and the possibility of success.

- The barriers to technology transfer are mostly man-made.
- For the process of technology transfer to occur, There must be a champion on both sides.
- People make technology transfer happen.
- Choose attainable objectives for some early successes toward the long term goals.
- When setting objectives, be sure the objectives selected can be monitored and tracked.
- The smaller the steps are, the likelier they are to succeed.

Dr. Ahmad thanked USAID and BOSTID for the opportunities given members of the Study Tour during the last week. He listed the strengths of American society which he felt encouraged interaction leading to policy development and pointed out that while massive investment in science and technology has come from the U.S. public treasury, this is now beginning to change. This visit has confirmed his belief that public/private sector linkages are imperative for Pakistan. He noted that Pakistan has strict laws (based on British law) for protection of intellectual property rights (IPR). (See Appendix K.)

Strengths, Constraints, and Gaps -- (See Appendix L.)

Dr. Ahmad noted a change over the last few years in Pakistan, from a belief that the private sector should have its own research and development, to the current concern that a large movement toward private research would dilute resources too much and therefore companies should be induced to come to the public sector with its strong facilities.

Dr. Goldman asked if there were any examples of where technology transfer has been successful in Pakistan. A few striking examples and how they worked in terms of private-public interaction would be a strong starting point.

Dr. Peter Carlson suggested discussing what works and what does not work in the U.S. system of technology transfer, and how CRADAs could be improved. CRADAs were developed by Congress in 1986 through frustration over the lack of technology transfer. He quoted two axioms:

- The perfect is the enemy of the good.
- We are all prisoners of our institutions.

Technology transfer has different kinds of institutions; ARS and the universities have a cycle of discovery, publication, and moving on. Just because something is invented, doesn't mean it's put to work. CRADAs were an opportunity to infiltrate the ARS with a fifth column and make their research results practical. Researchers in both the U.S. and Pakistan tend to feel they have a right to undertake research of interest or importance to them but do not feel responsible to deliver a usable finding.

Dr. Carter: What is the entrepreneurial gap?

Dr. Ahmad: Some technologies may not have commercial value for years. There first needs to be strong interaction between end-users and researchers.

Dr. Carter: Is this do-able?

Dr. Ahmad: It can be built into the system.

Dr. Khalid: Even before a scientist talks to industry, you need to know his motives.

Dr. Carter: Perhaps we had better educate scientists on their mission?

Dr. Mashkoor saw the need for direct linkages between the scientists and industry; PARC holds workshops where they get together. Dr. A. S. Khan suggested the Farm Machinery Institute as a model for this kind of linkage, but added that it was hard to get industry to the roundtable in Pakistan. There should be basic and applied research in each institute, along with a commitment and accountability for specific goals.

Dr. Khalid pointed out that researchers do not understand the private sector. There are two kinds of companies in Pakistan--the large multinational companies that do not need the input of Pakistani researchers and the small family businesses that cannot afford time to attend meetings. The large companies attend, but are not interested in science or research findings--they come only to lobby for government rulings that favor their industry. There should be an orientation for scientists before they

enter research institutes; he suggested interaction with industry during college so that when the researcher joins the institution, he or she would already have an appreciation of industry's needs. Most scientists lack this understanding. Dr. Carter noted that this educational problem was similar in the U.S. Dr. Ahmad noted that scientists are human beings, they cannot be programmed. Dr. A. S. Khan agreed that exposure of scientists to industry cannot be made compulsory.

Mr. James Finch asked whether Pakistan had the infrastructure to bridge the gap between discovery and commercialization. The U.S. system uses letters of agreement for the researcher and industry to work together to develop a project, but that is an expensive process.

Mr. Finch asked some practical questions: Are the laws in Pakistan properly enforced? Could a foreign investor register a patent and stop infringement? Are there practical problems with enforcing patent rights? Dr. Ahmad did not think so. Dr. McKell asked who issued the patent; Dr. Ahmad listed the Pakistan Consul of Industrial and Scientific Research, the Trademark Registry (Ministry of Commerce), the Patent Office (Ministry of Industry) and the Center of Copyright (Ministry of Education), all in Karachi.

Mr. S. M. Khan noted that few technologies are being developed in Pakistan, and he is not confident that even these are commercially viable. There is some collaboration between PARC/NARC and the private sector. PARC's Agri-Business Relations Cell (ABRC), represented in the provinces by Chambers of Commerce, attempts to bring the sectors closer. Scientists come to ABRC's annual meeting, where subcommittees decide whether a product can be commercialized. Dr. Carter asked whether there are other less formal occasions for bringing researchers and industry together.

Dr. Goldman commented that all applied research programs have the fundamental difficulties. How do you learn to solve problems and how do you learn what problem to solve? Part of the answer appears to be by using incentives, by being rewarded for solving the problem--not always with lots of money, but through status, recognition, or being held accountable for the results. We need a management system that encourages us to focus on problems. Young scientists have limited experience in producing science. In many developing countries, the scientists do not understand the practical problems of marketing. First, to produce new technologies, they need a free-flowing exchange of ideas, not just annual meetings. Part of this lack is due to budgetary constraints; there can only be a limited number of research projects.

Dr. Mashkoor noted that despite many meetings, bonds are not being forged between scientists and the private sector. In the U.S., everybody knows there's a reward for applied research when it is commercialized. Industry needs direct linkages with researchers, a knowledge of what is being done and where.

Dr. S.M. Khan noted that PARC has an agribusiness research committee (ABRC) that meets once each year. Members of the committee include chamber of commerce and industry, farmers' associactions, and research institutes. There are also technology scrutinizing committees that review the technologies emerging in their areas. The ABRC negotiates agreements. One example is the development of a vaccine for hydropericardium syndrome in poultry.

Dr. Khalid repeated that scientists need a better understanding of industry, and their attitude could be changed through orientation or internship.

Dr. Alvi described the situation in Baluchistan, where there is no industry. There the scientist goes to the farmer through agricultural extension. The farmers give no input and get no technology except farm machinery. He is seeking good linkages between extension workers, universities, and farmers in Baluchistan. Dr. Bale asked whether there was interaction when the farmers pick up seedlings from his institution; Dr. Alvi replied that the institute uses farmers' fields as well as their own fields as nurseries for seedlings provided to farmers, but that they need to do this on a larger scale. Dr. Carter commented that this was technology transfer.

Dr. Ahmad saw the need for a national policy statement because agricultural assistance had now been fragmented to the provincial level, and the linkages once well established by the University of the Punjab have been lost in this fragmentation. Dr. Mashkoor felt that PARC and the Government of Pakistan need strong technology transfer units rather than having everyone work on the problem. Someone from each department--crops, forests, fisheries, livestock--should act as a technology transfer specialist to coordinate at a provincial level. Dr. Carlson pointed out that having researchers in private industry at least encourages industry to think about research. Dr. Khalid said that the major problems in industry do get attention but the smaller ones still exist; the researcher needs to visit industry.

Dr. Carter asked about other problems.

Dr. Ahmad felt the biggest constraint is the very low budget allocation for agriculture--0.05% of total GDP--lower than in Thailand, Kenya, or Bangladesh. Dr. Carlson asked who supplies fertilizer and pesticides to small and large farms in Pakistan. Dr. Ahmad replied that it was a blend of public and private, but fertilizer suppliers were essentially private, as were seed companies and pesticide suppliers. Dr. Carlson asked who the average customer was; Dr. Ahmad answered that the average customers were the large cotton plantations.

Dr. Dow pointed out the large role of multinational corporations that do not contribute to local research. In Peru, where all economic activity is by multinational companies, a workshop on "directed expenditures" recommended that multinational companies pay 2% on their sales in-country, and this sum be directed toward local research by their company or be given to a local research institute.

Dr. Carlson commented that physics and chemistry work everywhere, but biologicals are localized. So as the world moves toward biologicals, this research must be done locally. Here is an opportunity to build local industry for biological crop protection. This could become an infrastructure for local research.

Dr. Carter asked panel members what opportunities they saw for strengthening the present system, what is in place and working now? The strengths mentioned were human resources, material resources such as laboratories, and the existing mechanisms for identifying research priorities; unfortunately, these mechanisms are not very effective at identifying needs. PARC can be a model for the provinces. Unfortunately, there is only one person (Mr. S. M. Khan) at PARC to work on technology transfer to the provinces.

Dr. Ahmad noted that strengths, such as manpower and mechanisms, are present, but not properly implemented. Dr. Khalid added that now researchers are allowed to go from public to private sector work provided they are on leave and the work is research-related. This has been made possible by a

recent change in the law, and several researchers have used this opportunity. The difference is that public work is an 8-hour day, while private work requires that the worker produce results. PARC's present policy is to charge fees for scientists' work when it is commercialized; of this, 25% goes to the researcher and the remainder to PARC. The flexibility for cooperation with industry is in place for PARC and Mr. S. M. Khan added that a similar arrangement could be made in the provinces.

Dr. Khalid pointed out that the MART project with USAID funding provided the opportunity for 10 scientists to have short-term training of a few months in the U.S., basically to study research-university linkages.

Dr. Ahmad commented that decision-making power often ends up in the hands of financial officers.

Dr. Carter asked whether any research funds came from the private sector. Dr. Ahmad answered that a few scientists do obtain money this way. Mr. S. M. Khan pointed out that there are also constraints on agribusiness, such as capital shortages.

Dr. Ahmad pointed out the need for projections on the manpower needed in different sectors. Dr. Carter noted that Bell Laboratories has developed a system that projects manpower needs.

Dr. Carter asked panel members how more money for research could be found. Mr. Finch pointed out that although taxing the companies is one solution, the power to tax is also the power to destroy; this solution should be applied only with great care, for fear of killing the goose that laid the golden eggs. Dr. Goldman said a major reason for public research is to lay golden eggs for the private sector. The problem is lack of resources, and the need for more funding to be added to the agricultural research budget. Dr. Carter suggested that, in view of this, planning should include strategies for providing these ideas to the decision makers in government. Dr. McKell emphasized the importance of the product; in the public sector as in the private sector, results are what impress decision makers. Dr. Carlson added that if the public sector can show the golden eggs they are producing, private corporations will collaborate. CRADAs are aimed to redesign science in government research agencies.

Mr. Farooq felt the system's basic weakness was that scientists do not see the benefits of collaboration. Agronomic research is accepted and used by the farmers, but there is a bigger gap between industry and science. A strategy is needed to bring them together.

Dr. Khalid listed some strengths in the American system that could be adapted for use in Pakistan:

- Inventors supported by the public sector can still share in the profits from their inventions; in Pakistan, they cannot invest in their own companies. This should be made legal. (Dr. Alvi disagreed with this point, and Dr. Bale pointed out that there are limits to this in the U.S. system).
- U.S. scientists are allowed to consult.
- There are strong research programs assisting commercialization in the U.S. universities.
- U.S. Technology Policy and Transfer Act gives guidelines as to what can be done.
- At the University of Florida, the Study Tour learned of the strong setup for soliciting gifts from the rich; there are some "godfathers" in Pakistan, but no system for approaching them.

Dr. Bale suggested possible training for research managers; Dr. Carter added that a research manager/leader needs vision and responsibility.

Another constraint Dr. Ahmad pointed out was the difficulty of transportation within the country. The scientists in Quetta or Karachi are seldom seen and work in isolation.

Dr. Shaheena suggested that a researcher could get an orientation training before joining the institute, so the researcher would know what industry wants, and industry would know who to approach for research help within the institute.

Dr. A. S. Khan asked when was the best time to invite industry to take part--at the beginning or middle of the research, or when ready to sell the product? Clearly there are benefits at all stages from the right kind of industry participation.

Dr. Ahmad mentioned one insight he gained on the Study Tour, the constant on-the-job development. Communication occurs through membership in societies, teaching, research, and interaction with colleagues. This does not happen so much in Pakistan. Dr. A. S. Khan suggested strengthening the Pakistan roundtable, which now meets only once a year.

Dr. Khalid remarked on the 6 or 7 job offers waiting for some of the graduates from the agricultural programs visited on the Study Tour. This kind of opportunity would seem wonderful in Pakistan. Dr. McKell pointed out that if linkages were established early in the education process and the student produced well, job offers might follow in Pakistan too. Dr. Carter asked how much research is done in Pakistan universities; the answer from panel members was that very little research is done in universities, except for the agricultural universities. Pakistan has 23 universities, 5 of them private. Several panel members are Ph.D. advisors, which gives them a chance to interact with graduate students. Universities do not undertake research as advanced as in the technical colleges, but PARC gives grants to university researchers.

Dr. Shaheena described student research into poultry disease as a model for private sector sponsorship. Dr. McKell commented that the scientist should come into private industry to consult, and do the research at public universities or institutes, thus involving industry in the research setting.

James Finch noted that the essence of technology transfer, from a legal viewpoint, is that each key person must receive incentives--the company, university, inventor, and the consumer. In the U.S., technology transfer has worked quite well because incentives and rights exist and are enforceable.

Dr. Carlson described the growth of Crop Genetics International, the firm he founded 15 years ago in the belief that biotechnology could be commercialized. They are now one of 7 companies attempting to commercialize plant biotechnology in the U.S. and abroad. It can be an empowering technology in the developing world, but Pakistan will have to figure out how to develop it. A clear goal is essential before taking the first step. It is important to be flexible and adjust expectations as necessary. And it is important who gets there first. Research at Crop Genetics' on sugarcane has increased yields by 25%, by developing disease-free plants.

A discussion of strategic planning followed. Dr. Ahmad remarked that PARC coordinates with provincial offices, and each major commodity (cotton, rice, sugarcane, etc.) has its own meeting. Dr. A. S. Khan added that Pakistan's agricultural policy is coordinated in 5-year plans, modified as

need arises. Dr. Carter commented that USDA reviews its 6-year plan every year. Dr. Carter asked how the needs of the private sector were identified. Mr. Khan replied that his office had 10,000 contacts, some in each category of the private sector. Mr. Finch wondered if the panel was talking too much in terms of central planning. Dr. Ahmad suggested a program similar to S. M. Khan's at the provincial level.

Dr. Goldman asserted that the meeting was now at the interface where perfect is the enemy of good. In describing the Pakistan system, members tend to describe it as perfect. Let's look at how to make it better, not perfect. It is too easy to blame lack of money for frustration.

Dr. Ahmad mentioned different perceptions and ideas gleaned from the Study Tour. He felt Pakistan must reduce the number of fragmented institutions. Another serious impediment was the 12 1/2 acre limit on land ownership. Food crops were exempted from land reforms, so there are still large holdings where absentee landlords do not maximize production. Islamic law does not allow consolidating into cooperatives.

Conclusion

Dr. Carter told the panel members that in tomorrow's meeting they would need to come up with an outline of what needs to be addressed and identify areas where issue papers might be needed. She asked for input from everyone, so the meeting could recognize the strengths in the agricultural sector of Pakistan.

Dr. Bale reminded the group that they looked forward to another meeting in Pakistan for putting together the strategy. Our burden here has been to piece together the experiences of the last week to produce solid recommendations. Background papers should be prepared before the Pakistan meeting. There is not one magic answer, like CRADAs, to Pakistan's agricultural problems. Tomorrow we will not draw up a finished plan, but rather seek to focus on what might work and what gaps exist.

End of First Day's Meeting

Panel Meeting for Study Tour from Pakistan
COMMERCIALIZATION OF RESEARCH

2101 Constitution Avenue, Room 180
Washington, DC
Thursday, April 29, 1993

SUMMARY OF DISCUSSION

Introduction

Dr. Khalid supplied panel members with copies of *Guidelines for Technical Collaboration with the Private Agribusiness Sector* (M. Khalid and S. M. Khan, PARC, Islamabad, November 1991) and *PARC's Policy for Technical Collaboration with the Private Agribusiness Sector* (The Directorate of Agri-Business Relations, PARC, Islamabad, May 1992). See Appendix M.

Dr. Bale remarked that the panel had heard about several committees set up to solve the challenges of coordination of researchers and the private sector, and of ensuring the maximum payoff for government investments in research. While it is important to be aware of mechanisms that are in place, we need to be aware of areas where the mechanisms can be improved. By prioritizing these areas and working for solutions to them, we have an opportunity to improve, and perhaps make a large impact, on technology transfer in Pakistan.

Dr. Carter added that it was most important to focus on problems that require a research solution in order to meet the nation's food needs.

Dr. Bale complimented the panel on the distance they had come during yesterday's meeting. She asked them to divide into groups for brainstorming. The group divided as follows:

Gaps in Information
(Finch, Khalid, A.S. Khan, S.M. Khan, McKell)

1. Scientific research - agribusiness

Government - institutional

2. Directorate of Agribusiness - size of staff now 1 person
(Relations of PARC) - missing in provinces

3. Scientists who are aware of patent and license process
Inventions

4. Scientist entrepreneur

5. Present course of agriculture - management courses
Study in university - practical training for students

6. Potential venture capitalists in agriculture - investment opportunities

7. Well known technologies - actual production
- educational
- business

Constraints to Technology Transfer
(Bale, Farooq, Goldman, Mashkoor)

1. Production of High Quality Commercially Viable Research

- Education and training toward longer-term goals of research accomplishments
- Recognition and reward of researchers for significant accomplishments beyond usual expectations
  - Reward/recognition to research leaders who have productive research programs producing significant accomplishments--basic and commercially viable--in their programs
  - Reward/recognition to researcher who makes significant accomplishments
- Policy regarding revenues from research going to <u>researcher</u> and <u>institution</u>
- "Arbitrary power" of financial/accounts office to decide
- More money for research
  [Solution: Tax? from pockets of consumers. Public research lays more golden eggs - - to pay taxes.]
  Too low allocation for agricultural research in Pakistan (0.17% of agricultural product). There is a big disparity in the size of crop sectors and commercial suppliers. Need more funding to meet the needs of Pakistani farmers.
- Convince the public
  - that <u>research</u> is worth support
  - that the "institute" is useful
  - show synergism with the public sector
  - develop a framework for interaction
- Government regulations and imports may discourage local research to solve problems

2. Demand for Research Findings

- Entrepreneurial class -- needs:
  - money
  - access to research and assistance
  - definition of opportunities
  - linkage with agribusiness
  - venture capital
- Manpower needs -- projects for industry needs should be anticipated

3. Interface between Production and Demand

- Too little interaction between research/extension/users (identifying demand)
  [Solution: 1. Develop user groups to work with and represent industry as a group.
  2. Some researchers combine teaching or extension with research.]
- Lack of processing industry to accommodate product surpluses at high season

Strengths in Technology Transfer
(Ahmad, Alvi, Carter, Hesser)

1. Human Resources
- Have the institutions (education and research) and well-trained scientists and educators (good scientific infrastructure)

2. Material Resources
- Productive land -- "can grow anything"
- Adequate water (16 million hectares; 30-35% not used)
  [If tap the unused water, could increase irrigated land to 21 million hectares; with high technology, could increase irrigated land by three times.]
- Climate generally good
- Crops
- Animals (could double output with healthier animals)
- Fisheries (both fresh water and salt water)

3. Mechanisms
- Planning Commission
- Ministry of Agriculture/ PARC (agricultural research priorities)
- Ministry of Science & Technology (non-agricultural research priorities)
- Links with IARCs
- Commercial (Chambers of Commerce/Ag...)
- Laws (to protect intellectual property)
  (Tie public sector, private sector, research)

4. Location
- Trade opportunities (eg., Central Asian Republics)
- Pakistan is potential financial hub for Central Asia

5. Policy
- Liberalization of exchange controls
- Spurs to investment

6. Improvements in Process
- Communications
- Infrastructure
  - -- Roads
  - -- Telephone
  - -- Power

Presentation by Mr. Walter Plosila, President of the Montgomery County High Technology Council, Maryland

Scientists are trained in a linear model--they first complete their research and then interact with industry. Increasingly we find that interaction is needed earlier and throughout the process; industry should be involved from the beginning. U.S. research institutions are not comfortable with this, but technology transfer is a body-contact sport, and person-to-person interaction should be encouraged. The interactive, nonlinear approach leads to a sense of partnership in projects; how you do this depends on culture. For example, Cyrus McKell represents entrepreneurial universities and will agree that in some parts of the U.S. it is hard to get researchers to talk to each other.

The environment for commercialization can be nurtured by the following:

1. Public venture (working) capital for starting or expanding firms.

2. Deriving commercial spin-offs from military spending.

3. An attitude, from administrators down through the staff, that faculty and industry should work together. Collaboration is encouraged and results rewarded.

4. A strong workforce with good skills.

5. An entrepreneurial culture (i.e., culture that rewards "deviant" [used in the positive sense] behavior). Certain cultures encourage risk-taking; this is not readily mandated.

In the U.S., most innovation comes from small, young, growing companies. Some countries concentrate on one sector for their investments. The same approach is not appropriate for every country.

In general, small firms are not interested in research; they do not trust institutions and are skeptical about their wasting time or stealing ideas. It is necessary to seek ways to involve such firms. Italy, for example, has service centers for small firms, where information, training, testing facilities, demonstrations, etc. are offered. Companies use these facilities, and learn to turn to researchers for help.

Government policy is very important for science and technology development. Of the 130 research

parks in the U.S., most are empty. Maryland is the only state in the U.S. to have a state policy on S&T. As a consequence, there are 61 national laboratories located in Maryland. Within three counties, Maryland can count 900 technical firms; Montgomery County alone has 100 biotechnology firms, mostly not government contractors.

Researchers assume that if you develop technology, it will be bought. This is not true. You need to involve industry from the beginning. There has to be a market for the product. The Utah Centers of Excellence program seeks out markets and delivers them to industry. University of California at Berkeley has business students doing market studies in national laboratories and giving them to industry. Remember that industry has a near-term rather than a long-term view. The Small Business Innovation Program (SBIP) is good for promoting commercialization.

Dr. Goldman noted that statistics show high rates of return on research. One product that sells big covers the costs of failed products. Dr. Ahmad asked what the success rate was of research ending up in the market; Mr. Plosila replied that the odds were against it. Dr. Goldman pointed out that if the value of Pakistan's agriculture in the GNP was 20%, then the value of Pakistan's wheat crop amounted to 8% of GNP--and a small increase in the wheat yield will make a big difference.

Dr. Bale asked Mr. Plosila what methods he had established for technology transfer during his time in Pennsylvania. He answered that Pennsylvania had four top research universities but no entrepreneurship centers. The critical momentum came from building relationships. Just getting representatives of small and large companies to sit down at the table with university and government people was important. One-on-one meetings are more effective than large meetings. Associations in Europe are more effective than those in the U.S. We are still trying to create service centers here. Such service centers can serve as middlemen and bring industry and researchers together, but cannot be liaison; the researchers must have direct relationships with industry.

Dr. Bale continued the meeting by reminding the panel of Dr. Zafar Altaf's charge for them to bring back ideas for Commercialization of Research from this Study Tour. She set two questions for members: What technology will Pakistan need in 20 years? What changed will be needed from government, private sector, and researchers to create and then take advantage of these opportunities?

Dr. Carter suggested the two groups look at the gaps they had identified earlier and brainstorm on ways to fill these gaps in order to avert problems in the year 2015. Dr. Bale urged members to think globally and for the long term, and Mr. Finch pointed out that they need not cover every topic in order to have possible policy input. Ideas began flowing quickly--establishing a reference laboratory for poultry diseases; needing to double or triple food production; establishing R&D in the private sector; introduction of new protein sources, such as ducks, quail, and rabbits, since meat will be scarce. The results of these small-group meetings follow.

What technology will Pakistan need in 20 years?

1. PRODUCTS (Ahmad, Alvi, Carter, Finch, Goldman, A.S. Khan, S.M. Khan)

   Superior seeds (i.e. disease resistant)
   Improved livestock
   Management/production systems

Appropriate mechanical cotton picker
Processes to reduce post-harvest losses
Farmers product input supply and marketing centers
Biofertilizers
Certified fruit plant nurseries
Sugar harvestor
Rice transplanter
Wind power generators
Ethanol

2. SERVICES (Bale, Farooq, Hesser, Khalid, Mashkoor, McKell)

Training of research managers/leaders to motivate their research teams
- motivate and reward managers for group accomplishments

Training of qualified technicians
- in-service training
- retraining for new technologies
- training leaders to develop plans for research and meetings to regularly evaluate progress toward annual goals

Establishment by universities/research institutes of specific services to private sector
- service centers that require training and have working budgets which recover funds from service fees
- technical assistance

Advanced testing facilities -- soil and crop testing

Highly specialized private consultation on field production

Marketing services (including quality control) -- export of high value crops, eg., white grapes

Locations for key crops and markets for them

Family networks around the world can be exploited for shipments of agricultural products

At national level, new opportunities office for

- marketing to identify promising opportunities
- new crops
- new uses of old crops
  [Example: muskmelon available in March from Sind; cauliflower from Punjab]

Research Parks -- link industrial estates

Advanced weather forecasting to allow time to protect crops (water crop, then rain and wind lead to lodging)

Specialized private service for farm machinery and equipment
(Commodity associations encouraged? Fertilizer/insecticide encouraged?)

What changes will be needed from government, private sector, and researchers to take advantage of opportunities?

Group 1: Ahmad, Alvi, Carter, Finch, Goldman, A.S. Khan, S.M. Khan

[Public]	1.	Extension - broad-based, inclusive of livestock, home economics, and machinery
[Private]	2.	Agro-industrial advisory/supply and marketing center
[Private & Public]	3.	Model/demonstration farms
[Public]	4.	Infrastructure (utilities, health, nutrition, education)
[Private]	5.	Corporate farming

Group 2: Bale, Farooq, Hesser, Khalid, Mashkoor, McKell

1. ROLE OF GOVERNMENT

- Improve integration of research, teaching, and extension at department and individual scientist level
- Improve interaction of universities/research institutes
- Improve quality of education
  - -- with particular reference to experience in real world (internships during undergrad training in specific industry and agribusiness)
- Examine import/export industries to provide incentives for innovations
- Internship in Pakistan (like a post-doc) for PhD, MS researchers when they return from U.S.
- Exchange of scientists between university and private sector (scientist in government to work in private sector)
- Participation of private sector on Board of Governors (headquarters PARC), technical committees, institute advisory committees, departments (NARC)
- Tax breaks to industry when it establishes in-house research capability in R&D
  (R&D tax incentive)

2. ROLE OF RESEARCH

- Be encouraged to follow directions for technology transfer -- incentives

- Exchange of personnel
  (Allocate funds for technology transfer or application; researcher seek collaboration with industry to transfer technology)

The ideas of the last day of the meeting are recorded as presented. The next step is to use them to develop a framework onto which the follow-up meeting in Islamabad can develop a strategy for technology transfer.

The major ideas generated from the study tour are given in the Summary of Findings on page 3.

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Orientation Meeting for Study Tour from Pakistan
COMMERCIALIZATION OF RESEARCH

1055 Thomas Jefferson Street, Room 2004
Washington, DC
Monday, April 19, 1993

AGENDA

8:30 am	Continental breakfast
9:00	Welcome Dr. E. William Colglazier Dr. Jordan Baruch, Chairman
	Introductions including what participants hope to accomplish on this tour
	Overview of study tour and orientation
9:30	How S&T works in the U.S.: the roles of government, research institutions, and the private sector Dr. Stephen A. Merrill
10:15	Coffee
10:30	The role of the government, industry, university roundtable in commercialization of research Dr. Don I. Phillips
11:15	How does National Science Foundation assist the private sector? Dr. Donald Senich
12:00	Lunch
1:00	Technology transfer in the U.S. Department of Agriculture Dr. William H. Tallent
1:45	The role of the Commerce Department in commercialization of science and technology Dr. Joseph Clark

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2:30		Coffee
3:00		How does commercialization of research and participation of the private sector fit into development in Pakistan? Dr. Ridwan Ali
3:45		BOSTID programs in commercialization of science and technology in Indonesia and Thailand Mrs. Rose Bannigan
4:15	o	What are the goals for commercialization of research in Pakistan?
	o	What do members of the study team hope to accomplish during this tour?
5:00		Conclusion

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Panel Meeting for Study Tour from Pakistan
Important Issues and Outlining of a Strategic Plan for Commercialization of Research in Pakistan

Wednesday, April 28, 1993
1055 Thomas Jefferson Street, Room 2003

Thursday, April 29, 1993
2101 Constitution Avenue, Room 180
Washington, DC

AGENDA

Wednesday, April 28

8:30 am	Continental breakfast	
9:00	Welcome Introductions Purpose of the Meeting	Dr. Mary Carter
9:30	Ideas and opportunities seen by the study tour group for commmercialization of research	Dr. Zafar Altaf
10:00	Coffee	
10:15	Discussion of ideas and opportunities	
11:00	Private sector issues on collaborations with research institutions	
12:00	Lunch	
1:00	Promising models for government/university collaboration with the private sector	
2:00	The legal infrastructure needed to stimulate commercialization of research	Mr. James Finch
3:00	Coffee	

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3:15 Strengths of the current system in Pakistan
-- what is in place and working adequately
Constraints of the current system in Pakistan
-- what is not in place or not working adequately?
Important gaps in knowledge of systems now in place
-- items for follow-up

5:00 Adjourn

Thursday, April 29

8:30 am Continental breakfast

9:00 Review of highlights and directions from the previous day

9:30 Discussion of the framework for a commercialization plan

1. Opportunities
   - o Products
   - o Services
2. Strategic issues related to opportunities
   - o Strengths
   - o Weaknesses
   - o Expected changes
3. General priorities for commercial opportunities
4. Commercialization plan
   - A. Input:
     - o Government, policies, and costs
     - o Public research
     - o Private sector interactions
   - B. Expected output:
     - o Products, amounts
     - o Services, kinds
     - o Involved sectors
   - C. Time frame for:
     - o Tasks
     - o Sectors

12:00 Lunch

1:00 pm Continue discussion

2:30 Identification of areas to be addressed in background papers for the next meeting

4:00 Adjourn

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Monday, April 19, 1993

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Pakistan Agricultural Research Council
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Mr. Abid Farooq
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Dr. Muhammad Khalid
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HIGHLIGHTS OF SELECTED STUDIES

INDUSTRY AND COMMERCE

NEW R&D ROLE FOR GOVERNMENT

The United States is a leading developer of new technologies and a major exporter of high-technology goods. Federal support of basic research helped to achieve this technology leadership. If the United States is to keep this edge, the federal government should also support the second stage in a technology's maturity: "pre-commercial" research and development, which bridges the gap between basic research and the development of prototype products or processes.

One way to support pre-commercial R&D is to create a quasi-public Civilian Technology Corporation (CTC) that promotes joint ventures between government and industry. A panel appointed by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine proposed the establishment of CTC in the report *The Government Role in Civilian Technology: Building a New Alliance*.

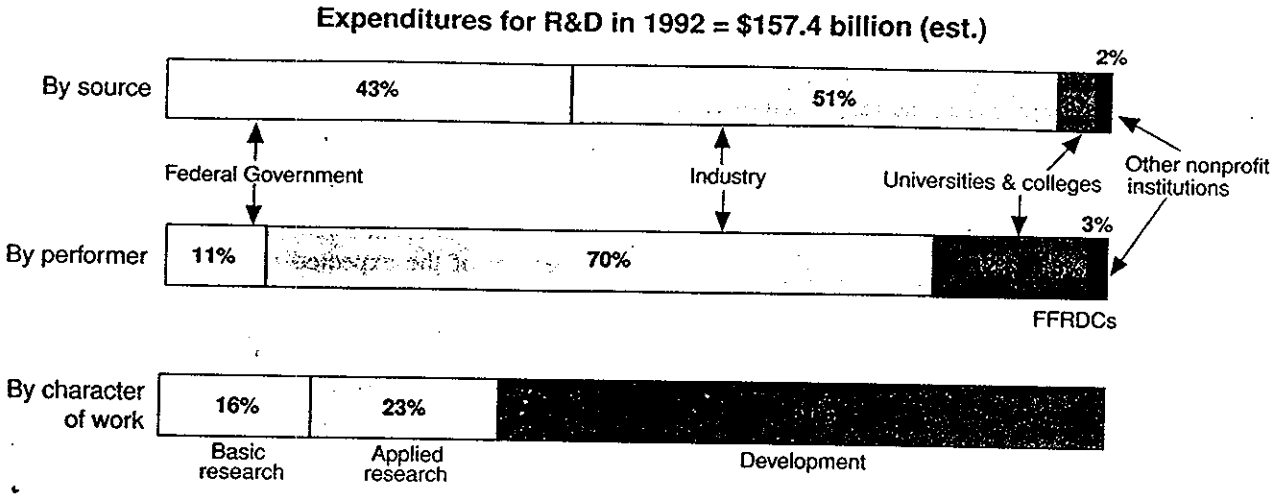
Funded with a one-time congressional appropriation of $5 billion, CTC would be managed by a board appointed by the president and confirmed by the Senate. Private firms would initiate and design projects, thus "[a]llowing private market signals to act as the first point of reference." Project costs would be shared by CTC and participating companies.

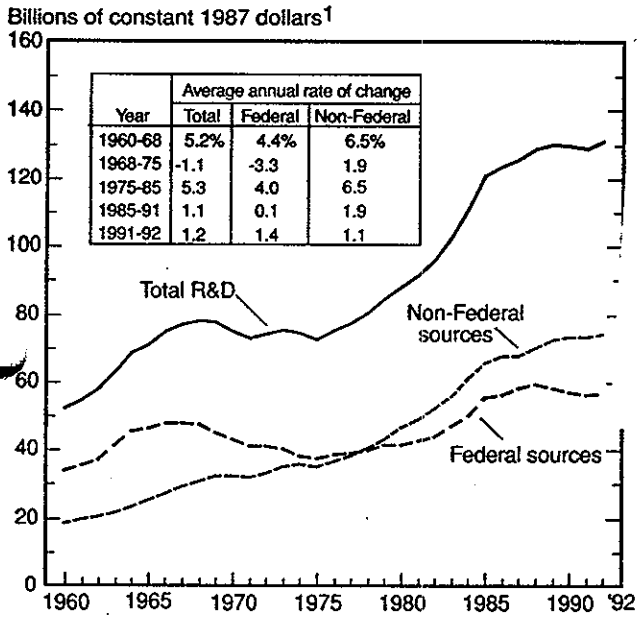
In addition to calling for establishment of CTC, the panel made the following recommendations to the federal government:

- Reaffirm the role of the Advanced Research Projects Agency in developing civilian and military technologies.
- Select only a small number of the 700 federal laboratories to work with private firms.
- Enlarge the scope of selected government agencies' R&D programs to include pre-commercial projects.
- Increase funding for the Small Business Innovative Research program.
- Appoint an independent panel to determine the appropriate size of the Department of Commerce's Advanced Technology Program.
- Establish an Industrial Extension Service in the Department of Commerce to speed the adoption of new technologies.

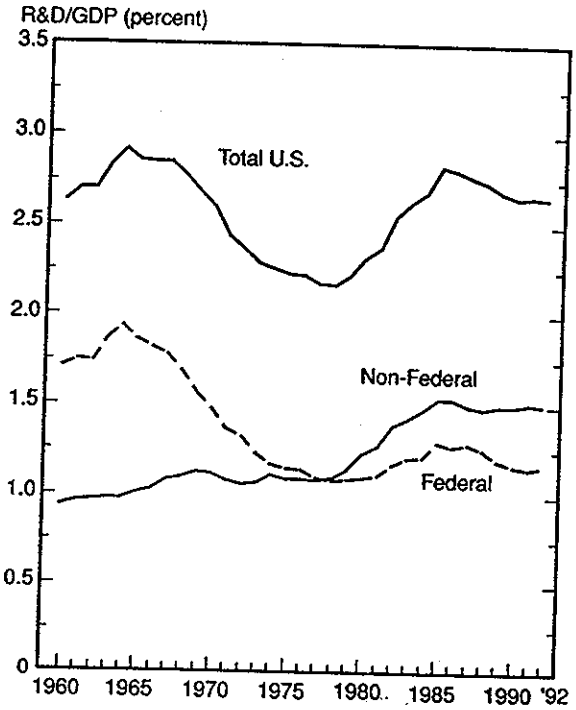
The study was mandated in the Omnibus Trade and Competitiveness Act of 1988. It was funded by the Department of Commerce's National Institute of Standards and Technology, the National Science Foundation, the Department of Energy, and the National Aeronautics and Space Administration.

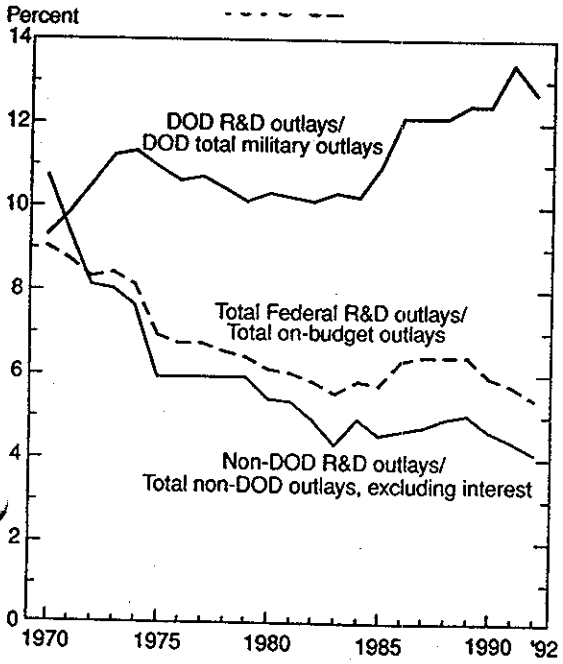
Chart 1. The national R&D effort





Year	Average annual rate of change		
	Total	Federal	Non-Federal
1960-68	5.2%	4.4%	6.5%
1968-75	-1.1	-3.3	1.9
1975-85	5.3	4.0	6.5
1985-91	1.1	0.1	1.9
1991-92	1.2	1.4	1.1





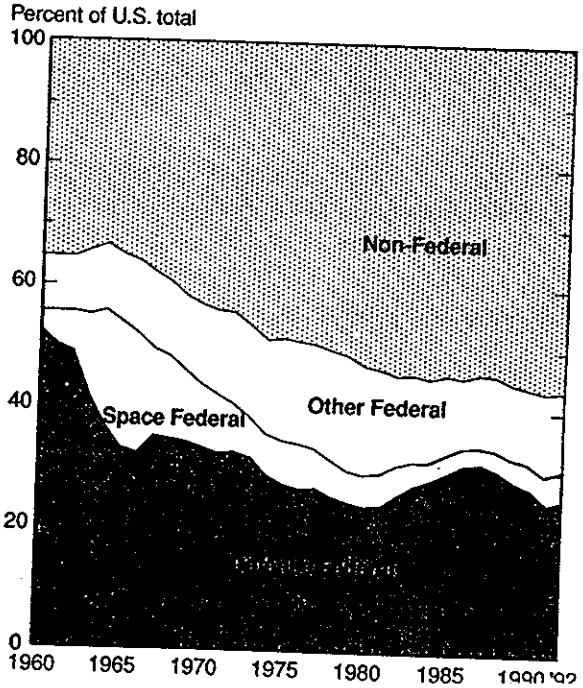


Table 1. Budget authority for R&D as a percentage of total Federal budget authority, by function: 1992
[Dollars in millions]

Function	R&D total	Federal total	R&D percentage share
Total budget	$69,824	$1,478,086	4.7%
On-budget	69,824	1,221,368	5.7
National defense	41,470	289,170	14.3
Nondefense (on-budget)	28,354	932,198	3.0
Health	10,030	95,502	10.5
Space research and technology	6,734	13,213	51.0
Energy	3,137	4,683	67.0
General science	2,745	4,142	66.3
Natural resources and environment	1,688	20,976	8.0
Transportation	1,419	36,767	3.9
Agiculture	1,140	17,675	6.5
All other	1,461	739,240	0.2

NOTES: Data are derived from the Administration's 1993 budget proposal. On-budget totals are for all Federal Government transactions except those of the social security trust funds (Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds) and the Postal Service.

SOURCES: National Science Foundation/SRS, and Office of Management and Budget

ROUNDTABLE PUBLICATIONS+

Academic Research Enterprise

Fateful Choices: The Future of the U.S. Academic Research Enterprise - A discussion paper including an optimistic and challenging vision for the future of U.S. academic research; an analysis of the near-term decisions and longer-term options facing the enterprise if the positive vision is to be pursued; and a description of the changing environment for decisionmaking (March 1992)

The Future of the U.S. Academic Research Enterprise: A Report of a Conference - A summary of a December 9-10, 1991, Roundtable conference held to address critical issues confronting U.S. academic research and to explore the possibilities for national consensus on the future directions of the research enterprise (March 1992)

Future National Research Policies Within the Industrialized Nations - A report of a February 1991 symposium on emerging national research policies and programs. Participants included senior government officials and leading scientists directly involved in formulating research and higher education policies in the United States, Japan, the Soviet Union, the United Kingdom, Germany, and the European Community (February 1992)

The Academic Research Enterprise Within the Industrialized Nations: Comparative Perspectives - A report of a symposium on the research systems of the U.S., Japan, Soviet Union, Great Britain, Germany, and France (March 1990)

Science and Technology in the Academic Enterprise: Status, Trends and Issues - A discussion paper on the status of the current academic research enterprise, emerging trends affecting it, and major issues to be addressed regarding its future; statistical information on financial, human resource, infrastructure, and organizational trends in academic research (October 1989)

Multidisciplinary Research and Education Programs in Universities: Making Them Work - A paper by Robert L. Sproull, Harold H. Hall, and members of the Working Group on Institutional Renewal, discussing how to organize, support, and operate multidisciplinary programs in universities (June 1987)

New Alliances

University-Industry-Federal Laboratory Partnerships: Expectations and Effectiveness - Summary of Issues Raised at the October 1992 Roundtable Council Meeting (forthcoming)

+All publications available free of charge by writing the Roundtable.

Richard F. Celeste, "A New Partnership in American Science and Technology," - An op-ed article published by the National Academy of Sciences OP-ED Service encouraging federal-state interactions in science and technology. (21 June 1992)

Federal-State Cooperation in Science and Technology Programs - A discussion paper by the Federal-State Dialogue on Science and Technology (February 1992)

Industrial Perspectives on Innovation and Interactions with Universities: Summary of Interviews with Senior Industrial Officials - Presents the views of 17 industrial officials on innovation processes in their firms, connections to universities, and national R&D policy (February 1991)

"Survey to Assess the Usefulness of Two Model Agreements for University-Industry Cooperative Research" - Results of a survey of about 70 university and industry "users" of the model agreements published in 1988 (August 1990)

Simplified and Standardized Model Agreements for University-Industry Cooperative Research - Published jointly with the Industrial Research Institute (1988)

"Commentary: University-Industry Alliances;" Dorothy Nelkin, Richard Nelson, and Casey Kiernan; Science, Technology and Human Values, Volume 12, Issue 1, pp. 65-74; (Winter 1987)

State Government Strategies for Self-Assessment of Science and Technology Programs for Economic Development - Proceedings of a workshop held April 10, 1987

New Alliances and Partnerships in American Science and Engineering - Background materials for a conference held December 5, 1985 (issues paper and case studies) along with interpreted highlights of conference sessions

Improving Research Administration

General:

Scanley, D. A. and W. Sellers, "Making Things Better: A Summary of Past Recommendations for Improving the Management of Federally Sponsored Academic Research," Research Management Review, Volume 5 Number 1, (Spring 1991)

Reducing Bureaucratic Accretion in Government and University Procedures for Sponsored Research: New Approaches in Process and Additional Areas for Attention - Proceedings of a hearing held June 5, 1985 (full report and summary)

About FDP:

"What is the Federal Demonstration Project?" - A description of a cooperative effort between universities and federal agencies to increase research productivity by eliminating unnecessary administrative procedures and by streamlining and standardizing needed controls (August 1991)

"Summary of Interim Reports Submitted by Grantee Organizations Participating in the Federal Demonstration Project" - Describes the positive impacts of the FDP on principal investigators, universities, and the general research environment as well as problem areas that need to be addressed (October 1990)

FDP Studies and Surveys:

"Federal Managers' Viewpoints on FDP Continuation Funding Pilot" - Prepared by the Federal Demonstration Project Task Group on Proposals/Applications, the report provides the results of a survey of federal agency views of the impact of the noncompeting renewal demonstration on the efficiency and efficacy of agency functions. (March 1992)

"Report on Equipment Screening Studies" - Prepared by the Federal Demonstration Project Task Group on Internal Systems, the report examines the cost effectiveness of equipment screening. (December 1991)

"The Impact of Noncompeting Continuation Applications within the Federal Demonstration Project" - Prepared by the Federal Demonstration Project Task Group on Productivity Assessment, the report provides the results of a survey of the time saved by principal investigators under the demonstration of new procedures for non-competing renewal applications. (Draft November 1991)

"The Impact of the Use of Expanded Authorities within the Federal Demonstration Project" - Prepared by the Federal Demonstration Project Task Group on Productivity Assessment, the report describes the results of a survey that assessed the amount of principal investigator time saved during the demonstration of research administration procedures that expand the authority of universities and principal investigators to manage grant funds. The survey also looks at how saved time was reinvested. (February 1991)

"Report on Survey of State Requirements Applicable to Externally Funded Research Activities" - Prepared by the Federal Demonstration Project Task Group on State/Grantee Relations, the report describes the results of a survey on administrative requirements states apply to university research. (November 1990)

"The Florida Demonstration Project: Observations on the Impacts of the Project" -

Observations on the impacts of the Project based on information collected on the operation of the Project by the Roundtable in cooperation with the participating universities in Florida (September 1987)

Priorities

Richard F. Celeste, Testimony before the Subcommittee on Science, Committee on Science, Space, and Technology, Regarding setting Priorities in Science (April 28, 1992)

What Research Strategies Best Serve the National Interest in a Period of Budgetary Stress? - Interpreted highlights of the discussion at a conference held February 26 and 27, 1986

Academic Research Facilities

"Research Facility Financing: Near-Term Options" (Working Draft) - Intended as a vehicle for discussion, this document sketches the purposes, costs, impacts, tradeoffs, and political considerations associated with a variety of mechanisms for research facility funding (February 1991)

James D. Ebert, Testimony before the Rules Committee of the United States Senate; Statement of James D. Ebert, Vice President, National Academy of Sciences, Regarding S. RES. 206-To establish a point of order against material that earmarks research monies for designated institutions without competitions. (June 21, 1990)

"Synthesis of Options for Academic Research Facility Financing" - A summary of three sector-specific workshops in which representatives of federal agencies, universities, and state governments each described alternative approaches their sectors can take to facility financing. The document describes the perspectives of each sector along with options for facility financing that each sector could take (March 1990)

Perspectives on Financing Academic Research Facilities: A Resource for Policy Formulation - A resource for policy makers and a reference work, this discussion paper addresses objectives of facility funding, strengths and weaknesses of financing mechanisms, facility needs and sources of support, roles of the sectors, and key policy issues (October 1989)

Academic Research Facilities: Financing Strategies - Proceedings of a conference held July 22 - 23, 1985 (full report and summary)

"Federal Funding of Scientific Facilities" - A discussion of the issues arising from direct congressional funding of facilities (February 2, 1985)

Science and Engineering Talent

Nurturing Science and Engineering Talent - A discussion paper on the broad outlook for science and engineering talent organized around three themes: the status of the science and engineering talent pool, the factors affecting career choice, and the effectiveness of special programs to encourage science and engineering talent (July 1987)

Competitiveness

Richard F. Celeste, Testimony before the Subcommittee on Technology, Environment, and Aviation, Committee on Science, Space, and Technology, Regarding the National Competitiveness Act of 1993 and the Role of the States (February 3, 1993)

"A Dialogue on Competitiveness," Ralph E. Gomory and Harold T. Shapiro, Issues in Science and Technology, Volume IV, Number 4, (Summer 1988)

Annual Reports

Government-University-Industry Research Roundtable Annual Reports, 1985-1992

NOTE: NSF SBIR proposal requirements may differ from those of other agencies and from NSF SBIR solicitations from other years. Before preparing your proposal, read this 1993 SBIR Program Solicitation carefully.

NATIONAL SCIENCE FOUNDATION

PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH (SBIR)

The National Science Foundation (NSF), an independent agency of the Federal Government, invites small business firms to submit research proposals under this Program Solicitation for Small Business Innovation Research (SBIR). NSF will support high-quality research proposals on important scientific, engineering, or science/engineering education problems and opportunities that could lead to significant commercial and public benefit if the research is successful.

1. PROGRAM DESCRIPTION

1.1. The Federal SBIR Program

The SBIR Program is a three-phase process. Eligible small businesses are invited to propose innovative ideas that meet the specific research and R&D needs of the Federal Government. SBIR operates under the Public Law 97-219 as amended, the Small Business Innovation Research Program Reauthorization Act of 1992, Public Law 102-564, and the Small Business Administration's (SBA) SBIR Policy Directive. SBIR has been established in eleven Federal agencies. Phase I is a six-month feasibility research project which establishes eligibility for Phase II. Phase II is the principal research effort. Phase III is to be conducted with non-SBIR and usually non-Federal funds to pursue commercial applications of the research funded in Phases I and II.

Because the program is intended to increase the use of small business firms in Federal R&D, for *Phase I : a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm; for Phase II : a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm.*

1.2. The NSF SBIR Program

The primary objective of the NSF Program is to increase the incentive and opportunity for small firms to undertake cutting-edge, high risk, high quality scientific, engineering or science education research that would have a high potential payoff if the research is successful. Additional objectives include stimulating technological innovation in the private sector, increasing the commercial application of NSF-supported research, and improving the return on investment from Federally-funded research for its economic and social benefits to the nation. The proposed research must be responsive to the NSF program interests stated in the topic descriptions of this solicitation.

NSF does not normally support bioscience research with disease-related goals, including work on the etiology, diagnosis, or treatment of physical or mental disease, abnormality, or malfunction in human beings or animals. Animal models of such conditions or the development or testing of drugs or other procedures for their treatment also are not eligible for support. However, research in bioengineering, with diagnosis or treatment-related goals, that applies engineering principles to problems in biology and medicine while advancing engineering knowledge is eligible for support. Bioengineering research to aid persons with disabilities is also eligible.

In addition, proposals for technical assistance, pilot plant efforts, research requiring security classification, the development of products for commercial marketing, or market research for a particular product or invention are normally not supported.

The objective of Phase III follow-on funding is to support development efforts using non-SBIR and usually non-Federal funding as a continuation of the research supported by NSF under Phases I and II.

This solicitation is for Phase I proposals only. It does, however, provide the basis for any Phase II proposals resulting from Phase I awards. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms used in other NSF programs. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or II.

1.3. Program Emphasis for 1993: National Critical Technologies

The NSF SBIR Program encourages proposals across all fields of science and engineering supported by the Foun-

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dation (See Section 11, Research Topic Descriptions). Within that framework, the following critical technology areas of national importance are emphasized:

- Materials synthesis and processing
- Electronic and photonic materials
- Ceramics
- Composites
- High performance metals and alloys
- Flexible computer-integrated manufacturing
- Intelligent processing equipment
- Micro- and nanofabrication
- Systems management technologies
- Software
- Microelectronics and optoelectronics
- High-performance computing and networking
- High-definition imaging and displays
- Sensors and signal processing
- Data Storage and peripherals
- Computer simulation and modeling
- Applied molecular biology
- Surface transportation technologies
- Pollution minimization, remediation, and waste management

When proposals are otherwise considered to be of approximately equal technical merit, proposals in these areas may be given extra consideration in the evaluation process.

1.4. Phase I—Feasibility Research

Phase I is a six (6) month experimental or theoretical investigation on the proposed innovative idea or approach.

Phase I should determine insofar as possible:

—the probable technical feasibility of the proposed idea, and

—the ability to produce significant results before consideration of additional Federal support in a Phase II project.

The work proposed for Phase I should be suitable in nature for subsequent progression to Phases II and III. Contingent upon the success of the research in Phase I, the ultimate aim of the research should be to develop commercializable products, processes, or techniques. The Principal Investigator should approach the SBIR Program with the objective of bringing the project to fruition in Phase III, via a Phase II effort.

Under this solicitation NSF anticipates that it will make about 250 Phase I awards of up to $65,000 each. Research results are to be submitted to NSF in a comprehensive Phase I Final Report.

The required Phase I Final Report is due at the end of the six-month performance period.

1.5. Phase II—Principal Research Project

Phase II is the principal research effort. Only the successful completion of a Phase I award makes the awardee eligible to submit a single Phase II proposal. Phase II proposals can only be submitted to the particular Federal agency that awarded Phase I of the effort.

NSF makes every effort to make timely award decisions. For administrative reasons, Phase II award decisions may be delayed considerably unless the following schedule is met:

1) The Phase I Final Report is received within 15 days of the end of the six-month performance period of Phase I, and;

2) The Phase II proposal is received within 30 days of the Phase I Final Report.

Phase II proposals should be prepared in accordance with instructions which NSF will provide to all Phase I grantees prior to the end of Phase I. (See Schedule, Section 3.3, and Phase I Final Report, Section 7.2.A.)

Phase II awards, expected to be for 24 months and not to exceed $300,000, will be made to those small businesses with projects that appear most promising. It is anticipated that approximately one-third of the Phase I awardees will receive Phase II grants.

Resubmission of a declined Phase II proposal is not permitted.

1.6. Supplement to Funding of Phase I Awards

As part of the Phase I Final Report, the proposer will be asked to declare whether he/she will be submitting a Phase II proposal. In the event that the proposer concludes that the success of the Phase I project warrants an application for a Phase II effort, he/she may be given an opportunity to receive a supplement to Phase I funding in order to increase the effectiveness of the project by maintaining its continuity.

Not all projects will be eligible to receive a supplement to Phase I funding. Requests for supplemental funding will be awarded based on the following criteria:

1) The Phase I Final Report ***must*** be received within fifteen (15) days of the end of the six-month performance period of Phase I.

2) An adequately justified budget for a supplement to Phase I funding may be for a period of up to three months, not to exceed $10,000. (Items in the supplemental budget must conform to the requirements for Phase I.)

3) The Phase II proposal along with the budget for the supplement to Phase I funding ***must*** be received within

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thirty (30) days of the submission of the Phase I Final Report. The requested start date for the supplement may not be earlier than October 15.

4) The acceptance by NSF of the Phase I Final Report.

NSF expects to grant supplements to Phase I funding to all requests which meet the above criteria.

Note: The deadlines indicated under criteria 1 and 3 are firm.

If a project is ineligible for a supplement to Phase I funding, the grantee will still be permitted to submit a Phase II proposal.

1.7. Phase III—Product Development

Phase III is the product development phase of the project and is not funded by NSF. In Phase III, the small business pursues commercial application of the research funded in Phases I and II. Phase III is to be conducted with non-SBIR and usually non-Federal funds.

1.8. Converting Research to Technological Innovation and Commercial Application

An important goal of the SBIR Program is the conversion of NSF-funded research into technological innovation and commercial application. ***Phase II submissions that provide a commitment for Phase III follow-on funding will receive extra credit in the Phase II evaluation process.*** The maximum credit will be given when a signed contingent agreement is obtained for follow-on funding to the SBIR grantee for a minimum of $200,000 for Phase III. This commitment for follow-on funding should only be obtained after receiving a Phase I award but prior to Phase II.

The awardee retains rights to an invention made in either NSF-funded phase—Phase I or Phase II—subject to certain conditions, in accordance with NSF patent policies. (See Section 7.6.)

NATIONAL SBIR CONFERENCES

MINNEAPOLIS APRIL 27–29, 1993	WASHINGTON OCT 13–15, 1993	SEATTLE NOV 15–17, 1993	HOUSTON APRIL 26–28, 1994

FEDERAL R & D OPPORTUNITIES FOR TECHNOLOGY INTENSIVE FIRMS

SPONSORED BY
DEPARTMENT OF DEFENSE/NATIONAL SCIENCE FOUNDATION
IN COOPERATION WITH ALL FEDERAL SBIR DEPARTMENTS AND AGENCIES

- R&D and Technology Marketing Opportunities to 11 Federal Agencies and 20 Major Corporations.
- Keynote Speakers and Special Sessions on Commercializing R&D, Joint Ventures, Strategic Alliances, Licensing, International Markets.
- Seminars in 20 Special Areas Important to Small Technology Firms, Including Procurement, Audit, Finance, Accounting, Proposal Preparation, Starting and Financing the Small High Tech Firm.

For Registration or Further Information Contact:
Foresight Science & Technology, Inc.
Hotline (407) 791-0720 Contractor to NSF/DoD

The National Science Foundation's Small Business Innovation Research Program (NSF/SBIR) funds research in most fields of science and engineering as well as in science and engineering education. The awardee is wholly responsible for the conduct and reporting of each research project. The Foundation, therefore, does not assume responsibility for the research results or their interpretation.

The Foundation welcomes proposals on behalf of all qualified scientists, engineers, and science educators, and strongly encourages women, minorities, and persons with disabilities to compete fully in any of the research and research-related programs described in this document.

Facilitation Awards for Scientists and Engineers with Disabilities provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on an NSF project. See program announcement (publication number 91-54) or contact the Facilitation Coordinator in the Directorate for Education and Human Resources.

In accordance with Federal statutes and regulations and NSF policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, denied the benefits of, or be subject to discrimination under, any program or activity receiving financial assistance from the NSF.

The NSF has TDD (Telephonic Device for the Deaf) capability, which enables individuals with hearing impairment to communicate with the Division of Personnel and Management about NSF programs, employment, or general information. This number is (202) 357-7492.

Technology Transfer Agreements Between Industry and ARS

Definition and Policy

Technology Transfer Cooperative Research and Development Agreements are an implementation of the Federal Technology Transfer Act of 1986 (Public Law 99–502). They differ from previous Agricultural Research Service research contracts and agreements by providing the cooperator with the first right to exclusive licenses on patented inventions made under the agreement. Also, in carrying out these agreements, ARS scientists are authorized to work as closely as necessary with private firms to help the companies commercialize technology based on the scientists' research.

Under a Technology Transfer Cooperative Research and Development Agreement (CRADA), the cooperator may or may not provide funds. As with other ARS cooperative agreements, the agency enters into a technology transfer agreement only when the research objective is commensurate with ARS' mission.

ARS policy is to take full advantage of the Technology Transfer Act and of Executive Order 12591, which charged agencies with implementing the Technology Transfer Act expeditiously. While the Office of Cooperative Interactions provides guidance and assistance, research scientists are the key to fulfilling this policy. The scientist is responsible for getting the research *used* as well as done.

Scientists should seek opportunities for cooperative industry/ARS R&D agreements that meet three conditions—

- The work is consistent with the ARS mission.
- There are no conflicts of interest.
- All potential cooperators have been given a fair chance to participate.

Funding

Cooperative research with the private sector is an addition, expansion, or continuation of a project. So none of the funding expected from a CRADA can be used to shore up base funding needed to carry out the original project. The additional funding might include costs of an added research associate, a technician, special equipment, and so on.

Procedures

For expeditious implementation of industry/ARS research cooperation, the following procedures must be carried out in accordance with the provisions of the Technology Transfer Act. This means that *all parties must deal with documents promptly.*

1. Individual scientist and cooperator determine what research will be done cooperatively.

2. Scientist consults with line managers—research leader, laboratory/institute director, and area director—and with the appropriate National Program Leader. If they agree, scientist proceeds to step 3.

3. The scientist and cooperator develop a brief proposal—no longer than a page, two at most. This can be a few sentences, an outline, or a list, whatever format works best. A copy is forwarded to the Assistant Administrator or Deputy Assistant Administrator for Cooperative Interactions.

4. A staff member of the Office of Cooperative Interactions will be assigned to monitor and coordinate subsequent negotiations and clearances for development of the agreement.

5. This staff member will work with the scientist and cooperator to develop an appropriate CRADA. They will use generic provisions previously reviewed for patent clearances and for administrative requirements by an ADO (Authorized Departmental Officer, an official delegated to sign contracts for the agency). The Area Director and appropriate National Program Leader will be kept informed on its progress.

6. Once an acceptable agreement is completed, the following steps are taken:

   a. For agreements involving the receipt of funds, the scientist obtains approval from the National Program Staff via normal channels: ARS CRIS report approval forms 425, 416, and 417 through the Research Management Information System.

   b. If no funds are to be transferred under the agreement, the scientist sends the completed agreement to the National Program Leader through the Area Director for approval. The National Program Leader responds to the scientist, and copies are sent to the Area Director and the Office of Cooperative Interactions.

   c. The completed CRADA will be forwarded to the Office of Cooperative Interactions for agency approval.

   d. If changes are needed, the Office of Cooperative Interactions will expedite revisions.

7. The ADO will make sure that clearances (for conflicts of interest and similar matters) are received. The ADO will then send the final version of the agreement to the cooperating firm for signature.

Technology Transfer Agreements With the Agricultural Research Service

To help translate research results into practical products, processes, and services, the Agricultural Research Service (ARS) has worked closely with commercial firms for many years. Technology transfer cooperative research and development agreements (CRADA's) were created by Congress in 1986 to enhance and facilitate this traditional cooperation, increasing the benefits to the agency, the public, and the commercial firms.

These CRADA's are an implementation of the Federal Technology Transfer Act of 1986 (Public Law 99–502). They differ from other ARS research contracts and agreements mainly by providing the cooperator with the first right to exclusive licenses on patented inventions made under the agreement. Also, in carrying out these agreements, ARS scientists are authorized to work as closely as necessary with private firms to help the companies commercialize technology based on the scientists' research.

Under a CRADA, the cooperating firm provides the know-how needed for development and commercialization of a new product, process, or service. The firm may also provide funds to cover some of the added costs to ARS for work done under the agreement. Or the firm might contribute personnel (for example, a postdoc or technician), equipment, or materials. Many agreements involve no transfer of funds to ARS. The agency provides research personnel, laboratory facilities, materials, equipment, supplies, and other "in-kind" contributions. As with its other cooperative agreements, ARS enters into a CRADA only when the research objective is commensurate with the agency's mission.

A CRADA between a commercial firm and ARS will include provisions on:

- Research, development, and commercialization to be done by each party.
- What ARS will contribute.
- What the commercial firm will contribute.
- Confidentiality.
- Publication of results.
- Inventions.
  - Definition.
  - Ownership.
  - Right to license.
- Copyrights.
- Liability.

Benefits of CRADA's to Commercial Firms

- First right to exclusive licenses on patented inventions made under the agreement.
- Improved access to ARS scientists and facilities.
- Better access to expertise related to research results and inventions.
- Profitable new products and processes.

Benefits of CRADA's to ARS

- Improved opportunities to develop and transfer technology.
- Better feedback from industry on what research is needed.
- Increased familiarity with problems related to commercialization of a product or process.
- Scientists and ARS share licensing fees and royalties.

Steps Commercial Firms Can Take To Initiate a CRADA With ARS

1. Learn of ARS research capabilities, programs, and results. (See below for sources of information.)
2. Contact ARS scientists responsible for programs that interest you.
3. With the scientist, develop a brief proposal.
4. Ensure that the draft proposal receives appropriate preliminary review and clearance within the firm.
5. Work with the ARS scientist to develop a cooperative research and development program.
6. Approve cooperative research and development agreement incorporating the proposed research plan.

Sources of Information About New ARS Technology

Other than contacts with individual scientists, professional society meetings, and professional journals, commercial firms can learn more about ARS research from:

Online Databases

TEKTRAN—Over 12,000 brief, easy-to-read summaries of the latest research results that have been peer-reviewed and cleared by ARS management but, in most cases, have not yet been published; about 400 new findings are added to the database each month. Call or write National Technology Transfer Coordinator, Agricultural Research Service, USDA, Room 415, Bldg. 005, BARC-West, 10300 Baltimore Ave., Beltsville, MD 20705 (301) 504-5345.

CRIS (Current Research Information System)—Abstracts describing all ongoing (and some recently completed) agricultural research projects at least partly funded by the Federal Government. CRIS is one of the databases available through Dialog Information Services, a commercial online service. Call or write Current Research Information System, Cooperative State Research Service, USDA, National Agricultural Library, Beltsville, MD 20705 (301) 504-6846.

AGRICOLA—The bibliographic database of the National Agricultural Library. Provides comprehensive coverage of worldwide journal literature and monographs on agriculture and related subjects. Available through Dialog and through the Bibliographic Retrieval Service. Call or write AGRICOLA, National Agricultural Library, USDA, Beltsville, MD 20705 (301) 504-6813.

U.S. DEPARTMENT OF COMMERCE

INTERNATIONAL TRADE ADMINISTRATION
Promotes exports.
Promotes fair trade policies in GATT, NAFTA, etc.
Enforces laws such as antidumping.

BUREAU OF EXPORT ADMINISTRATION
Controls exports, for reasons of national security [MCTL].
Promotes non-proliferation of chemical, biological and nuclear weapons.

ECONOMICS & STATISTICS ADMINISTRATION
Collects business & economic data.
Analyses & distributes the data.

ECONOMIC DEVELOPMENT ADMINISTRATION
Promotes economic development and job creation, especially in less-developed areas of the U.S.

MINORITY BUSINESS DEVELOPMENT ADMINISTRATION
Promotes entrepreneurship in minority businesses.

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
Describes and predicts weather and environment.
[Weather Service, Global change]
Manages U.S. coastal ocean & marine resources.
[Fisheries Service, Ocean Service, Satellite Service]

TRAVEL & TOURISM ADMINISTRATION
Promotes tourism to the U.S.

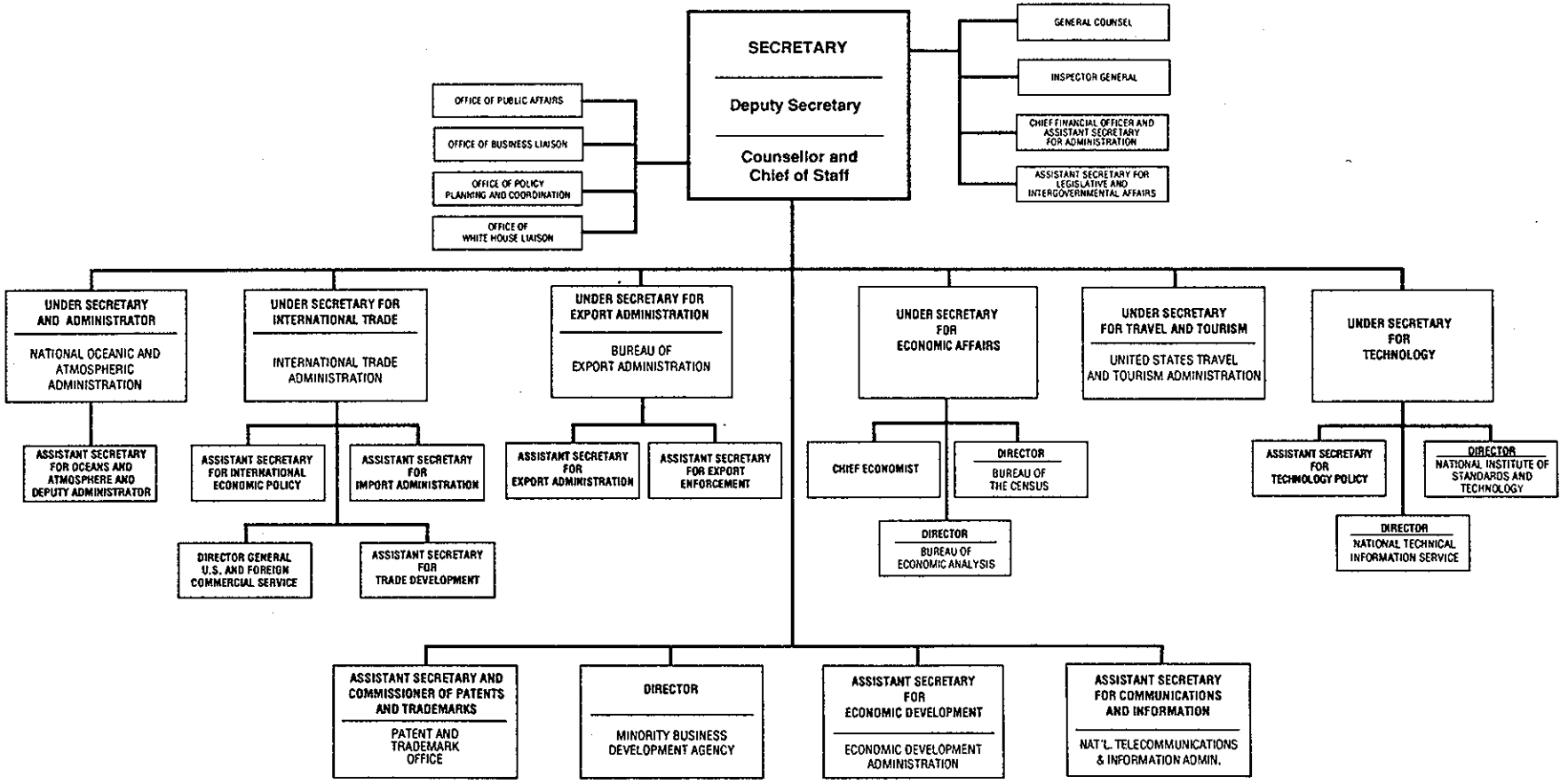
NATIONAL TELECOMMUNICATIONS & INFORMATION ADMINISTRATION
Develops policies to improve domestic & international telecommunications, including allocation of electromagnetic frequencies to users such as radio, TV, air traffic control, police & fire departments, etc.
Aids development of the National information Infrastructure.

PATENT & TRADEMARK OFFICE
Grants patents and registers trademarks.

TECHNOLOGY ADMINISTRATION
Promotes technology for economic growth and competitiveness.
Develops policies to aid development of technology.
NIST => Aids industry to develop technology [Formerly NBS].
[ATP, MTC's, Baldridge quality Award, CRADA's,]
NTIS => Collects and distributes technical information worldwide [An "enterprise"].

U.S. DEPARTMENT OF COMMERCE

EXHIBIT TO DOO 1-1



Amendment 29
October 14, 1992

THAILAND

Applying Science and Technology to Development

The U.S. Agency for International Development (USAID) in Thailand and the Thai Ministry of Science, Technology, and Energy (MOSTE) designed a seven-year project to help Thailand increase its capability to identify, develop, and produce the scientific knowledge and technology it requires to strengthen its industrial and agricultural development. The goal of this project is increased Thai self-reliance.

The project aims, specifically, at giving substantial assistance to Thailand's science and technology community (i.e., higher education institutions and government and private research organizations) through a newly-created Science and Technology Development Board to undertake research, development and engineering (RD&E) efforts that will focus on problems facing agriculture and industry. The three main areas of scientific emphasis of the project are: (1) bioscience/ biotechnology, (2) materials technology, and (3) applied electronic technology.

BOSTID's Role

BOSTID was asked to assist by providing a resident scientist/administrator to advise STDB and to coordinate BOSTID's activities in Thailand. In Washington, BOSTID staff managed and coordinated assistance. This included:

- Advice on Operations and goals of the STDB organizational structure and administrative control systems and assessment and evaluation of the relevance of activities to its program goals and economic impact to Thailand.

- RD&E Project Design and Review by providing experts to assist with the design of RD&E research grants and in both the formal and informal review of RD&E project preproposals and proposals.

- Provision of experts for scientific conferences, workshops, symposia, and training programs related to program goals, for studies and preparation of reports on matters of interest. Studies and reports focused on current Thai science policy relating to institutional and human resources, economic policy issues, and industrial development policy.

- Through a technology transfer component stimulating the introduction and/or adoption by Thai industrial firms of existing, newly developed, and newly introduced technologies with significant potential for enhancing profitability or productivity in the Thai industrial setting.

- Assistance in developing and implementing an effective standards, testing and quality control program aimed at increasing domestic and export salability of Thai-produced products by advising on its overall organization and establishment of a national quality control program.

- Through short-term expert visits, the conduct of a training program for Thai FDA and other regulatory agencies to ensure that Thai products met international standards, in exports of low-acid canned foods, frozen seafood, and rubber gloves.

- Assistance in the design and the establishment of a Technical Information Access Center.

- The designed and management of a program on U.S.-Thai Commercialization of Science and Technology (UST/COST) to promote technology transfer through the private sector. A detailed description of this program is attached.

Attachments

SUMMARY OF U.S.-THAILAND COMMERCIALIZATION OF SCIENCE AND TECHNOLOGY PROGRAM (UST/COST)

BACKGROUND

In Thailand, the application of science and technology for commercial benefits has been actively pursued by professionals in various sectors, ranging from private firms, financial institutions, government agencies to foundations and academia. In the early years of its creation, the Science and Technology Development Board (STDB), now the National Science and Technology Development Agency (NSTDA) had been frequently asked to assist and facilitate the commercialization of results from scientific research, development and engineering (RD&E) projects and technologies developed locally or abroad. The need for such assistance became apparent in the early 1990's and the NSTDA had been requested by the private sector to provide such assistance.

In 1990, the NSTDA through BOSTID commissioned a study on the Assessment of Biotechnology in Thailand and its potential for commercialization. The study was carried out by BioTechnology International, at that time a program at the University of Maryland. It was coordinated with a parallel project funded by the USAID mission in Thailand carried out by the Maryland Office of International Trade whose objective was to match Thai and U.S. companies (primarily located in Maryland) in order to commercialize biotechnology.

In the summer of 1991, during a visit to the United States by Dr. Thalerng Thamrong-Nawasawat, then NSTDA Director, under its existing technical assistance program, BOSTID was requested to develop a larger plan for proceeding with a U.S.-Thailand Program for commercializing science and technology. The new program would not only include biotechnology but would also encompass materials and applied electronics. The overall objective of the new program (UST/COST) was to promote the economic development of Thailand through the application of science and technology using commercial agreements between Thai firms and U.S. companies.

PROPOSED PROGRAM

In September 1991 during a visit to Bangkok by BOSTID's Program Manager, the outline of the plan was agreed to by officials of the NSTDA and BOSTID and NAS-01-298 was issued by STDB authorizing BOSTID to proceed with the initiation of the UST/COST program up to a direct cost total of $500,000 under Task E, Technology Transfer. Subsequently, the initial plan for proceeding with the U.S.- Thailand Program for Commercializing Science and Technology (UST/COST) was proposed to prospective program participants at an organizational meeting held in Washington, October 17, 1991, as follows:

1. U.S. Regional Liaison Experts (RLEs) would be selected who would have knowledge of industry in their geographical area with potential interest in international linkages with Thailand.

2. The RLEs would be invited to a meeting in Washington in mid-October to discuss plans for initiating the UST/COST program and their possible role. A schedule of visits to Thailand would be proposed together with possible regional meetings.

3. Regional liaison experts would prepare themselves for a visit to Thailand for approximately 10 days. Prior to the visit, they would communicate the areas of potential interest to the NSTDA staff and the possible dates of visit. The NSTDA staff would make all appointments in Bangkok and other parts of Thailand as necessary in order for them to meet as many local industry individuals as possible. This program would include one or two meetings at the STDB with a group of potential industrial people, venture capital individuals, etc. It was hoped that the RLE would have gained a knowledge of the type of companies and areas of potential interest of the Thai companies.

4. In cooperation with BOSTID, the RLE would arrange a meeting in his/her geographical area for local private companies, venture capitalists, etc. In addition, the following individuals would be invited to attend:

   - NSTDA official(s)
   - Local interested company representatives
   - State offices of trade or development association officials
   - Representatives of local chambers of commerce
   - Appropriate Thai officials
   - If possible, representatives of interested Thai companies
   - AID, TDP, EPA parties who have expressed interest in being invited
   - Individuals from trade associations who would be informed of the meeting through their association network

5. For interested companies, arrangements would be made to have U.S. company representatives visit Thailand and Thai company officials visit the United States. In certain instances it might be desirable to have the RLE accompany the U.S. companies (by region) on their visit to Thailand and have university officials as well as NSTDA staff accompany Thai company officials to the United States.

In the UST/COST program, the financial support provided to private firms, either Thai or U.S., would be made on the principle of cost-sharing. This means that the participating private firms only receive a round-trip airline ticket from the BOSTID/NRC and have to bear the remaining costs for their participation.

October 1991 Organizational Meeting

At this meeting, there were two different sessions. During the morning only those individuals who might be considered as Regional Liaison Experts participated in the discussions. The afternoon session was used as a means of launching the program to individuals in the Washington, D.C. area and who might possibly be interested in playing a role in the program or may want to be informed of the regional meetings. Also present at the meeting was Dr. Montri Chulavatnatol, Deputy Director of NSTDA, responsible for managing the program in Thailand, and Mr. Richard Kalina, Acting Director of Administration and Finance, NSTDA.

At the Washington, D.C. meeting, it was decided to consider the activity in the following sequence:

Phase I: U.S. RLEs would be invited to visit Thailand to participate in workshops and to meet with appropriate private sector companies.

Prior to the visit, areas of potential interest and visit dates would be communicated to the NSTDA staff. Requisite appointments in Bangkok and elsewhere in Thailand would then be arranged by the NSTDA staff to insure that entrepreneurs, financiers, technologists and scientists are involved and the RLEs obtain a comprehensive knowledge of Thai companies and technologies involved or needed.

Phase II: Following the visits, meetings are arranged in the liaison expert's specific geographical region for acquainting U.S. local private companies and potential financial sources of the Thai potential capabilities and needs. In addition to U.S. participation, appropriate representatives of interested Thai companies would also attend.

Phase III: Arrangements are made by the NRC and NSTDA staff for appropriate U.S. company representatives to visit Thailand to meet with Thai company officials to discuss or negotiate further potential commercial linkages.

The determination for a visit by a U.S. company (when the NRC provided the airline ticket) would be made by the NSTDA based on a specific request by a Thai company for the visit by a specific U.S. company representative.

It was acknowledged at the beginning of the program that the activities would have to be undertaken at a very rapid pace since there was limited time available to complete all three phases of the program and, hopefully, show results before the proposed end of the UST/COST Program, May 31, 1992. This period was later extended to July 15 due to the

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political demonstrations in May 1992, which necessitated the postponement and in some cases, cancellation of travel of Phase III participants.

Schedule of Activities

The following schedule of meetings was established within the time frame in 1991-1992:

1.	Boston	Phase I -- September 23-28 Phase II -- December 9
2.	Pennsylvania	Phase I -- (Had visited earlier) Phase II -- January 10
3.	Mid-Atlantic & BioEast	Phase I -- (Yuan visited November 17-26) Phase II -- January 16

At the BIO/EAST Conference, there was a Thailand display booth on Thai products and Thai industry.

4.	Northern California	Phase I -- November 17-26 Phase II -- January 21
5.	Texas	Phase I -- February 7-16 Phase II -- March 2
6.	Washington State	Phase I -- November 17-26 Phase II -- March 6
7.	Iowa	Phase I -- February 8-15 Phase II -- April 27
8.	Kansas/Missouri	Phase I -- February 9-14 Phase II -- April 29
9.	North Carolina	Phase I -- February 10-17 Phase II -- May 4

The regional liaison experts visited Thailand and their schedules were coordinated by the National Science and Technology Development Agency. The normal procedure was for the NSTDA to hold general meetings at their office inviting appropriate and interested private business representatives. Subsequently, one on one appointments were scheduled

between the RLEs and the business representatives. This presented a good opportunity for the Thai to determine whether a visit to the United States might be fruitful. Visits to Thailand by RLEs were grouped in order to provide a broader menu to the Thai business community. The regional meetings in the United States were grouped in line with the visits to Bangkok. For example, experts from Iowa, Kansas and North Carolina were in Bangkok at the same time to permit the Thai business officials to attend regional meetings at the same sites.

The attendance at the regional meetings was determined to a large extent by the amount of effort given by the RLE in identifying appropriate individuals to invite. In the majority of instances, the RLEs furnished BOSTID a proposed list of companies to invite. In some instances, BOSTID was provided with directories of companies in the region and BOSTID staff had to make judgement on the appropriate companies to invite. Letters of invitation for most meetings were sent from BOSTID. By this procedure, we attempted to differentiate the meeting from a regular "trade" activity.

There was good attendance by Thai company representatives who used the meeting to discuss their needs and meet one on one with the U.S. company officials. It provided a good opportunity for visits to U.S. companies and getting the Thai company representatives to become acquainted with the U.S. company officials.

It should be noted that at each of the meetings, there were representatives of the Thai Board of Investments and the Royal Thai Embassy.

Interim Evaluation

In early 1992, NSTDA decided that an interim evaluation of the UST/COST program should be conducted. In the United States, evaluation forms were sent to all Regional Liaison Experts and individuals who had attended the regional meetings which had been held thus far. The results of the responses were summarized for discussions in Bangkok, April 16, 1992. In addition to NSTDA staff, Rose Bannigan and Robert Yuan attended the evaluation session. The following represents the summary of the responses received as prepared by the NSTDA staff:

"A. Comments

"The UST/COST program achieved its primary mission and objectives in a very short time frame. A total of 200-300 Thai/U.S. companies and 14 regional liaison experts were involved. There were 10-20 active U.S.-Thai companies in the process of serious negotiations on possible trade-technology agreements.

"From a survey of the U.S. companies who participated in the program, a general consensus was that the program should be continued in promoting the business relations even though only marginal profitable outcome can be seen at this stage. It was a good start and a

similar program should be instituted for longer term goals. In addition, the roles of the regional liaison experts seemed to be indispensable.

"In general, the enthusiasm was high during Phases I and II of the COST program. At Phase III, both Thai and U.S. companies will need to think much harder about a possible deal. The U.S. firm might back off after having assessed that the Thai company's market size was too small to be worthwhile. Another difficulty was that parent firms of a U.S. company might not agree to the idea of doing business in Thailand due to concerns over patent protection and possible political considerations.

"The role of the regional liaison experts was a very important one. Not only did they provide the contacts and organization expertise, but they also worked for the success of the program. However, many program officers thought that it would be necessary for the liaison experts to provide additional effort in clearing up communicational obstacles and in helping Thai and U.S. companies in the actual link-up.

"A survey was conducted of the Thai companies which participated in the program. Responses were received from 20 companies out of 60 companies. Ninety percent of the respondents said that the objectives of the program were clear and 75 percent of the respondents stated that the meetings in Phase I were effective. Also, over 90 percent of the companies said that the program indeed broadened their awareness of the opportunities and the program should be continued and improved. However, when considering the actual benefit of the meetings, less than 50 percent expected that any substantial exchange would result. Among the companies that had followed up negotiations, only 25 per cent expected certain specific agreements. However, in some cases, a corporate decision needed may require a lot of negotiations and preparation for financial arrangements.

"For a future program, all recommendations below should be considered and incorporated. In addition, the NSTDA should take advantage of the fact that the NSTDA is allowed to help purchase technology. However, the NSTDA might have to work out a scheme in which financial support in terms of technological assistance of any kind should be considered as an investment in successful companies. Alternatively, it might be considered as part of a joint venture. Another possibility might be that the NSTDA provide an incubator type funding or venture capital type funding for a start-up firm. In this respect, NSTDA should look to the Midwest Research Institute (MRI) which is a non-profit organization that has a for-profit organization to handle technological investment ventures.

"B. Recommendations

"1. In the future, more emphasis should be put on the technology commercialization opportunities/needs in the material and electronics sectors.

"2. The liaison experts should meet the Thai academic institutes or related research and development centers in order to develop familiarity with existing science and

technology in Thailand.

"3. Future meetings should be organized as sector-specific, similar to the BIOEAST and California meetings. Future programs should be designed to focus on specific technologies as well as existing and new products in a specific field.

"4. A formal statement relating to conflict of interest needs to be developed, particularly, as related to regional experts working in the private sector.

"5. Manpower to implement the program should be allocated sufficiently.

"6. More time should be allowed for planning and following through. Detailed description about the programs, itinerary, reimbursements and responsibilities of participants needs to be formalized and stated explicitly in print.

"7. More time should be allowed after Phase I visits so that Thai or American companies can exchange detailed information about their interest and technology needs.

"8. Continued efforts by NSTDA are needed for the possibilities of link-up between Thai and American firms.

"9. Company databases specifically for the UST/COST program should be set up to facilitate the matching of companies. TIAC should play a major role providing technical information assessment.

"10. NSTDA should not recommend or certify a specific company for the link-up purposes since NSTDA might be liable for such an action.

"11. Criteria should be developed in selecting Thai and U.S. companies to participate in the program.

"12. Future efforts should include FTI, BOI and other agencies that can collaborate closely and fruitfully with NSTDA in this kind of program."

Phase III Activities

In order to ensure that the U.S. companies had specific appointments with interested company officials in Thailand, it was decided that the NSTDA would be the authorizing office for travel of U.S. company officials to Thailand. The Thai company would contact the NSTDA and ask for a visit by a specific U.S. company or company official. The NSTDA would then inform BOSTID accordingly.

Unfortunately, the number of U.S. company officials able to visit Thailand was very limited due to the shortness of time between the original contact with the Thais and the political disturbances in Thailand in May which caused several of the company officials to cancel their visits. In some cases, there was insufficient time to reschedule a visit before the imposed end of the program after the political situation improved. However, according to Dr. Montri, fifteen U.S. companies are in direct negotiations with potential Thai partners.

Other Issues

In addition to the companies who actually joined and talked together, there are other benefits that have been derived from the UST/COST program:

1. It has sensitized the private sector in areas other than the major cities (New York, Los Angeles, etc.) to the potential for doing business with and in Thailand.

2. It has made these private sector officials as well as many others aware of the very good scientific expertise that exists in Thailand, and the possibility of doing applied R&D there.

3. It has relieved companies here to some degree of the negative impact of the press' remarks about the IPR and patent issues. Personal relationships and one-on-one discussions help a lot in these cases.

4. One aspect that is overlooked is the friendships or acquaintances that have bloomed between Thai company officials. When they traveled together to the United States, they became friends and even talked about the possibility of forming joint ventures between their companies in dealing with U.S. companies. Also, the nucleus for the a newly-created Thai Technical Society for Business Ventures are those Thai business representatives who participated in the UST/COST program.

5. Similar programs are being established by Thailand; already there are programs with Australia and Belgium.

The time limitations imposed by the expiration of BOSTID's contract required regional meetings and visits to Thailand of U.S. company officials to be arranged very quickly. In addition, as mentioned previously, political disturbances caused approximately 5-10 cancellations of U.S. company visits. However, given these restrictions, the outcome was a positive one.

UST/COST Program Aids U.S. Biotechnology Companies

By Robert Yuan, Ph.D.

A group of selected U.S. biotechnology companies have taken advantage of an innovative program called UST/COST (U.S.-Thai Commercialization of Science and Technology) to develop commercial agreements with a group of Thai firms. Fifteen U.S. companies are in direct negotiations with potential Thai partners. Not surprisingly, given the importance of the Thai agricultural sector, 12 of these possible agreements involve biotechnology products and processes mainly relating to food and agriculture.

The UST/COST Program, which began on October 1, 1991, and ended on July 30, 1992, recently underwent a preliminary evaluation. The program was found to be successful based on the following parameters:

- the number of direct contacts and potential agreements between U.S. and Thai companies;
- the introduction to the Thai companies of the wide variety of new biotechnology products and processes currently available in the U.S.;
- the promotion of the Thai market for U.S. biotechnology companies; and
- the development of an important network of U.S. contacts for Thai organizations and companies.

Since visits by U.S. companies to Thailand and negotiations did not begin until the late spring and early summer, contracts have yet to be signed in most cases. However, it is interesting to note that in at least one case, what had started as a licensing agreement has now progressed to a point where the Thai partner is willing to acquire equity in the U.S. firm. Furthermore, Dr. Montri Chulavatnatol, deputy director of the National Science and Technology Development Agency (NSTDA) and the Thai official most directly responsible for UST/COST, pointed out two intangible benefits: a closer working relationship between the Thai government, academia, and industry in promoting technology development, and the creation of an association of Thai technology companies by the firms involved in the UST/COST program.

Regional Meetings

A crucial element in the matching of U.S. and Thai firms was the establishment of a network of officials in state economic development agencies and private consultants in different regions of the U.S. Under the planning and coordination of the U.S. National Research Council, this group of individuals selected and recruited companies in their respective regions, and organized nine regional meetings at sites such as Boston, Washington, DC, San Francisco and Seattle.

The original budget for UST/COST was $500,000, but the actual expenditures totaled $354,000, mainly used for payments to liaison experts, and travel costs for U.S. and Thai companies. The lower-than-expected costs are explained in part by the willingness of companies to pay for their own travel in order to expedite their commercial interests.

The results of the UST/COST program hold promise that it will proceed to a third stage pending two specific events: the establishment of a new Thai government, and the resumption of the USAID program in Thailand. Although no official decisions have been made, it would appear that the continuation of the UST/COST program will involve financing of such joint ventures and the creation of appropriate training programs.

It remains to be seen whether other U.S. government agencies will develop a similar approach to expand opportunities for U.S. biotech companies in such rapidly industrializing countries as Taiwan, Singapore and South Korea.

Robert Yuan, Ph.D., professor of microbiology at the University of Maryland in College Park, is director of the Business Development Group of Biotechnology International, a program focusing on worldwide biotechnology development.

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INDONESIA

Science and Technology for Industrial Development (STAID)

The Agency for the Assessment and Application of Technology (BPPT) is responsible for managing STAID, a major institutional and human resource development program funded by the World Bank. The overall program objective is to improve policy making and implementation in critical areas of S&T by:

- Strengthening institutions and developing analytical support for S&T policy making
- Strengthening RD&E planning and coordination at the office of the Minister of State for Research and Technology (RISTEK)
- Strengthening the independent governmental research agencies
- Accelerating development of a science-based city at the Center for Science and Technology (PUSPIPTEK)
- Developing S&T manpower in the governmental research agencies and in Indonesia's strategic industries.

The BPPT requested that the U.S. National Academy of Sciences, through its Board on Science and Technology for International Development (BOSTID), provide technical assistance for the implementation of the following six complementary activities:

Task 1: Technical assistance to strengthen the Indonesian National Research Council (DRN)

Task 2: An analysis and design of a science and technology information network (IPTEKNET)

Task 3: A study of governmental policies concerned with identifying the principal constraints on the effective application of S&T to industrial development in both the public and private sectors.

Task 4. A study of technology management and utilization in Indonesian industry. This involves case studies of the productive sector and will identify priority actions to support industrial development.

Task 5. The design and implementation of a science and technology decision support information system (S&T indicators)

Task 6. Development of a system and procedures for establishing an S&T project analysis capability at the national level

Together, Task 3 and 4 will produce an Action Plan for the Minister of State for Research and Technology and the Chairman of the BPPT to alleviate constraints for industrial development, improve the utilization of S&T in Indonesia, and assist in policy-making as it affects industry. Several interventions have been identified and will be recommended which fall under action or implimentation initiatives, mostly adapted from existing similar U.S. programs:

Action Initiatives

- Indonesian technical assistance program to small- and medium-scale sized firms.
- Product testing incentive program to promote adoption of world-class product quality systems, and provide technical assistance and incentives to strengthen product testing so Indonesian products can meet international standards.
- Indonesian component supplier incentive program to encourage development of component suppliers and initiate linkages between existing suppliers and large firms through incentives.
- Indonesian technology acquisition and development program to provide financial, advisory and matching services to form partnerships that will engage in joint product and process development, manufacturing and sales, thereby increasing the technical content of Indonesian manufacturing.
- Generic Technologies Development Program to award competitive grants to support joint efforts by industry and government laboratories for the development, adoption and application of technology to industry.
- Establish a science and technology management center to provide training for public and private sector senior executives in areas of strategic importance, e.g., industrial strategic planning, human resources management, quality control management, and science and technology policy.

Implementation Initiatives

- Establish a program to certify and accredit science, engineering and technical programs as a means of helping technical training and professional degree-granting institutions achieve world-class standards.
- Establish an Indonesian Technology Advisory Council from industry to help government remove barriers to technology development and competitiveness, and advise the GOI on mechanisms to enhance science and technology utilization, policy formulation and implementation.

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- Develop and strengthen the technical and administrative capability of the government laboratories to provide technical assistance and services to industry, specifically that required to implement previous initiatives.

Currently, BOSTID's contract with the BPPT ends September 1993.

Washington, DC
April 27, 1993

Ladies and Gentlemen, it is my great honor to talk to you on behalf of this Study Group from Pakistan. It is my personal view that had Dr. Zafar Altaf addressed you, the discourse would have been more eloquent, more thought provoking, and analytical. Nevertheless, I am making a sincere effort to express the perceptions, ideas, opportunities, and views of this group.

This study visit provides us the opportunity to look through a small window of time to see, appreciate and become inspired by the panorama of great scientific and technological advancements that your great nation continues to make.

Our whirlwind tour began with our landing at New York on the afternoon of April 17 and will end all too quickly. The tour has ushered us through a very wide spectrum of American society, provided us with an opportunity to visit with intellectuals, thinkers, technocrats and bureaucrats in their ivory towers, scientists in their labs, businessmen and farmers in their respective places of work and encounters with simple hardworking technicians, students and ordinary workers.

Our consensual impression is that we found every dedicated, motivated and honest to his profession. Our general impression is that this great society of the people, by the people,

and for the people is a living, throbbing nation, active and ready to meet the challenges of time.

Our group had numerous discussion sessions and I have elicited responses from my colleagues about their impressions. The specific question that I posed was what has made the USA what it is in science and technology. Let me enumerate some of the responses:

1. Foundations of this country are solidly based on the principles of individual freedom and the right of its citizens to the pursuit of happiness.
2. Availability of huge natural resources.
3. Zeal and spirit of immigrants and the Puritan principles of honesty, hard work, etc.
4. A strong, competitive and sometimes cruel environment which induces people to work hard.
5. Commitment to human rights.
6. Passing laws and acts which encourage demand based on research and development; laws such as the Land Grant College Act of 1862 and subsequent acts that provided the framework for transfer of technology.
7. An environment that attracts intellectual resources from all over the world and provides conditions conducive for intellectual pursuits.
8. An education system which is dynamic and designed to meet changing needs.
9. Few regulatory impediments to free market forces.

10. A built-in reward system within research and development establishments for innovators/inventors and laws for protection of intellectual property.

11. A very strong democratic system that has seeped through all walks of life, determining norms of behavior and awareness of rights creating democratized nation-building institutions.

12. A secular society prone to self assessment and self critique as a result of strong adherence to democratic principles.

13. Organizational ability and activity of interest groups.

14. The great philanthropic attitude of Americans for the promotion of arts and sciences.

15. National pride in being Americans.

We have observed that American society has this great strength based upon its constitution and democratized institutions which encourage dialogues and react to issues. I witnessed the great debates and dialogue that resulted after launching of "Sputnik" in the late 1950's and the massive restructuring and changes that were brought to the education system as well as the allocation of resources for science and technology.

In this environment of awareness where problems and issues are openly discussed, I believe different segments of the society as opinion and policy makers, business houses and industrial processors both small and large, producers of raw materials, and consumers strongly interact. This interaction and thorough thrashing of issues until consensus develops

provides the basis for policy development which is translated into law by the legislature. Thus, everybody feels involved and committed.

I believe that it is this conducive environment that allows interaction and dialogues that also provides direction to researchers for generation of technologies and their embodiment into useable products.

We learned that in the past that massive investments in science and technology came from the public treasury. It still appears to be the case in certain areas of pure science but changing circumstances have created now a more abiding public - private sector interaction in the USA and support comes from users of research results.

My views, and to an extent those of my colleagues whom I had been hen-pecking during the past 10 days, are expressed here more in a generic form and I do not want to mention here many more examples of linkages between the public and private sector that we witnessed during our visit. Upon our return each one of us will prepare notes based on his/her own experience, observations, and perceptions. I am sure he or she will cite specific examples in their reports.

My personal view is that there is no single panacea for our problems and issues. No particular model of research - industry or private - public linkages that we came across and studied during our visit can be directly transplanted to Pakistan, although principles of

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linkages are sound and applicable. We need to develop for our own socio-economic conditions specific models using the principles upon which such linkages are developed in the USA. Initiated a few years ago, the Pakistan Agricultural Research Council experimented with some models of public/private sector linkages. Our visit to the USA confirmed our belief that for faster national development such linkages are imperative.

The underlying theme of CRADA appears very attractive. We will seek more information and advice from our American friends.

Summing my rather inarticulate thoughts I would say that we in Pakistan need no re-invention of the wheel. There is so much available for application. It is accessible and free for humanity to adopt. For other research oriented technologies and their commercialization we should aim at encouraging more active participation of the private sector.

As a passing remark, I may say that Pakistan has the strictest laws against infringement of intellectual property than in any country in the sub-continent. I will leave behind notes prepared on this topic and a copy of a publication by UNDP along with court rulings which will confirm my statement.

It will not be out of place here to thank you and all those who were involved in arranging, organizing, and sponsoring this visit. My special thanks go to Dr. Judith Bale and her

colleagues. A frail, but brave lady made of nerves of steel who suffered chaperoning eight of us during the past 12 days while making sure that each of us learned the maximum.

During this visit which began on the evening of April 16 in Islamabad and due to finish on May 2 when most of us shall return to Islamabad, we have logged 27000 miles in the air and upon the ground, changed, embarked and disembarked planes 28 times and spent 125 hours in the air, and journeying to and from the airports.

Once again on behalf of all the participants and their organizations, I thank our gracious American hosts. In all sincerity I hope that Pakistan and the United States with their long history of friendship and cooperation will continue to collaborate in research, especially agricultural research, and we will learn from our experience in the USA the commercialization of research. Thank you.

Mumtaz Ahmad

Group Leader

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Panel Meeting for Study Tour from Pakistan
Important Issues and Outlining of a Strategic Plan for Commercialization of Research in Pakistan

Some Ideas -- Issues

Identify real world problems, set priorities, work with researchers and users

The gap between institutions and private sector industries
- small industries (can't afford)
- large industries (don't need)

Lack of availability of resources: funds, facilities, training opportunities

Identify the opportunities for commercialization

Cooperation within national research capability
- to communicate
- to suggest commercialization
- other means for collaboration
- priorities

ISSUES

- Institutional gap
- Lack of understanding of scientists' goal
  Product? Research, interaction with industry
- Research Institutes should make relationships with industry groups
- "Training" of scientists to be entrepreneurs (lack). No orientation.
- Small industries lack money to talk or work with institutes -- and don't understand how institutes can help.
- Scientists are not robots, don't blame them. Help them to understand National Goals.
- Legal structures needed to bridge
  Relationship: Industry/Research
- Patenting process needs to be better implemented:
  - Collaboration with private sector
  - Institute does not explain or help. What to do? How?
- Need improvement in communication and collaboration within national research groups and institutes. Give scientists some priorities.
- Recognize opportunities to close a project--achieve some goals.
  (Small steps).
- Place greater emphasis on scientist-to-industry relationships.

CONSTRAINTS

1. Policy regarding revenues from research going to researcher and institution

2. "Arbitrary power" of financial/accounts office to decide

   [Solution: Set clear rules -- then give more responsibility for scientists to follow rules.]

3. Entrepreneurial class -- needs:

   - money
   - access to research and assistance
   - definition of opportunities
   - linkage with agribusiness
   - venture capital

4. More money for research

   [Solution: Tax? from pockets of consumers.
   Public research lays more golden eggs -- to pay taxes.]

5. Convince the public

   - that research is worth support
   - that the "institute" is useful
   - show synergism with the public sector
   - develop a framework for interaction

6. Too little interaction between research/extension/users

   [Solution: Develop user groups to work with and represent industry as a group]

7. Government regulations and imports may discourage local research to solve problems

8. Too low allocation for agricultural research in Pakistan (0.17% of agricultural product). There is a big disparity in the size of crop sectors and commercial suppliers.

9. Manpower needs -- projections for industry needs should be anticipated.

SOLUTIONS

1. Strengthen the infrastructure between PARC and industries to obtain more commercialization.

2. Orient scientists to local and national research needs:
   Institutes-universities-extension-farmers-institutes

3. Develop a National Policy for Technology Transfer -- work with provinces (involve all research sectors)

4. Involve entrepreneurs in research policy

OPPORTUNITIES -- as seen by Panel in U.S.

1. Give some ownership to scientists in developing their products.

2. Allow consulting by scientists.

3. Develop commercialization office in research institutes.

4. Solicit gifts from people of means, who can be interested in the research program.

5. Consolidate similar research--improve linkages.

6. Require scientists to prepare proposals for their work that identifies:

   - objectives
   - time line -- end point
   - methods -- plan
   - expected output
   - present plans for review

7. Strengthen producer groups--ask for further help in setting priorities.

8. Encourage professional associations--national and international.

9. Change the attitude/policy for reserach. Orientation to more application/commercial.
   On-the-job orientation....
   Communication with users.

10. Seek to establish internships in private sector.

11. Elaborate on models in Pakistan for interaction between universities and industry

    - PARC-university - for thesis research
    - Research institute/university
    - PARC - private sector

STRENGTHS

to build upon

1. Human resources:
   - o commercial
   - o research institutions

2. Material resources:
   - o land
   - o climate
   - o crops

3. Mechanisms
   - o to identify needs in research/public sector/private sector
   - o for research
   - o administration

4. Access to West - USA
   East - China, Asia

5. New policies that encourage research, reduce restrictions to work with industry/private sector
   eg., the fee now charged to industry (25% to scientist)--not yet in provinces.

6. Shift of society to a demand base; be an agent for change
   eg., tractors

PARC's POLICY FOR TECHNICAL COLLABORATION WITH THE PRIVATE AGRIBUSINESS SECTOR

Prepared by

The Directorate of Agri-Business Relations
Pakistan Agricultural Research Council
Islamabad

May 1992

No.F. 2-3/92-DD(AB)
PAKISTAN AGRICULTURAL RESEARCH COUNCIL

Islamabad the June, 3, 1992

Subject: POLICY FOR TECHNICAL COLLABORATION WITH THE PRIVATE AGRIBUSINESS SECTOR

A proposal from the Directorate of Agri-Business Relations regarding policy for technical collaboration with the private agribusiness sector was considered and approved by the Executive Committee of the Council in its meeting held on February 26, 1992. The policy and procedure approved by the Committee is as under:

1. Modes of Collaboration

PARC will provide technical assistance to the private agribusiness firms in the following areas:

i. Consultancy Services

ii. Transfer of Technologies developed by PARC

iii. Design, Development, Testing and Evaluation of products; market studies; and staff training, etc

iv. Collaborative Research activities

2. Modus Operandi

i. Directorate of Agri-Business Relations would be responsible to deal with all matters and activities related to collaboration with the Private Agribusiness sector.

ii. The Institute Directors will keep the Directorate of Agri-Business Relations informed of the new developments in their respective units. The latter will assist the Institute Directors in the preparation of feasibility reports of new technologies. Director Agribusiness and the Institute Directors will work together in generating business with the Private Agribusiness sector.

iii. Institute Directors will send their proposals for Technical collaboration with Private Agribusiness firms to the Directorate of Agribusiness Relations through their Technical Members.

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iv. Technical assistance to Private Agribusiness firms will be provided for a fee. Schedule of fees is given under Section 3. The cost of the projects will be carried out by a team comprising Director Agribusiness, the concerned Institute Director and Director Finance.

v. The Directorate of Agri-Business Relations will negotiate the terms of the Agreement with the Agribusiness Firm in consultation with the concerned Institute Director and Finance Director, prepare protocols and obtain approval of the Chairman.

vi. A formal Agreement will be signed between PARC and the agribusiness firm for each collaborative activity. PARC will be represented by the Secretary of the Council.

vii. There will be no restriction on the transfer of a Technology to more than one agribusiness firm.

viii A scientist will be treated on duty during the period of PARC's collaboration with an Agribusiness Firm under the agreement. A scientist will receive his salary from PARC during the Short Term Consultancy (less than three months) and from the Agribusiness Firm during Long Term Consultancy (3 months or more). A PARC employee engaged by an Agribusiness firm as a Long Term Consultant will remit one-third of his salary to PARC on monthly basis to cover his contribution towards GP Fund, pension, overhead costs and other charges, etc.

ix. Institute Directors shall be fully empowered to execute Private sector Agribusiness projects. This includes preparation of work plans, purchases, billing the private Agribusiness Firms and maintaining accounts, etc. Each Institute Director will open a bank account for Private sector related activities. These accounts will be open to audit by PARC.

x. In case of short term consultancies and projects carried out for Agribusiness Firms, PARC will pay honorarium equivalent to 25% of the labor charge (fee charged for time spent by scientists, technicians, etc) to the concerned staff member(s). A scientist on long term consultancy will not be eligible for honorarium.

xi. The Institute Directors will deposit with PARC the savings from collaborative activities with the Private Agribusiness Firms at the close of each fiscal year.

xii. Director of the Institute concerned will ensure successful collaboration with Private Agribusiness Firms. The Directorate of Agri-Business Relations and PARC management will facilitate the Institute Director in his operations.

Institute Directors will submit quarterly progress reports on the collaborative activities to the Directorate of Agri-Business Relations. The progress will be jointly reviewed by the concerned Technical Member of the Council, the concerned Institute Director and Director Agribusiness.

3. Schedule of Fees

i. Consultancy Services

A. Short Term Consultancy

The Agribusiness firms will be charged for the Consultant's time spent on duty and for travel according to the schedule provided as under:

a. Rs. 1000/- per day for officers in BPS 19 and above

b. Rs. 700/- per day for officers in BPS 17 and 18

c. Rs. 400/- per day for officers in BPS 16 and below

TA/DA admissible to the Consultant will not be less than the prevailing PARC rates.

B. Long Term Consultancy

The Agribusiness firms will pay salary, perquisites and relocation expenses to the scientists. A scientist on Long Term Consultancy will remit one-third of his salary to PARC on monthly basis to cover his contribution towards GP Fund, pension, overhead costs and other charges as mentioned earlier under para 2-(viii)

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ii. Transfer of Technologies Developed by PARC

The Agribusiness Firms will be charged by PARC the cost of technology transfer i.e consultancy fee, travel and transport related expenses. In addition, the Agribusiness will pay a TOKEN ROYALTY equivalent to a minimum of 1% of the ex-factory value of the product for a period of 5 years to PARC. Furthermore, the Agribusiness will be required to mark the product as under during and after expiry of the agreement:

" PRODUCED WITH THE TECHNICAL
COLLABORATION OF PARC "

PARC in collaboration with the Agribusiness Firm will monitor the production volume of commodities for which royalty will be charged by PARC. The agribusiness will be required to make royalty payments on quarterly basis.

iii. Product Design, Development, Testing and Evaluation; Market Studies; and Staff Training, etc

The Agribusiness Firms will be charged by PARC full cost of the project plus an overhead fee equivalent to 50% of the cost. The cost will include salary of staff, travel and transport expenses, cost of consumables, depreciation cost of laboratory and field equipment and all other costs.

iv. Collaborative Research Activities

Costing of collaborative research program will be carried out by a committee comprising of Director Agribusiness, Institute Director and Director Finance as stated earlier in para 2-(iv) above.

(Zafar Uddin)
Secretary

Distribution

- All Members of the PARC
- Director General, NARC
- Directors/Coordinators/PIs/Officers Incharge of Projects/Outstation Directors of PARC
- PS to Chairman PARC
- DAS (WM.&E)

Draft

GUIDELINES FOR TECHNICAL COLLABORATION WITH THE PRIVATE AGRIBUSINESS SECTOR

by

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Pakistan Agricultural Research Council
Islamabad

November 1991

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GUIDELINES FOR TECHNICAL COLLABORATION WITH THE PRIVATE AGRIBUSINESS SECTOR

by

Muhammad Khalid[1] and Sultan Mahmood Khan[2]

1. INTRODUCTION

The agricultural research system of Pakistan has experienced rapid development during the last decade. This has resulted in the generation of an extensive knowledge base and training of the scientists. Research over the years has, however, played a limited role in the development of agriculture on scientific lines. This has been because of the absence of effective linkages between research and extension organizations and the private agribusiness sector. It is not possible for government research organizations to go to every farmer. The agribusiness firms, by virtue of their being in the market place, are in a better position to influence research programs, guide on product design as suggested by the market forces and incorporate research findings into products for end users i.e. the farmers and general public.

Linking public agricultural research organizations with the private agribusiness sector invariably entails, among other things, close interaction of the research institutions with the private agribusiness firms for transfer of locally developed technologies, designs and processes, etc. Active collaboration of government research organizations with private agribusiness firms is a relatively new concept in Pakistan. Because PARC is now actively pursuing the policy of effective collaboration with the private agribusiness sector, there is a need to develop guidelines for the research institutes on such aspects as prioritization of collaborative projects, fees, utilization of funds generated from fees, etc. An analysis of the various aspects of collaboration with the private agribusiness sector, and recommendations are presented in this working paper.

2. MODES OF COLLABORATION WITH THE PRIVATE AGRIBUSINESS SECTOR

Collaboration with the private agribusiness sector may take one of the following forms:

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[1]Consultant Agribusiness, Winrock/USAID, Pakistan Agricultural Research Council, Islamabad

[2]Deputy Director (Agribusiness), Pakistan Agricultural Research Council, Islamabad

- Consultancy/Advisory Service. The research scientist visits the agribusiness firm on agreed schedule and all work is carried out on site without using PARC laboratories or facilities.

- Testing and Evaluation Service. A product is supplied to the research institute for testing and evaluation. Expertise of the scientists, laboratory and transport facilities, inputs such as crop, seed, fertilizer, machinery, etc may be used in carrying out the testing and evaluation activity.

- Collaborative Research Projects. In this type of interaction research scientists may be required to work both at the premises of the agribusiness firm as well as the research institute on project related activities. In addition collaborative research projects may involve the use of laboratory and transport facilities, etc of the institute.

- Market Studies. Social scientists may be called in by an agribusiness firm to study markets for specific products, develop new markets, assess acceptability of new products, etc.

- Joint Ventures. A facility (e.g. vegetable seed processing plant, feed mill, etc) owned by a research institute may be operated under joint venture agreement with a private agribusiness firm. Commissioning of the facility, technical advice, collection of data and overall management may rest with the institute while the agribusiness firm may be fully responsible for operation of the facility. Operational aspects may include procurement of raw material, processing, marketing and related financial aspects. Profits may be shared on agreed terms.

  Joint ventures may not be a desirable mode of interaction with the private sector because an element of mistrust between the two managements always exists. Long term leasing is considered to be a better alternative.

3. CAPACITY OF PRIVATE AGRIBUSINESS SECTOR TO PAY TECHNICAL FEES

The private agribusiness sector can be divided into two distinct groups i.e.:

A. Cottage Industry with limited capital and characterized by no in-house R&D facilities or links with a R&D group. Farm machinery, seed and feed industries are examples of the Cottage Industry.

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B. Organized Industry which has access to capital, and in-house R&D facilities or R&D network of foreign partners. Examples include fertilizer, insecticide & pesticide and pharmaceutical industries.

The Organized Industry generally gives a low rating to indigenous R&D facilities. Nonetheless, Pakistani agricultural research institutes are capable of providing solutions to the majority of researchable problems of this group at a fraction of the price paid by this group of businesses to foreign R&D organizations.

The Cottage Industry needs immediate attention and is also desirous of technical assistance from research institutes. The economy of these businesses, however, usually does not permit the entrepreneurs to invest in R&D or pay technical fees to the R&D institutions. Furthermore, the entrepreneurs risk uncertainties by investing in a new product or bringing changes to an existing product which may not be acceptable to the farmers. The Cottage Industry although willing to experiment with new products is reluctant to pay research institutes a technical fee. Thus introduction of a technical fee may hinder the commercialization of locally developed technologies and slow down progress.

Director Farm Machinery Institute (FMI) informed the FMI Technical Advisory Committee during a meeting held on June 18, 1990 that the farm machinery manufacturers are reluctant to take assistance from FMI due to high rates of technical fee. Director (FMI) invited the opinion of the TAC and the TAC proposed that technical fee should be charged only to those manufacturers who seek FMI assistance for proven technologies while actual expenses should be charged for development projects.

If a technical fee is charged, such earnings in the present atmosphere may constitute at the most a meager one percent of total budget of a research institute. Is this worth jeopardizing the usefulness of the whole research system for such petty earning? Certainly not. Now is not the right time. Nonetheless, the effectiveness of free technical assistance is also questionable. Thus there is a need to address the issue so as to make best use of the available resources.

4. CREDIBILITY OF RESEARCH ORGANIZATIONS WITH THE PRIVATE AGRIBUSINESS SECTOR

In addition to the financial constraints of Cottage Industry and preference for foreign R&D facilities on the part of Organized Industry, it will not be out of context to mention here that research scientists, in general, lack credibility with the private agribusiness sector because of their theoretical approach. An entrepreneur will be interested in adopting a new technology only if he feels that his capital investment will be safe and that he can make a reasonable profit. The

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research scientists usually face difficulty in satisfying the entrepreneur on the financial and economic soundness of new technologies developed by them. Thus, the agricultural research institutes have to first establish credibility with the private agribusiness sector before demanding technical fees.

5. PRIORITIZATION OF COLLABORATIVE PROJECTS WITH THE PRIVATE AGRIBUSINESS SECTOR

Projects involving basic research are the hallmark of prestigious research organizations such as PARC. Basic research is necessary for providing better and efficient processes and products for times to come and for maintaining dynamism in the system. Nonetheless, application of current knowledge in solving existing problems is more important. A research system which can help society with its present day problems can also be trusted to be the leader in the years to follow.

Successful private sector establishments derive their survival from staying ahead of the crowd. Right decisions and timely actions on part of business managers is what keeps businesses alive. Thus research organizations have to provide solutions which private agribusinesses can convert into efficient products. Invariably, the research organizations have to provide such solutions quickly before the agribusinesses turn to alternate sources (e.g. imports) to fill the vacuum.

The following criteria for prioritization of collaborative projects may be used:

- Relevance to the established terms of reference of the research institute. These terms of reference may be modified to accommodate changes in the business environment
- Degree of impact and catalytic effect on the industry
- Financial implications on the resources of the research organization
- Availability of staff to carry out the project

Following proposals are made in this regard:

Priority I. Agribusiness firm seeking technical assistance (short or long term consultants, testing & evaluation , market studies, etc) on proven technologies and expertise developed by PARC and willing to pay a fee.

Priority II. Agribusiness firm seeking technical assistance on new technologies under investigation by PARC and willing to share the cost of collaboration.

Priority III. Collaborative research projects.

Priority IV. Specialized projects not included in the work plan of PARC.

Priority V. Freebies

6. WHO SHOULD BE RESPONSIBLE?

The responsibility of the success of a collaborative project with a private agribusiness firm lies with the concerned Institute Director. The role of the Directorate of Agribusiness and PARC management is to facilitate the Institute Directors. As success of collaborative projects is highly dependent on how quickly PARC can respond to the needs of the private sector, Institute Directors have to assume all responsibilities and, therefore, should enjoy certain powers to fulfill their responsibilities. Following proposals are made:

- A collaborative project may be initiated by an Institute Director. The Institute Director will prepare pre-feasibility reports on research based technologies for review by the prospective agribusiness firms. The Institute Director will help the Directorate of Agri-Business Relations in locating a counterpart in the private sector.

- The Directorate of Agri-Business Relations will send acknowledgement letters in response to all enquiries from the private agribusiness sector within 7 working days of the receipt of the enquiry at PARC/NARC. The Institute Directors will pass on the enquiries to the Directorate of Agri-Business Relations immediately on receipt.

- The Institute Director will scrutinize technical assistance enquiries from the private businesses and discuss with the Directorate of Agri-Business Relations who will negotiate the terms with the concerned agribusiness firm and draft the text of the agreement. The draft agreement will be sent to the Secretary, concerned Member and Chairman for approval. On approval, a representative of the agribusiness firm will be invited to the PARC headquarters to sign the agreement with the Secretary PARC.

- The funds generated by an institute from collaborative projects will be used solely by that institute to undertake project related work and travel, pay honoraria to scientists, upgrade laboratory facilities, purchase laboratory and office supplies, hire short term technical and non-technical help and generate new business. Each Institute Director will open and operate a special bank account for private sector related activities. Such accounts shall be open to audit by PARC.

7. PROPOSED SCHEDULE OF FEES

The question related to fees for assistance rendered to private agribusiness firms has surfaced at several occasions in the past. The PARC Executive Committee on its meeting held on May 22, 1989 approved a schedule of technical fees to be charged by the Farm Machinery Institute from the clients. Honoraria to concerned staff @ 25% of the technical fee was also approved. This schedule of technical fees, however, could not be followed due to reasons mentioned under Sections 3 and 4.

Keeping in view the financial constraints of the private agribusiness sector and lack of experience and credibility on part of the research institutes, the following schedule of fees is proposed for uniform application by all institutes and programs of PARC in respect of collaborative projects with the private agribusiness sector:

I. <u>Agribusiness Firm Seeking Technical Assistance for Proven Technologies.</u>

i. Technical fee for consultancy and advisory services at the following rates per actual day spent on the job in addition to TA/DA:

- Rs. 700/- for officers in Grade 19 and above.
- Rs. 500/- for officers in Grade 17 and 18.
- Rs. 300/- for officers in Grade 16 and below.

The above rates are based on actual cost of employees to Pakistan Agricultural Research Council.

ii. Honorarium to the concerned officer (s) shall be paid at the rate of 25% of the technical fee. Seventy five percent of income from technical fee will be used by the Institute Director on project related activities.

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II. Agribusiness Firm Seeking Technical Assistance for New Technologies under Investigation by PARC.

No technical fee will be charged for consultancy and advisory services. However, the agribusiness firm will be required to bear the expenses related to TA/DA and accommodation (not less than GOP rates) and provide local travel to the scientist.

III. Collaborative Research Project with Agribusiness Firm

No charge to the agribusiness firm.

IV. Agribusiness Firm Seeking the Services of a Long Term Consultant.

The agribusiness firm will pay salary, perquisites and relocation expenses (both ways) to the scientist. In addition, the agribusiness firm will deposit every month an overhead fee equivalent to 25% of the salary of the scientist with PARC.

V. Testing and Evaluation

Fees according to rates established by each institute for various kinds of tests will be charged.

VI. Agribusiness Firm Seeking Technical Assistance on Specialized Projects not Included in the Work Plan of PARC.

The agribusiness firm will pay all expenses including technical fee, TA/DA, use of laboratory facilities and transport, etc. Technical and budget proposals will be prepared by the concerned institute for the interested agribusiness firm.

8. PATENTS AND ROYALTY

Ambition is generally found among administrators and scientists of agricultural research organizations to patent the indigenous technologies and charge royalty from private agribusiness firms who adopt these technologies. As per internationally accepted laws, only original technologies are patented after exhaustive scrutiny of existing patents. Patents and royalties are more common where concepts and designs are devoid of any ambiguities (e. g. mechanical

designs), the research organizations have credibility with the private sector, private sector is organized, the products are of high value, end-users are quality conscious and, most of all, there is active presence of law enforcement agencies to prevent breach or theft of patented technologies.

From a quick analysis of the scenario in Pakistan, one can draw the conclusion that none of the pre-requisites of patents identified in the previous paragraph can be easily met. The technologies and concepts which we may claim as ours have in fact been borrowed from other societies and adopted in its crude form by research organizations using public funds. The financial condition of the majority of farmers is miserable which reflects equally bad on the private agro-industries. The patenting process is lengthy and cumbersome which may delay the process of technology transfer, and there is virtually no protection to a patent holder in case of illegal use of patented designs.

There may be isolated cases of original technologies developed by our research organizations. In the event that such a technology is patented and a private agribusiness does agree to pay royalty, it is obvious that this particular agribusiness firm will ask for full rights to exploit the patent. This may result in depriving general public of the valuable information which was developed by spending public funds.

It can be concluded from the analysis presented in the previous paragraphs that technically, economically and socially, it is not feasible for the agricultural research organizations to get involved into patents and royalties. It will simply add to the work load of the research staff, delay the transfer of technologies and drastically reduce the quantum of collaboration with private sector.