FOSTERING A RESEARCH-AGRIBUSINESS PARTNERSHIP: A STRATEGY FOR EFFECTIVE TECHNOLOGY TRANSFER

A Summary Report of Two Workshops

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... agricultural scientists and research scholars should launch coordinated efforts for promotion of meaningful research....

Farooq Ahmed Khan Leghari
President of Pakistan
The Pakistan Times, *April 9, 1994*

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FOSTERING A RESEARCH-AGRIBUSINESS PARTNERSHIP: A STRATEGY FOR EFFECTIVE TECHNOLOGY TRANSFER

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I. INTRODUCTION

Historical forces are changing the ways in which nations order their domestic affairs and resolve international issues. The balance of power, which has long served as the framework for world affairs, is gradually being replaced by a balance between economic competition and economic interdependence. At the same time, skill in using technology is replacing natural resources and location as the principal source of wealth. The way each nation addresses this challenge will determine its place in the emerging world order.

The challenges to Pakistan's traditional policies are many, but so, too, are the options available. A long tradition of building a scientific and technical infrastructure has created a cadre of talented individuals that would be the envy of any developing nation. The challenge for Pakistan now is to manage its national technology enterprise in a way that gives these individuals the incentive to use technology for improved production and thus increased competitiveness in national and international markets.

Success here will require change--to continue the old ways is to prolong the old results. Pakistan stands at a crossroads in its approach to economic development and nation building. During the mid-1990s, Pakistan has an opportunity to adopt and implement plans for economic development that will position the nation for its role in the world economy of the twenty-first century.

This report on fostering a research-agribusiness partnership builds upon the *National Technology Policy and Technology Development Action Plan* of November 1993 to, first, recommend a foundation and framework for effective leadership by government administrators, research managers, and agribusiness leaders; and, second, recommend specific actions these leaders can take to strengthen the linkages between research and agribusiness. There are two ultimate goals for these linkages:

- That the needs of agribusiness will animate and inform research and teaching.
- That timely research results and appropriately trained personnel will improve the competitiveness of Pakistani agribusiness.

The report is organized as follows:

Section II. PRINCIPAL THEMES
Section III. A FRAMEWORK FOR ACTION
Section IV. SPECIFIC RECOMMENDATIONS FOR ACTION
Section V. PRIORITIES AND TIMELINES
Section VI. CONCLUDING THOUGHTS

Because of the importance of two areas for technology transfer, an appendix on each is included:

Appendix A: Applied Research: A Technology Transfer Partnership Between Research and Agribusiness
Appendix B: Intellectual Property Rights

II. PRINCIPAL THEMES

The recommendations of this report reflect three principal themes.

Market-Driven Incentives. It has become clear that a market system is the most effective way to organize economic activity. But research and development is a special kind of economic activity. To stimulate economic development through research, the market must reward, not deter, innovation by offering the successful entrepreneur a reasonable prospect of return on investment. This, in turn, requires effective laws that protect an inventor's right to his invention. Such protection facilitates the transfer of technology between research and business, as well as among countries.

Communication. There must be continuous and effective communication among the principal agribusiness institutions: businesses that use technology, including large, multinational corporations and small entrepreneurial companies; universities and research institutes, which provide both technology and trained manpower; and government, which represents the public interest and sets the policies that shape economic development.

The Role of Government. Private business, not government, is the principal agent of economic growth through technology. Nevertheless, the policy environment created by the government strongly influences the effectiveness of the private sector. Indeed, every element shown by experience to be essential for the success of technology-driven entrepreneurship (as enumerated in the next section) is shaped by government policy.

III. A FRAMEWORK FOR ACTION

The experience of many nations, both developing and industrialized, suggests that five key attributes characterize those that are most effective in using technology as an engine of economic development:

1. **Source of Technology.** Successful innovation requires a state-of-the-art technology base in university/government laboratories. This, in turn, provides a cadre of technically competent people who may become inventors or skilled adopters of technology developed elsewhere.

2. **Attitudes About Innovation.** The personal attributes of successful innovators include a reasoned dissatisfaction with the *status quo*, an inclination toward continuous experimentation and learning, a market orientation, and an ability

to thrive on rapid change. The national policy environment should nurture these attitudes.

3. **Support for Entrepreneurs.** Large companies sometimes provide such support internally, but small and start-up companies require external support systems. These include technical assistance, business management training, and incubation services. Also essential is a skilled and diverse work force of supporting technicians.

4. **Capital.** Access to venture capital is essential. This is particularly true for first-stage venture financing, also termed "seed capital."

5. **Markets That Reward Innovation.** The market system must reward innovation and allow innovators to reap the fruits of their efforts. By doing so, it communicates to the research community the priorities of the particular business and of the economy in general. All this requires adequate and enforceable protection of intellectual property rights.

All of these elements of success are necessary. To the extent that any one is weak, the likelihood that technology will become an effective driver of farm and agribusiness competitiveness diminishes. In that sense, these attributes can be thought of as the infrastructure for technology transfer.

The responsibility for creating and nurturing this infrastructure is necessarily a shared one. Government, businesses, and the research community each have unique missions, and the entire national enterprise is best served when each sector acts within the province of its own unique capabilities.

The matrix on the following page illustrates this. The rows contain the five elements of successful technology transfer, and the columns the principal sectors of Pakistani agriculture: government, the universities and research institutes, and farms and agribusinesses. The specific recommendations for action prepared by the panel can then be arranged within the resulting matrix. This creates a highly effective planning tool, in that:

- The interdependencies among the actions can be recognized and communications strengthened.

- Priorities can be set, thus making more effective use of the available resources.

- Gaps and omissions can be recognized before they lead to diminished effectiveness.

- Progress can be monitored and lessons learned.

The specific actions shown on the matrix are described in detail in the next section.

Matrix for Successful Technology Transfer

ELEMENT	A. GOVERNMENT	B. UNIVERSITIES AND RESEARCH INSTITUTES	C. FARMING AND AGRIBUSINESS
1. SOURCE OF TECHNOLOGY	(1) Develop a Diverse and Capable Research Base (2) Identify Promising Opportunities Through Annual Study Tours (3) Hold Special Conferences on Change in Agribusiness	(1) Reward Scientists for Performance (2) Develop More Effective Curricula	Attract and Retain Skilled Technical Manpower
2. ATTITUDES ABOUT INNOVATION	Attract Skilled Emigrés Back to Pakistan	(1) Establish Technology Transfer Offices in Universities and Research Institutes (2) Encourage Scientists to Start New Businesses (3) Encourage Joint Ventures with Foreign Technology Companies (4) Encourage Close Liaisons with Agribusiness	(1) Provide Internships for Students (2) Sponsor Annual Awards
3. SUPPORT FOR ENTERPRISE	(1) Form a Technology Transfer Company (2) Improve Extension Services	(1) Organize International Matches Between Institutions with Similar Technology Transfer Interests (2) Improve Scientific Communications	
4. CAPITAL	Stimulate Early-Stage Venture Financing		
5. MARKETS THAT REWARD INNOVATION	(1) Provide Market-Driven Opportunities (2) Maximize Return from Research (3) Provide Adequate Protection for Intellectual Property		Seek Contracts with Researchers on Specific Problems

IV. SPECIFIC RECOMMENDATIONS FOR ACTION

Specific actions, begun now, can improve the productive interplay between research and agribusiness in Pakistan. Viewed collectively, as in the matrix, these actions form a vision for change. Clearly, the matrix is not intended as a rigid set of prescriptions, but as a framework for discussion and for the development of appropriate policies. Our first recommendation, therefore, is that this matrix be adopted, not only as a planning tool, but more importantly as a means to communicate the vision for change. But for this vision to be effective, it must be widely shared and durable over time, and this in turn requires communication and leadership. To this end, three overall actions are recommended to provide a sound basis for the action plan.

Assign a Lead Agency to Develop the Vision for Change. The government should assign a lead agency to nurture and develop the vision represented by the matrix, although not to impose the government perspective on the other participants. This lead institution would work cooperatively and communicate widely, recognizing that effective action will spring from the independent, entrepreneurial actions of individuals beyond its control. It would follow up on the specific actions described herein, learn from both mistakes and successes, share the results widely within Pakistan, and constantly develop new actions to encourage research-agribusiness linkages.

Identify a Champion for Technology Transfer. Success with this action plan depends on individuals and organizations interacting in new ways. Institutional changes will be necessary. Accomplishing these changes will require high-level leadership from a champion for research-agribusiness linkages who shares the vision of the Secretary of Agriculture in this area, and is able to oversee and integrate a series of actions that will bring new technology to agribusiness in Pakistan. This leader would come to the position with an established stature in the scientific and business communities. He and a small staff located in the PARC Agribusiness Unit would report directly to the Secretary of Agriculture. He would motivate leaders in research, agribusiness, and government to implement the recommendations in this report, and would facilitate communication among leaders in these groups until they had other adequate channels. His leadership and access to the Secretary could overcome the many obstacles involved in the serious reorganization of a sector.

Create a Government-Agribusiness Partnership through Applied Research Grants. Developing effective relationships between the *users* of technology, farmers and agribusiness, and the *providers* of technology, the universities and research institutes, requires practice. The Secretary of Agriculture can encourage both sides to begin this interaction by establishing a program of applied research grants. In contrast with the BOSTID-PARC Research Program, which is designed to build basic research capabilities, this program would be designed for immediate value to farms and agribusinesses. Its goals would be set by their needs and its priorities governed by their priorities. This program of applied research grants would include the following features:

- A committee of businessmen, researchers, and government leaders in agriculture, who together would select for support those research projects with the greatest

promise for solving the significant scientific and technological problems of Pakistani agribusiness.

- Rigorous peer review, beginning with selection of an objective, experienced panel, to ensure that the program is truly competitive and thus able to have the maximum impact.

- Initially, a single operation at the national level, which might eventually serve as a pilot for similar provincial programs. The intent is to encourage an active, competitive program responsive to the broad needs of businessmen, farmers, and farm organizations.

- Funding support for the program from the central government, evolving to include funding from other sources, especially the private sector.

- Management of the research projects to ensure that the program operates efficiently and effectively.

- Incentives for researchers aligned with those for businessmen to encourage continued cooperation for success.

Appendix A provides a detailed description of such a program. This program would have several benefits for technology transfer:

- It would work to ensure an industrially relevant research establishment by supporting research as it moves along the path to commercialization.

- It would enhance the local skill base for recognizing and accepting relevant research from abroad by reinforcing local experts as receptors of technology, and by minimizing the problems in technology transfer created by skill differences between senders and receivers.

- It would retain research strength in the universities and research institutes, and serve communities and their provincial economies.

- It would open new possibilities for technology transfer internationally, along with an expanded export base.

Several other vehicles are useful for fostering technology transfer. These are presented in the following subsections as specific actions for government, technology centers, and agribusiness. The alphanumeric designators introducing the actions correspond to the cells in the technology transfer matrix. We believe all these actions should be started now. Some will yield results in the short term, while others are structural in nature and likely to have long-term impact.

A. Actions for Government

A.1-(1) Develop a Diverse and Capable Research Base. Because solutions to agricultural problems are multifaceted and the needs of agribusiness are interdisciplinary, government needs to support a diverse and capable research establishment. Rewards such as the sharing of royalties (e.g., one-third to the research institution, one-third to the department, and one-third to the scientists) would encourage research directed toward the needs of agribusiness.

A.1-(2) Identify Promising Opportunities Through Annual Study Tours. Because agriculture is not vertically integrated, private companies do not have a good overview of activities that begin with seed selection and end with a final product. Government can assist in the evaluation of opportunities outside current niches by organizing study tours for agribusiness and research leaders with demonstrated ability and interest in technology transfer. The tours could be domestic or international; take about 10 days each; and be organized to demonstrate "best practices," current techniques, and emerging technologies. Participants on tours should be those who are most likely to contribute to technology transfer, and should represent different commodities to offer a broad look at how related problems are addressed and at opportunities beyond current specific niches.

A.1-(3) Hold Special Conferences on Change in Agribusiness. Pakistan, like other countries, can adapt to the challenges of the emerging competitive international environment. Technology offers opportunities to ensure sustainability in agriculture and improve productivity for all the steps toward the final product. The government can promote leadership by convening national conferences annually to discuss these issues, as well as ways of facilitating effective communication among businessmen, researchers, farmers, and teachers. The conferences would begin with an opening address by the Prime Minister or Minister of Agriculture to challenge technology centers and agribusiness to lead Pakistan toward increased productivity. A portion of each conference would provide for commodity-specific groups to discuss issues specific to their sectors. The general theme would be the new economic and technological circumstances and how to change to meet new challenges.

A.2 Attract Skilled Emigrés Back to Pakistan. The government can offer financial incentives to lure a few of the many well-trained and highly skilled Pakistani researchers, educators, and businessmen living abroad back to key positions of leadership in the initiative for technology transfer. Their experience and talents will enhance Pakistani agribusiness, research, and education. One incentive for their return could be to create a first-class pre-college elementary and secondary school system for the community surrounding a large industrial/research park that would provide excellent education for their children. Another approach would be to invite them back to Pakistan for a contract period of perhaps two years--in the hope that some would remain beyond that time. This latter approach worked well for the Hong Kong University of Science and Technology.

A.3-(1) Form a Technology Transfer Company. In order for research to better respond to the needs of the agribusiness marketplace, the government might consider forming a technology transfer company similar to FIST S.A., a French technology transfer company headquartered in Paris. The company would seek out promising research projects already under way in universities and other research institutions, and attempt to find appropriate

agribusiness partners to commercialize the results of the research. It might also find foreign business partners to commercialize research findings.

For the technology transfer company to be most effective, it would operate independently of the government. Start-up capital might be provided by the government, while operational funds would be raised from fees, commissions, and royalties charged to the clients--who would be the agribusinesses and research institutions. The shareholders of the company would include government scientific and technology organizations. A search would be conducted for an entrepreneurial chief executive officer (CEO) who would be willing to work in a high-reward, high-risk environment. The CEO would also be a shareholder, except that his shares, based on know-how rather than cash, would be subject to forfeiture over the first several years. The CEO's compensation would be based partly on salary and partly on performance-based bonuses, and the position would carry responsibility for hiring a small staff of professionals with expertise in technology transfer and knowledge of agricultural-related technologies and markets.

The start-up capital, provided in return for equity in the technology transfer company, would be sufficient to fund all the fixed expenses of the company during its first year, 70 percent of fixed expenses during its second year, and 35 percent of fixed expenses during its third year. After three years, the company would have to be self-sufficient. If the company were not able to generate sufficient business by the end of three years, it would be liquidated. However, if the company were successful, it would play a major role in promoting and expediting technology transfer. It is anticipated that the staff of the company would consist of only six professionals and two support personnel by the end of the first year, which would be sufficient until the company had achieved a profitable status.

It is further anticipated that the technology transfer company would follow a technology it had transferred from a research institution to an agribusiness, such that at the appropriate time it could act as the extension agent of the business. In this way, the company would complement government extension programs.

A.3-(2) Improve Extension Services. While this report does not focus on extension, some previous reports have noted weaknesses in current extension programs. There should be a high-level review of the effectiveness of these programs. Based on this review, reforms should be a high priority to ensure that extension can facilitate, not limit, agricultural technology transfer. Extension agents need adequate training, adequate pay, and responsibility as members of the technology transfer team from the outset.

Reformed extension programs would not attempt to duplicate extension activities currently undertaken by private companies, such as suppliers of seed and other agricultural inputs. Some agricultural countries have successfully experimented with extension services operated totally by the private sector. An effective mechanism is to provide financial support for programs in other areas and allow the private sector to deliver the services. Others have successfully integrated private initiatives into their own agricultural extension programs, and achieved both lowered cost and increased effectiveness. In some cases, the private sector is providing full extension services and financing them with a fee for service. This could be a good medium- to long-term goal for Pakistan. We recommend starting the process with a

single commodity for which extension is important to the farmer. Reforms in other commodity areas should follow quickly and be modified for maximum effectiveness based on this initial experience.

A.4 Stimulate Early-Stage Venture Financing. The early stages of financing new ventures are the most important and the most risky. The government could stimulate early-stage venture financing in two ways. First, it could provide equity capital, which could be in the form of convertible debt. The government would provide small, interest-deferred, start-up loans, which would convert to equity when entrepreneurs obtained additional equity capital from the private sector. Second, the government could provide debt capital to companies already capitalized but still in their infancy. The government would offer low-interest loans large enough to be of meaningful assistance, but small enough so that other venture capital would be required. An early-stage company would not receive such a loan without evidence of substantial cofinancing from the private sector. In this way, government expenditures would be made more productive.

A.5-(1) Provide Market-Driven Opportunities. For agribusiness to advance technologically, government must establish open, competitive markets. Such markets provide information on opportunities for investment in agricultural technologies; they include not only conventional markets for agricultural inputs and outputs, but also markets for inventions and discoveries. For these markets to operate correctly, developers of new technologies must be protected by intellectual property rights (see recommendation A.5-(3)).

A.5-(2) Maximize Return from Research. As the primary funder of science, the government must use its resources to support only science of the highest quality. This requires rigorous peer review in the selection and evaluation of funded research. Evaluation of results from previous research projects must be included as a key predictor of success when future proposals are submitted. Lack of a full and thorough research study from a previously funded project would indicate that a new proposal should be given a low priority.

Getting the best return on research investments also requires that support be focused on projects with potential for increasing agricultural productivity. The majority of research funding (about 80 percent) should be allocated to projects that address specific problems in agriculture and agribusiness. The remaining 20 percent of funding should be allocated to investigator-initiated projects. The increased competition among these proposals would, over time, generate a strong competition and reduce the chance of funding less productive lines of study. The applied research program mentioned earlier and described in detail in Appendix A would be the focal point of research directed toward technology transfer.

Researchers must be rewarded for producing useful applications for industry, and for attracting matching funds from industry. These rewards will motivate other researchers. Within 5 years, universities and research institutes should be required to derive part of their support from private business. This will give them an incentive to develop programs attractive to agribusiness and to market these programs aggressively.

With significant research funding being allocated in the provinces, it will be necessary to undertake similar rigorous management of these programs. A competitive federal research program provides an excellent model for such efforts.

Annual reviews on the quality and direction of the research program should be used to establish priorities for succeeding years, to recognize important new opportunities, and to redirect resources from areas that are no longer productive. The special agribusiness conferences discussed under recommendation A.1-(3) may be a good opportunity for beginning the process of establishing research priorities.

A.5-(3) Provide Adequate Protection for Intellectual Property. Only the federal government can provide the legislative and legal basis for adequately protecting the rights of innovators and entrepreneurs, particularly the means for effective enforcement of these rights. New technology is at the heart of Pakistan's future economic growth, and it is only when an investment in new technology can be protected against misappropriation by others that business will be willing to invest the money needed to introduce such technology. The most effective shield against misappropriation of new technology is a strong and vibrant patent and copyright system and the legal recognition of trade secrets as a protectable form of property. This topic is covered more fully in Appendix B of this report.

B. Actions for Universities and Research Institutes

B.1-(1) Reward Scientists for Performance. Career enhancement--recognition, reward, and promotion--must be based on scientific accomplishment, which is reviewed regularly. Strong, productive research can develop when excellence is rewarded; when length of service is rewarded, the less productive stay on, and productivity stagnates.

B.1-(2) Develop More Effective Curricula. A fundamental requirement for the absorption of new technology is education and training of scientific and technological personnel:

- Universities and technical institutes that combine academic training with experience in private business are able to prepare students for positions in industry as well as research. This broader program enriches the educational experience for students, provides cost-effective assistance to business, and opens a channel for communication between business and research. In the medium term, experience in industry should become a compulsory part of a degree in agriculture.

- Academic courses in the basic sciences should be complemented with courses in technology management. This will prepare students to meet the joint challenge of performing strong science and adapting technologies to solve industrial problems or create new products. In the short term, a diversified curriculum should be offered. In the medium term, each student should be required to select a balanced set of courses.

- Traditionally, university instruction has been grouped into disciplines for teaching and research. However, the research of greatest value to business is

interdisciplinary, and the most valued researchers are the synthesizers who can integrate several technologies into one technical solution. Just as the government must emphasize interdisciplinary research in its funding (see recommendation A.1-(1)), so must universities adapt curricula to teach interdisciplinary skills.

B.2-(1) Establish Technology Transfer Offices in Universities and Research Institutes. An official at each agricultural university and research institute should be designated as responsible for promoting and coordinating technology transfer. That person would serve as the window for agribusiness to learn about the institution and its capabilities. It would be useful for that office to maintain a data base on the expertise of researchers, research programs, patents, major research awards, invention disclosures, agribusiness needs, and agribusiness products and services of the institution.

B.2-(2) Encourage Scientists to Start New Businesses. Partnerships between researchers and agribusiness could be expanded into new forms of joint venture research, strategic alliances, common bench work, personnel secondment arrangements, and joint ventures. If businesses are not interested in these opportunities, it may be necessary for researchers to start new businesses. First they should have an opportunity to become familiar with the business aspects of technology transfer. Then when they recognize the potential for new products and processes made possible by technologies emerging in their areas of expertise, they may be encouraged to commercialize promising technologies. Caution is advised here to avoid excessive failures. To encourage such entrepreneurship, universities and research institutes should consider the following policies:

- Permit a scientist to take a leave of absence for up to 2 years to start a business based on a new technology.

- Provide seminars in entrepreneurship to interested employees. These would include discussions with those who have successfully started new businesses, as well as with some who have failed.

- Establish a few business incubators adjacent to agricultural universities or research institutes. This was also a recommendation of the *National Technology Policy and Technology Development Plan* of 1993. The established institutions would provide the support needed by new entrepreneurs, who are often skilled in technology, but not in the business aspects of developing it to a commercially viable product. Incubators near universities or research institutes would also provide a positive scientific environment, including library facilities, computing facilities, and a concentration of highly trained scientists and engineers. These would represent a middle ground between the research establishment and conventional industry, and furnish a unique, supportive environment for applied research, new businesses in advanced technology, and branch research facilities for major industry and light production of goods.

B.2-(3) Encourage Joint Ventures with Foreign Technology Companies. Consideration should be given to attracting state-of-the-art agritech joint ventures in Pakistan with foreign

technology-oriented companies in order to increase the exposure of Pakistani scientists and engineers to the interface of management and technology in an entrepreneurial setting.

B.2-(4) Encourage Close Liaisons with Agribusiness. Researchers should be encouraged to maintain close liaisons with agribusiness so they will remain aware of the latter's needs and problems. To this end, the following specific actions should be taken:

- Align tenure and promotion policies to reward the successful transfer of technology to businesses. For example, successful technology transfer might advance a promotion by as much as 5 years.

- Exchange assignments so that researchers from universities and research institutes work for a period in industry on a specific problem or product, and technical persons from industry spend a similar time working in a university or research institute. This can be initiated on an experimental basis until qualified people become available.

- Provide financial awards to scientists who win competitive research contracts from agribusiness and successfully transfer a promising technology.

- Assign more of the discretionary resources, such as laboratory equipment and research assistants, to productive researchers, including those who are successful in establishing new technologies in business.

- Provide travel expenses to conferences where researchers can market their capabilities in new technologies.

B.3-(1) Organize International Matches Between Institutions with Similar Technology Transfer Interests. International matches could be between faculties, research parks, institutions, government agencies, or cities, and would provide mutual support. Linkages to international programs such as TOKTEN (Transfer of Knowledge Through Expatriate Nationals) in the United Nations Development Program would be useful as well.

B.3-(2) Improve Scientific Communications. Scientists need to be linked to scientific information and to other scientists through international databases and library collections. While Internet is being used increasingly at research locations, this initiative will need continued support. Opportunities to work with professional peers on sabbaticals and at conferences are important investments in developing science's human capital.

C. Actions for Business

C.1 Attract and Retain Skilled Technical Manpower. To compete successfully in domestic and international markets, agribusiness must attract talented people and retain the best of them by providing challenges, professional growth, and appropriate financial rewards. Once technology transfer is under way, agribusinesses in Pakistan will presumably recognize the value to their companies of well-trained scientists who have insight into new products and

processes, and can implement appropriate technologies from home and abroad. Industry will then benefit from its efforts to recruit and retain highly qualified staff. This action will be effective in the medium to long term.

C.2-(1) Provide Internships for Students. Agribusiness companies, particularly large ones, should provide internships for a summer or an academic semester for students selected through competitive review from universities and technical schools. This should be done immediately and can yield results within a few years.

Internships assist businesses by providing cost-effective labor and technical skills in selected disciplines. At the same time, they provide experience for students in the needs and motivations of agribusiness, and in the application of university learning to produce improved products. Leaders in the research community will need to coordinate the selection and oversight of students to ensure that the needs of business are well served. Students should be well qualified for the selected tasks in agribusiness. Their work should be monitored and assisted by a senior scientist in the research institution to ensure that they deliver above and beyond the expectations of the business. This is particularly important in the early stages of establishing the program and developing a demand for such services by a broad-based group of industries.

C.2-(2) Sponsor Annual Awards. The larger companies could sponsor awards, given in the company's own name, for the most valuable research and development project of the past year. To ensure that both the science and the application are of high quality, the competition could be judged by both scientists and the company. The amount of the award need not be large. More important is the recognition and the incentive for academic researchers to align their work toward applications in industry. This action can be effective in the short term.

C.5 Seek Contracts with Researchers on Specific Problems. Agribusinesses can identify the most promising researchers in Pakistan in areas important to their own companies. By communicating over time on the problems and needs of a business, they can identify a specific problem or challenge in which one of those researchers can, for a modest contract, provide a solution that generates profits beyond the cost.

V. PRIORITIES AND TIMELINES

The technology transfer program should begin with a set of expectations against which to measure progress, a framework that is at once aggressive and realistic. The start of the program should be measured from the time a lead agency and program champion are designated (see Section IV). Effective action is unlikely until these leadership issues are settled, and so the milestones begin with them.

Beginning of Program

1. Select a lead agency to develop a vision for the agribusiness/farming sector and its competitive position in world markets. The lead agency should publish and disseminate for discussion a formal vision statement

for the technology transfer partnership between agribusiness/farming and the research institutes.

2. Provide effective leadership by identifying and empowering a champion for technology transfer.

End of First Year

1. Reach a consensus on the vision statement among agribusiness/farming, government, and the research/university community.

2. Hold the first organizing meeting of a technology transfer partnership to support applied research.

3. Appoint a task force to prepare a discussion paper on intellectual property rights, and begin national debate on creating effective patent laws.

End of Second Year

1. Award the first grants for applied research projects.

2. Observe the effects of establishing long-term working relationships between research and agribusiness--for example, incorporation of agribusiness experience into university curricula and opportunities for practical experience for students.

3. Plan for and prioritize the remaining initiatives recommended in Section IV.

End of Fifth Year

1. Obtain beneficial results from the early round of applied research grants.

2. Observe funding of some applied research grants by agribusiness.

3. Implement the higher-priority initiatives recommended in Section IV.

4. Gain strong business support for protection of intellectual property.

5. Make technologies and research findings useful to small farmers through effective outreach and extension.

End of Tenth Year

1. Replace government support of applied research grants with funding by farmers and agribusiness.

2. Establish practical, enforcable intellectual property laws.

3. Observe new business start-up companies emerging from universities.

4. Observe strengthened capital markets providing first-stage venture financing for start-up companies.

5. *Observe greater productivity improving the competitiveness of Pakistani agribusinesses and farmers.*

VI. CONCLUDING THOUGHTS

It has been well documented that the elements of success outlined in Section III must be strong for technology to drive productivity in agriculture. There is no unique formula for accomplishing these elements. Rather, success will require continuous experimentation and learning, augmented by effective partnerships between the research and business communities.

Government is the important catalyst for that partnership, but insofar as possible should resist the temptation to become a participant. If it must participate to initiate action, it must also withdraw as soon as possible, allowing business to make the business decisions and to function effectively. The correct macroeconomic and sectoral policy environment will open markets to competition, provide capital for entrepreneurs, and create a culture for experimentation and risk taking.

The recommendations presented in this report can effectively move Pakistan toward a policy environment. Progress should be evaluated regularly to provide a guide for future steps. More important than any single recommendation is a willingness by all parties--government, universities and research institutes, and farmers/agribusiness--to experiment and evaluate regularly in order to learn how technology transfer works best in Pakistan.

The vision can then be achieved: linkages accomplished between and among universities, research institutes, cooperative extension programs, and private and public technology transfer organizations; enhanced agriculture and agribusiness; and new opportunities in the global agribusiness markets at the turn of the century.

A MODEL FOR TECHNOLOGY TRANSFER IN PAKISTAN

A.I INTRODUCTION

Technology is transforming agriculture worldwide. With new and better technologies being adopted, agricultural systems are becoming more efficient and more competitive. As world trade agreements go into effect over the next decade, the competitiveness of agricultural countries in world markets will depend increasingly on the quality and effectiveness of their research systems and their ability to translate better technologies into practice.

Pakistan has a long tradition of building its scientific and technical infrastructure and has created a cadre of talented, well-trained scientists capable of developing solutions to the important technical problems of agriculture. Currently, the research being undertaken is funded largely by government, is conducted in universities and research institutes, and is frequently less applied in orientation. The challenge for Pakistan now is to manage its national technology enterprise in a way that gives scientists an incentive to use technologies available from all sources to increase the economic productivity of agriculture.

Efficient technology transfer requires more than a strong research capability; it also requires a strong linkage between business and technology centers. Only thus can technologies from national and international centers be fully exploited for Pakistani business and farming. These technologies are vital for creating a more profitable, more reliable, and more durable agribusiness[1] sector that is better equipped to compete in domestic and international markets. Clearly, these technologies and their effective transfer are critical to the future development of Pakistani agriculture.

This appendix addresses the current isolation of Pakistani agribusiness from the nation's technology centers (universities and research institutes), and describes an opportunity to develop a partnership between the two groups. The effort described here is part of the broader strategic plan presented in this document, but is discussed separately because, as a program, it can stand alone, it has been identified as a priority, it is likely to be highly successful, and it provides an excellent starting point.

The principal vehicle for the partnership is a program of grants for applied research to develop needed agricultural technologies. This program provides a way to direct some funding toward priority agricultural needs, while also developing an essential linkage between agribusiness and technology centers. This linkage and the joint decision making of researchers and businessmen can initiate an important process of working together to open new opportunities for agriculture in Pakistan.

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[1]The term agribusiness as used here includes farmers, who are, in fact, a large part of the sector. It is anticipated that businessmen and farmers will work together for technology transfer.

The remainder of this appendix addresses the following topics:

- The attributes of successful technology transfer
- The opportunity to build a strong linkage between technology centers and agribusiness
- The design of a research-agribusiness partnership
- The benefits of such a partnership

The goal of this appendix is to convince the leadership of Pakistan of the need and value of extending the substantial agricultural research establishment to include a strong technology transfer capability so the country can fully benefit from its investment in agriculture.

A.II THE ATTRIBUTES OF SUCCESSFUL TECHNOLOGY TRANSFER

To fully exploit future agricultural opportunities and technologies, it is critical to begin with a national vision for agriculture, and then develop a national strategy that can achieve this vision. Agricultural research and its transfer to farmers is one of the important components of a national agricultural strategy.[2] The key elements of an effective program of technology transfer include the following:

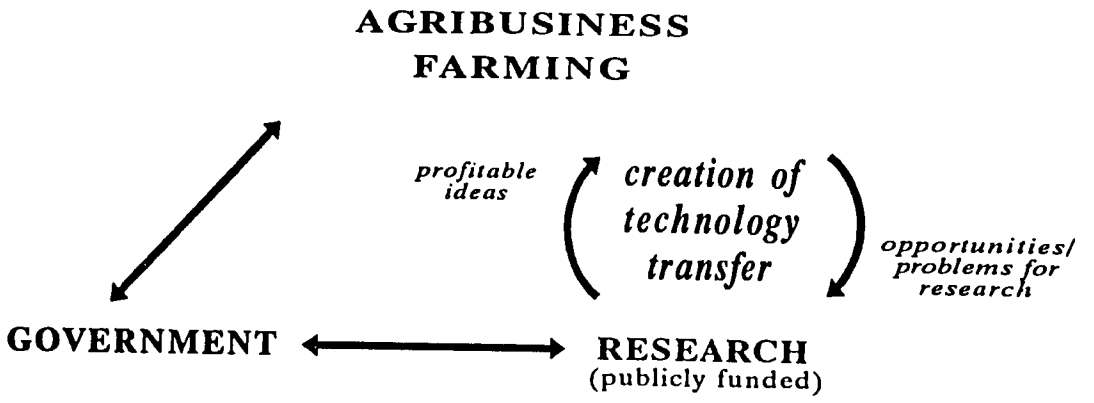
- Users of the technologies being developed--agribusiness, including progressive farmers--need to be actively involved in decisions on funding research projects.
- Selection of research proposals for funding should be on a provincial basis so projects can be responsive to local needs, and business can support local research.
- Incentives for researchers should be aligned with incentives for users so the two groups will cooperate to produce the most useful applications.

A.III THE OPPORTUNITY TO BUILD A STRONG LINKAGE BETWEEN TECHNOLOGY CENTERS AND AGRIBUSINESS

The three major players involved in agriculture and related policy, research, and business are (1) the government (through its Ministry of Agriculture, Food, and Fisheries); (2) the research community (mainly publicly funded); and (3) agribusiness, including farmers. Each of these groups can be viewed as a stakeholder in the success of the system. As shown in the chart on the next page, there are interactions between government and agribusiness and between government and research. The opportunity addressed here lies in

[2]It is also necessary to have effective, innovative farm management, extension services, private sector businesses, and government policies, each serving the needs of agriculture.

the linkage between agribusiness and research, which is so essential for technology transfer. To develop this linkage and exploit technologies with important potential for agriculture, a program of partnership between agribusiness and research is proposed.



A.IV THE DESIGN OF A RESEARCH-AGRIBUSINESS PARTNERSHIP

The central focus of the proposed partnership is a program of grants for applied research. This program incorporates the key elements for effective technology transfer cited above, as well as some additional elements important for a research grants program:[3]

- A committee of businessmen, researchers, and government leaders in agriculture, who together select for support those research projects with the greatest promise for solving the significant scientific and technological problems of Pakistani agribusiness.

- Rigorous peer review, beginning with selection of an objective, experienced panel, to ensure that the program is truly competitive and thus able to have the maximum impact.

- Operation at a provincial level to encourage the active participation of local businessmen, farmers, and farm organizations, and a focus on local agricultural problems.

- Funding support for the program from the central government, with matching funds from provincial budgets for agricultural research, evolving to include funding from other sources, including the private sector.

- Management of the research projects using a systems approach to ensure that the program operates efficiently and effectively.

[3] Success of the applied research program may ultimately require an underlying infrastructure of progressive intellectual property and tax laws as discussed in the report (section A.5-(3)), and in Appendix B.

- Incentives for researchers aligned with those for businessmen to encourage continued cooperation for success.

These elements of the proposed program are discussed in turn below.

Participation of Agribusiness, Research and Technology Centers, and Government. Businessmen and progressive farmers would participate with scientists and government leaders on an Applied Research Committee that would define research priorities and select proposals for funding. This cooperative approach and leadership could effectively focus the program on projects that will contribute significantly to agricultural production. At the same time, the participation of research and government scientists could ensure that the projects selected are scientifically feasible. Cooperation between agribusiness and research could also evolve at the level of proposal preparation--businessmen could challenge their scientific colleagues to use their research skills to answer questions of major importance to agriculture, or they could work together with the scientists to develop proposals involving good science and addressing relevant problems. These leads would be valuable for researchers needing guidance on how to use their skills and experience to compete favorably in the program. Examples of potential applied research projects are new seed varieties, improved breeding stock, improved agronomic practices, new farm equipment such as cotton harvesters, and development of new and improved textiles.

Peer Review of Projects. Selection of research projects by the Applied Research Committee would involve consideration of written peer reviews on the feasibility of the science, as well as the importance and applicability of the research problem. Peer review of grant proposals and previous accomplishments is the most effective mechanism for ensuring that research funds are invested in effective research, and that judgments made in allocating funds are equitable and discerning. Careful attention to the objectivity, quality, and breadth of expertise among the Applied Research Committee and its reviewers is necessary to ensure sound decisions. Participation by at least one international scientist with expertise in the peer review process would be valuable in the beginning stages of this program.

Program Serving National Needs. Initially, the program would operate at the national level to create a model that might be replicated in the provinces or at individual universities. Because the benefits will accrue to the entire nation and because the program will be highly experimental, it is apppropriate that seed funds be provided by the Government of Pakistan. Once experience had been gained, alternative funding sources could be considered, including a special tax on selected commodities, and matching funds or "in-kind" contributions from private sources. In the mature program, government funding might be replaced largely by private sources.

Diversity of Funding. Technology development and transfer requires substantial funding and is risky, since many good ideas turn out to be impractical or uneconomical. It is therefore necessary to cultivate a variety of funding sources, which together can provide the required levels of funds in a sustainable program to support field trials, product scale-up, or other aspects of technology development. The amount of funds should be adequate to support the types of activity that can generate relatively short-term results, and can thereby demonstrate the validity of the approach and the opportunity it presents for the private sector

to invest directly in this type of technology research and development (R&D). Funding sources that can be tapped to create a technology R&D funding pool include the following:

- Redeployment of a percentage of the current research budget
- National government funds--a national levy for this type of R&D
- A levy[4] on agribusinesses (especially international firms operating in Pakistan) to support R&D

In later stages, the partnership concept might be replicated at the provincial level, and additional funding sources here could include:

- Provincial government funds[5]
- Local municipality funds[6]

The amount and mix of funding from these various sources will, of course, depend on the political realities of the current and local situation in agriculture and the economy. Alternative funding could be phased in gradually. As the private sector became more confident about the benefits accruing to them from the funding, they would increasingly be encouraged to "buy in" to the fund, contract directly with institutes and individuals for specific technology development work, or establish their own in-house R&D capacity.

Management of Research Grants. It is intended that the program will fund applied R&D projects, rather than basic research. This will enable both researchers and businessmen to define specific R&D objectives for products to meet the needs of the marketplace. A systems approach to project management must therefore be implemented for the program to operate both effectively and efficiently, and to maximize the number of individual projects whose goals are successfully achieved. However, it is most likely that researchers will lack

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[4]An analogous approach was used in Peru in 1974 to create incentives for industrial support of R&D. The General Law of Industries provided for the establishment of the Institute of Technological Research and Standards (ITINTEC), and required all industrial enterprises to invest 2 percent of their net income before taxes in technological R&D projects approved by the new institute. R&D could be done within the company; by a university research group, a public agency, or a private group; or by ITINTEC itself as agent-contractor for the R&D. Approved projects could be financed with the firm's 2 percent of net income up to a maximum of five years. Only if a company decided not to invest in R&D, or if its proposals were not approved by ITINTEC, would it be required to pay its 2 percent to the government. The fund was created, and 80 proposals were funded during the first year of ITINTEC's operations. Unfortunately, the political situation in Peru led to a deteriorated economic situation and interrupted the transfer of research findings into industrial production.

[5]Incentives could be used to encourage provincial government participation. For example, if a province did not match central government funding, the level of central government funding for projects in that province would be limited to the level of the provincial government support.

[6] Much of the R&D development work in agricultural biotechnology will be local and specific to a particular location. Funding for these local technology development efforts could be managed through a municipal cooperative revolving account, with external technical assistance as needed from the national funding mechanism, or a start-up grant.

the requisite project management skills at the onset of the program. Thus, there should be provision for one or more consultants to operate project management training sessions for all researchers participating in the program. The consultants would also be accessible to all researchers throughout the program to help them resolve management problems that might arise. In this way, researchers can be sensitized to the ongoing need for planning, scheduling, and controlling. Goals must be met in accordance with time and cost constraints. Projects that do not demonstrate sufficient progress within these constraints must be terminated, but this will be minimized as researchers acquire project management skills.

Incentives for Businessmen and Researchers. Successful completion of research projects will, of course, provide opportunities for businessmen to commercialize new or improved products. There should be a mechanism by which those businesses successfully commercializing products can share the rewards with the researchers involved. This would provide a strong incentive for the most talented researchers to participate in commercially relevant research. Royalties would be paid to the researchers, either based on a small percentage of sales of the pertinent product over a period of some years, or perhaps as a percentage of cost savings resulting from research leading to a less costly manufacturing process. Royalties would be shared between the researchers and their institutions. Apart from the financial rewards, the application of a new or adapted technology deserves joint recognition of both the businessman and the researcher. This could involve an annual presentation of awards, with press coverage. In addition to acknowledgment of the roles of these players, the ceremony would be an opportunity to highlight the program and its successes, and to encourage others to seek their own success.

A.V THE BENEFITS OF A RESEARCH-AGRIBUSINESS PARTNERSHIP

The most important benefit of the proposed research-agribusiness partnership is that it would create a strong linkage between research and business that would support effective technology transfer. The partnership would also focus part of the research establishment specifically on identifying opportunities and solving problems in Pakistani agriculture. In this program, Pakistani agribusiness could work actively with the excellent national research capability to produce specific, practical improvements for agricultural production. The key to producing more and better research findings that would be applied by agribusiness is having agribusiness equally represented on the Applied Research Committee, where they would be actively involved with scientists in setting priorities for research, selecting proposals, and monitoring progress.

A second benefit of the partnership is direct access of agribusiness, through contacts with and the experience of local scientists, to new technologies being developed abroad. These technologies offer great opportunity to countries that have the national capability to recognize innovations that will serve them well and avoid those that will not. Effective recognition of innovations follows naturally when scientists are involved in regular discussions on the needs and opportunities of business.

Transferring technology and applying research results to agriculture places new demands on the relationships among research institutions, influences patterns of funding, and alters established goals and mechanisms. In other countries, these adjustments have proven

to be well worth the effort, as they have invigorated research and created a dynamic and productive environment for agriculture. International competition in the twenty-first century will force the use and development of new technologies to improve the efficiency and quality of agricultural production. The proposed partnership is a mechanism by which the agricultural system can prepare for future opportunities in world markets.

The proposed partnership for technology transfer in agriculture would focus on solving important agricultural problems, would use research funds and institutional structures effectively, would train researchers in new scientific areas, and would efficiently transfer technologies developed at home and abroad to progressive farmers and businessmen. In all of these ways, it offers the potential to do no less than transform agriculture in Pakistan.

INTELLECTUAL PROPERTY RIGHTS

BASIC DEFINITIONS

There are several different types of intellectual property rights (IPRs): patents, trade secrets, copyright, and trademarks. Of these, patents and trade secrets are most relevant to research-agribusiness linkages.

A *patent* is a temporary monopoly on the use, sale, and/or manufacturing rights to an invention, which may be a product or a way to make or use a product. Because a patent is granted by a government, it is limited to the jurisdiction of that government. That is, the government of Pakistan can grant only a patent limited to Pakistan. There are over 140 independent governments that grant patents, each of which is limited to the territory over which that government has jurisdiction. The patent monopoly is granted for a limited number of years (sixteen in Pakistan, seventeen in the United States, up to twenty in many other countries). It is a basic condition of its grant that the patent discloses how the invention can be made. Thus, there is a fair exchange--in return for a temporary monopoly, the patent owner must disclose to the public how the invention can be made! The patent cannot be renewed, although some countries permit a patent to be extended for a few years under special circumstances. The minimum requirement for obtaining a patent in most countries is that (a) the invention is *novel* (has not been made by anyone before), (b) the invention is *not an obvious variation* of something already known, and (c) that the applicant for the patent is the inventor or has purchased the invention from the inventor. A patent is expensive to obtain.

A *trade secret* is very different from a patent. A trade secret can apply to any knowledge used in a business that is not disclosed to the public. It can include an invention that otherwise could be patented, but is far broader since it also may include business information, such as where to obtain the best components needed to manufacture an invention, techniques for manufacture, or even the most economical sources for components. A trade secret is immortal--it will last forever, *unless* someone else learns about it. Once someone else learns about it, a trade secret is no longer secret, and is lost. A trade secret costs nothing to establish, but can be very expensive to maintain.

A *copyright* cannot protect an invention, but rather the form in which an idea is expressed. Copyright is obtained for books, music, sculpture and graphic arts, videotapes, soundtapes and CDs, and computer software. It should not be confused with a patent.

A *trademark* is the name or symbol used by a manufacturer to indicate that it made a product. It is not the name of the product itself. An example of a trademark is "Coca-Cola"; the product to which it relates is "carbonated beverage."

A *product registration* is not related to a patent and is not an IPR at all. A product registration is an indication that a regulatory agency has approved the sale of a product to the public. Reasons for such registration are that a product is safe to use, or that it conforms to what it is labeled to be (correct contents, weight, and size), or that it has government approval for the use claimed by the manufacturer. A registered product may or may not be patented.

WHERE DO INVENTIONS COME FROM?

Inventions do not suddenly appear like a Djinn from out of the air. They arise because a technical problem exists that requires a solution, and the invention is the solution of this problem by the inventor. This easily can be shown by examining some patents, since patents are excellent representatives of inventions of their time.

Example. In the state of Georgia, U.S.A., there is a large lumber industry in which bark and leaf residues are a waste product after the wood is cut. Dr. Chia-Ming Chen, a professor at the University of Georgia, looked for a useful method of disposing of this agricultural waste. His invention, for which U.S. patent 4,469,858 was granted on September 4, 1984, was to convert the waste materials to phenol-aldehyde resins. The resins were then used as adhesives for plywood, and also to form particle board from the chips of wood produced when cutting trees into lumber. This invention was of great interest to a large corporation.

United States Patent [19]

Chen

[11] Patent Number: 4,469,858

[45] Date of Patent: Sep. 4, 1984

[54] TREE FOLIAGE EXTRACTS AND THEIR USE IN PHENOL-ALDEHYDE RESINS

[76] Inventor: Chia-Ming Chen, 205 Dove Valley Dr., Athens, Ga. 30606

[21] Appl. No.: 305,904

[22] Filed: Sep. 25, 1981

Related U.S. Application Data

[62] Division of Ser. No. 126,982, Mar. 3, 1980, abandoned.

[51] Int. Cl.³ C08G 83/00; C08L 61/06; C08L 61/10; C08L 61/14

[52] U.S. Cl. ..... 528/129; 528/1; 527/105; 260/124 R; 260/112 G; 428/528; 428/529

[58] Field of Search ..... 260/112 G, 124; 527/105; 528/1, 129; 428/528, 529

[56] References Cited

U.S. PATENT DOCUMENTS

2,782,241	2/1957	Gray et al.	260/124 R
3,062,783	11/1962	Gray et al.	260/124 R
4,082,903	4/1978	Chow	523/27
4,098,765	7/1978	Kays et al.	528/1
4,200,273	4/1980	Chen	260/112 R
4,201,699	5/1980	Chen	523/27
4,201,700	5/1980	Chen	523/27
4,201,851	5/1980	Chen	528/1

OTHER PUBLICATIONS

"Studies on the use of Bark and Agriculture Residue Components in Phenolic Resins and Glue Mixes," Chen Paper Delivered at the 30th Annual Meeting of Forest Products Research Society, 1976, Toronto, Canada.

"Organic Chemicals from Biomass", Goldstein Ed., CRC Press, Boca Raton, Fla., pp. 249-280.

V. S. R. Das, et al., "Biochemical Studies of the Fresh and 9-Month Stored Pods of Groundnut (*Arachis Hypogaea L.*)", Z. Pflanzenphysiol. Bd. 79:368-371, (1976).

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Assistant Examiner—Nathan M. Nutter

Attorney, Agent, or Firm—Mark A. Greenfield; Jean A. Buttmi

[57] ABSTRACT

Tree foliage extracts, their extraction processes, and the use of such extracts in formulating resins suitable for use in plywood adhesives and as wood bonding agents.

6 Claims, No Drawings

B2

MECHANISMS FOR TECHNOLOGY TRANSFER

One of the most important practical problems in transferring technology is finding a mechanism or "tool" which the originator of the technology can use to transfer it to a recipient. The simplest mechanism is publication of the information. While this is an effective method between colleagues in the same profession (such as by using professional journals), it has proven to be remarkably poor where the transfer is between different groups, such as research to business, business to government, or even business to business. Why is this? Perhaps the answer is that we place more value upon something that must be purchased than upon something given without cost. Perhaps the answer is that when technology is given without cost, the originator may consider that any gift should be appreciated by the recipient and that the originator should not have to make further effort to ensure that the recipient can use the technology. The reason really does not concern us. The fact is that simple publication usually does not act to transfer technology.

Fortunately, technology has a value which can be expressed in money--one of the values in thinking in terms of the monetary value of technology is that it gives an objective and universal measure by which the technology can be evaluated. This is true regardless of who is the recipient and who is the originator. The most convenient vehicle for making such a transfer, and one which is objective and independent of self-interest, is IPRs.

For the researcher, IPR transfer can be a means to obtain additional funding. For the recipient, IPR transfer can be a means to improve competitive position or solve a technological problem. The problem with this simple solution is that unless the IPR exists in a protectable form (such as patents and trade secrets), the transfer cannot take place.

PROTECTION OF INTELLECTUAL PROPERTY RIGHTS IN PAKISTAN

Unfortunately, at the present time, the law protecting patents and trade secrets in Pakistan is not adequate to serve as the mechanism for technology transfer. One can review the law itself, as well as read the "Issue Paper on Intellectual Property Rights in Pakistan" by Amir Saleem, published by the Pakistan Agricultural Research Council (1994), to understand this.

Patent Law. Pakistan is still using the British India Patents and Designs Act of 1911, with only minor modifications. It is not suitable for the patenting of modern technology, and has long since been replaced with a new patent act in Great Britain, the country of its origin. Furthermore, Pakistan has not signed certain almost worldwide patent treaties, as the result of which Pakistani citizens are deprived of distinct benefits if they wish to file patents in other countries.

This might have been acceptable in the past, when it was considered that patents would benefit foreigners but not the citizens of Pakistan. If this was ever true, it is true no

longer. Pakistan, unlike many other still developing countries, has a large number of well-trained scientists, working in advanced areas of technology. Such Pakistani scientists are being denied the opportunity to start Pakistani technology companies in cooperation with Pakistani business. Foreign companies are not willing to invest in joint Pakistani-foreign technology companies because the patent/trade secret mechanism for technology transfer is not available to them. As a result, these companies invest in other countries, such as Singapore, which gains not only increased exports and jobs, but also a larger population of technical and business people from whom future companies will arise.

Trade Secret Law. This can best be described as nonexistent in Pakistan. In a 1990 private communication, a Pakistani attorney-at-law specializing in Intellectual Property Law stated:

> There is no law in Pakistan, as in western countries, to protect Trade Secret(s) against theft and the use of a technology Trade Secret by the misappropriator. However, criminal prosecution can be instituted in a Criminal Court as misappropriation is a criminal offense under section 403 of the Penal Code. This will depend on the nature (of the) evidence. Commencing any proceedings in criminal courts here is not advisable.... Law delays in this part of the world are not only notorious but also proverbial. If one files a suit in the high court for infringement and/or passing off, it takes sometimes more than 10 years for final disposal.

Trade secrets are thus an extremely important part of IPRs, but are not protected in Pakistan.

RECOMMENDATIONS FOR CHANGES IN INTELLECTUAL PROPERTY LAW

Pakistan has now reached the point where its approach to intellectual property law, understandably designed to prevent exploitation of its citizens by foreign companies, is preventing those same citizens from achieving the economic rewards resulting from their own innovations.

It is difficult to recommend short-term changes in this area, since such changes require not only the passage of updated intellectual property laws (such as a modern patent law), but also the establishment of effective enforcement mechanisms where they do not already exist (such as a trade secret law).

As an interim measure, in the absence of any Pakistani law preventing the export of technology, one might consider the initial filing of a patent application by a Pakistani inventor in a country that both has an adequate patent law and belongs to important international conventions such as the Patent Cooperation Treaty. This would afford the least expensive opportunity for a Pakistani invention to be protected in the various world markets in which it would most likely be sold. With this protection, royalty payments by a foreign

producer to the Pakistani patent owner, or the sale of products protected by patents in other countries, could result in a worldwide income flow into Pakistan.

For the long term, it is clear that the Pakistani patent law must be modernized and made enforceable, and a trade secret law enacted--this would be more appropriate for a country with the potential for innovation shown by Pakistani scientists, engineers, and technicians. Furthermore, economic development in Pakistan has advanced sufficiently to justify adherence to international intellectual property conventions. Pakistan has advanced to the point where Pakistani technology innovators must have the opportunity to achieve the economic rewards they deserve.