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Cooperating to Enrich Earth's Capacity: The Agricultural Biotechnology for Sustainable Productivity Project

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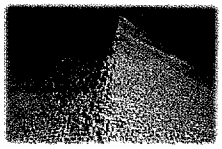

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FROM THE DIRECTOR

Food self-reliance continues to be an elusive goal for many developing nations. Obtaining world food security is a complex and difficult task, but it is clear that, with increased agricultural research and education, agricultural production may be improved. Biotechnology applications, integrated into traditional systems, hold much promise for augmenting conventional agricultural production and productivity.

Most developing countries' agricultural research is conducted within public sector institutes. The private sector in many developing countries is underdeveloped or poorly linked with public sector research institutions. Additionally, government policies may not encourage investment in research-intensive industries. Therefore, the policy environment surrounding agricultural biotechnology—which has fueled public/private sector interactions in the United States and other developed countries—is often weak or absent in developing countries. Realizing the positive impact of biotechnology will depend upon developing countries' ability to access and/or generate technology that is suitable to their needs.

It was within this environment that the Agricultural Biotechnology for Sustainable Productivity (ABSP) project was designed by the U.S. Agency for International Development (USAID). The ABSP project, begun in 1991, is a consortium of public sector institutions and private companies in the United States and developing countries of which Michigan State University (MSU) is the lead institution. It takes an integrated approach, combining applied research, product development, and policy development in the areas of biosafety and intellectual property rights (IPR) to assist developing countries not only in accessing and generating technology, but also in using that technology in an environmentally and legally responsible manner.

ABSP establishes linkages between developing country public and private sectors and the U.S. private sector, where much of the technology is proprietary, as well as the U.S. public sector, which has a long and distinguished history of technology development and human capacity development. The ABSP consortium of public research institutions and private companies is committed to the concept of development assistance, and the cognizant role agricultural biotechnology can play in food self-sufficiency and the development of new goods and markets.

The project has had policy, research, and product development collaborations with Costa Rica, Egypt, Morocco, Indonesia, and Kenya focusing on the application of plant biotechnology to production constraints in food crops such as banana, cucurbits, maize, pineapple, potato, sweet potato, and tomato. Private sector partnerships, both formal and informal, have been developed with DNA Plant Technology, Garst Seed Company, Pioneer Hi-Bred, Asgrow Seed Company, Monsanto Company, and the Biotechnology Industry Organization in the United States; with Fitotek Unggul in Indonesia; and with Agribiotecnología de Costa Rica in Costa Rica. Collaboration and the flow of information are not unidirectional or confined to one sector. In addition to applied research and development, the ABSP project allocates significant resources to addressing policy issues that affect the adoption of biotechnology, particularly in the areas of biosafety and intellectual property, as well as building a network for information sharing.

Consistent with the ABSP project's focus on developing information resources for biotechnology, this publication illustrates the strengths and complications of developing complex relationships and educational opportunities within an international biotechnology program. The publication is not an exhaustive account of the ABSP project, but instead is intended to present highlights of the project's activities and provide a general audience with widely applicable "lessons learned."

Catherine Ives
Director
Agricultural Biotechnology for Sustainable Productivity
Michigan State University

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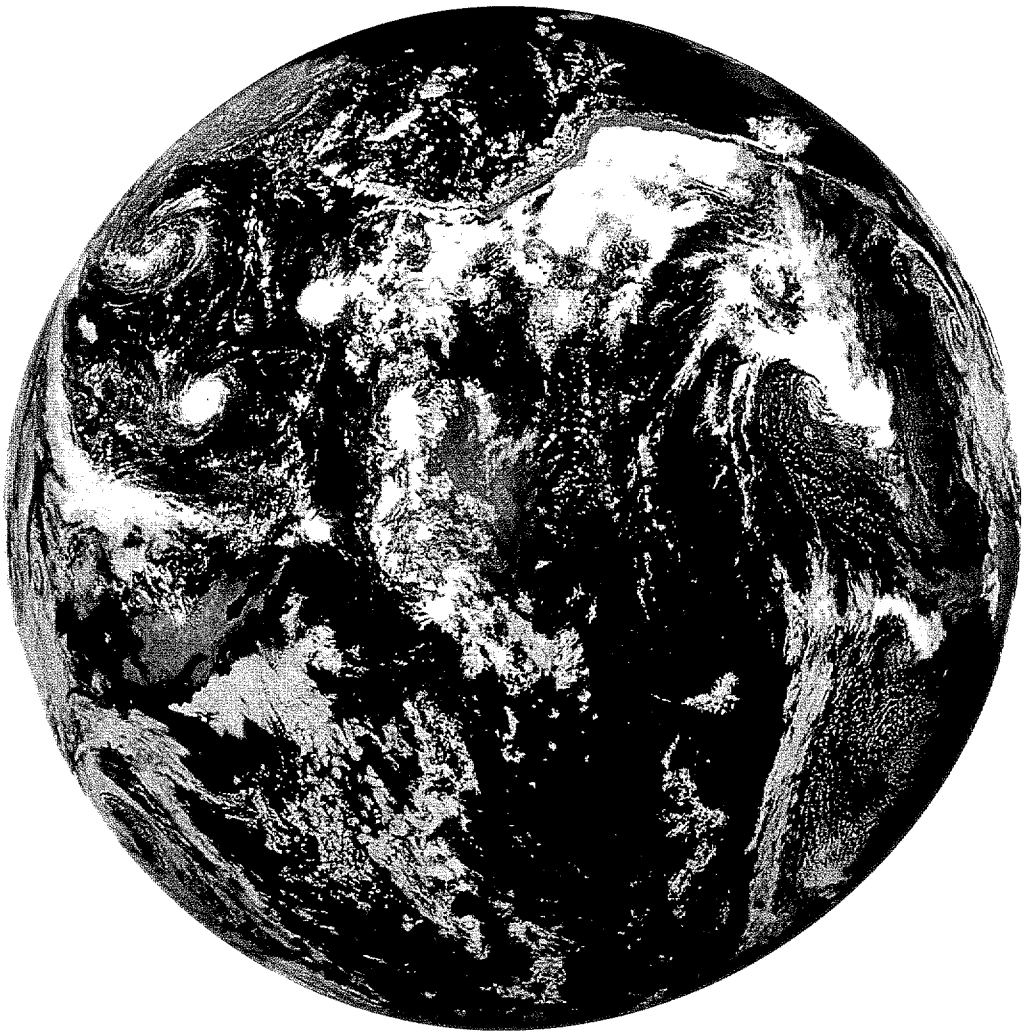
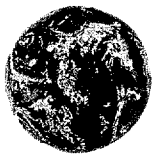


O R I G I N S

EARLY FARMERS ENSURED A SUPPLY OF FOOD CROPS FOR THE FUTURE BY SELECTING PLANTS WITH DESIRABLE TRAITS AND CULTIVATING THEM. TODAY'S CROP PLANTS, WHICH HAVE THEIR ORIGINS IN THOSE EARLY PLANTS, ARE GREATLY IMPROVED YET CANNOT KEEP PACE WITH THE NEEDS OF AN EXPLODING WORLD POPULATION. FOOD PRODUCERS MUST NOW DELIVER MORE FOOD GROWN IN THE SAME OR LESS SPACE WITH GREATER NUTRITIONAL VALUE AND LESS EFFECT ON THE ENVIRONMENT.



Origins

Plant biotechnology, which includes a set of techniques that assist in changing the genetic makeup of plants, has become the focus of late twentieth-century research for addressing this crisis. Plant biotechnology seeks to overcome three limitations of classical breeding for desirable plant traits: the length of time classical breeding entails, the variability in yield and other traits associated with intermediate breeding stock, and a limited gene pool from which to isolate new traits. The use of biotechnology for plant propagation and breeding could dramatically raise crop productivity and overall food production in developing countries and, early in the third millennium, now less than two years away, it may become one of the most important technical forces in the economies of industrialized nations.

Until the decade of the 1980s, commercial products resulting from nonrecombinant biotechnology were limited largely to disease-free clones of fruit and vegetable crops, fast-growing trees for reforestation, biopesticides, and traditionally bred insect-resistant and herbicide-tolerant cultivars. In 1989, the U.S. Agency for International Development, or USAID, long a champion of support for the developing nations of the world, began to identify areas of biotechnology that held promise for their client countries and that might be promoted through innovative collaborations with U.S. scientific counterparts. One early program, the Tissue Culture for Crops Project (TCCP) based at Colorado State University, served as a model.

Based on its review, USAID decided to design a new project in plant biotechnology that would bring together public sector and commercial research efforts in an integrated product-development program. The project, Agricultural Biotechnology for Sustainable Productivity, or ABSP, was awarded to Michigan State University in 1991.

How ABSP Set Its Goals*

Underpinning the project goals were USAID's initial review of TCCP as well as the National Research Council's culminating report *Plant Biotechnology Research for Developing Countries*. USAID, at that time limited in its experience with plant biotechnology and facing static budgets, set two parameters for such a project: it must be near term—that is, three to five years in duration—and it must address policy or institutional issues as well as research priorities. The project was to be guided by certain values or guiding principles.

Institutional Issues

Sustainability

The project should fit into the context of agricultural sustainability—that is, an agricultural system that meets rising demands for food at economic, environmental, and other social benefits consistent with improved living conditions.

Biosafety

Biosafety review and regulation should be internalized in the developing countries themselves as a result of the project.

Intellectual Property Rights

As collaboration between public and private research groups in the United States increases through the course of the project, patent protection of research should be assured so that products can be developed for public benefit.

Human Resource Development and Networking

Human capacity for biotechnology should be enhanced through doctoral and postdoctoral fellowships or other forms of training.

Research Priorities

Tissue culture, micropropagation, and transformation

Plant disease and pest control

Genetic mapping of tropical crops (restrictions on funds ultimately eliminated this priority)

Guiding Principles

Mutual Benefit

The project should benefit all participants by encouraging partnerships between the public and private sector in both the United States and developing countries for research and commercialization of products.

Proven Research, Integrated Programs, and Sustainability

Proven, applied research should be integrated with conventional and sustainable agricultural programs that provide for human resource development.

Multiple Routes for Germplasm Development

Development of germplasm should take place through public sector institutions, university release programs, international advancement of germplasm, and commercial cultivar development.

Innovation

The project should be designed to give equal weight to innovation, particularly in the implementation phase. Innovation is defined to include commercial links among U.S. companies, universities, and developing country institutions; internships in intellectual property rights; development of scientifically based regulatory policy; use of consultants; participation by developing countries in

* The opening of this section is drawn largely from Joel I. Cohen, "Beginning an International Initiative: Agricultural Biotechnology for Sustainable Productivity (A Case Study)," a paper prepared for the course "Managing Biotechnology in a Time of Transition."

biotechnology trade associations; coordination with other USAID projects and field missions; sponsorship of three industry-based management seminars; and comprehensive environmental and field analysis of proposed larger-scale field tests in both the United States and host countries.

John Dodds, former director of ABSP who, together with Mariam Sticklen, wrote the Michigan State University (MSU) project proposal, credits the success of goal setting to Joel Cohen and Judy Chambers, former USAID project officers and biotechnology specialists. "They made the needs of the contracting agency very clear and our job as a contractor more straightforward," he said. "Michigan State was a strong potential bidder because we had the right mix of skills: people who had international contacts and knew the countries and the problems, strong scientific credentials in molecular biology and genetic engineering, a campus oriented to building links with the private sector, a proactive intellectual property office, and people who were already working on a number of the crops that had been determined as important.

"There was a commonality of goals between USAID and MSU, although the outputs were different. In the case of pesticide reduction, for example, the major benefit to a farmer in the developed world is reduction in costs. But in a developing country, reducing pesticides by using a plant that is naturally resistant leads to increased yields. We were able to look at the skills and resources we had in place and orient them to the goals of the project. It was a good fit."

Management Guidelines

On the basis of the parameters established by USAID, ABSP established its management guidelines. Differing from most basic research projects, ABSP took an approach that fosters development and facilitates the transfer of specific research products to host country partners—currently, Costa Rica, Egypt, Indonesia, Kenya, and Morocco. It set these guidelines:

- Maintain a highly focused research program concentrating on specific crops—maize, sweet potato, potato, cucurbits, tomato, banana, and pineapple—and technologies
- Implement product-oriented research linking the public and private sectors in the United States and developing countries
- Assure intellectual property protection and apply biosafety procedures as products are commercialized
- Maintain a geographic focus on specific centers of expertise
- Build a global information network
- Establish links with other similar organizations

The Research Approach

At the beginning of the project, plant biotechnology by-and-large had not been transferred to most developing countries. ABSP's research goal was to improve the economic and environmental sustainability of agriculture systems and the quality of life in developing countries by building capacity for the use and management of agricultural biotechnology. Its focus was to produce high-quality plant material at lower economic and environmental cost with the potential to reduce chemical inputs by genetically engineering pest and pathogen resistance mechanisms in selected plants.

Specific research objectives were to:

- Develop disease-free, high-quality planting material of tropical crops, specifically banana, pineapple, coffee, and palm
- Assemble vectors containing insect- and virus-resistant genes
- Genetically engineer potato, sweet potato, and maize for resistance to virus and insect pests in developing countries
- Genetically engineer cucurbits with a virus coat protein for development of resistance to potyviruses
- Transfer scientific knowledge and techniques to developing countries through postdoctoral fellowships
- Demonstrate pest resistance of transgenic crops and integrate this into sustainable agricultural systems via collaborations

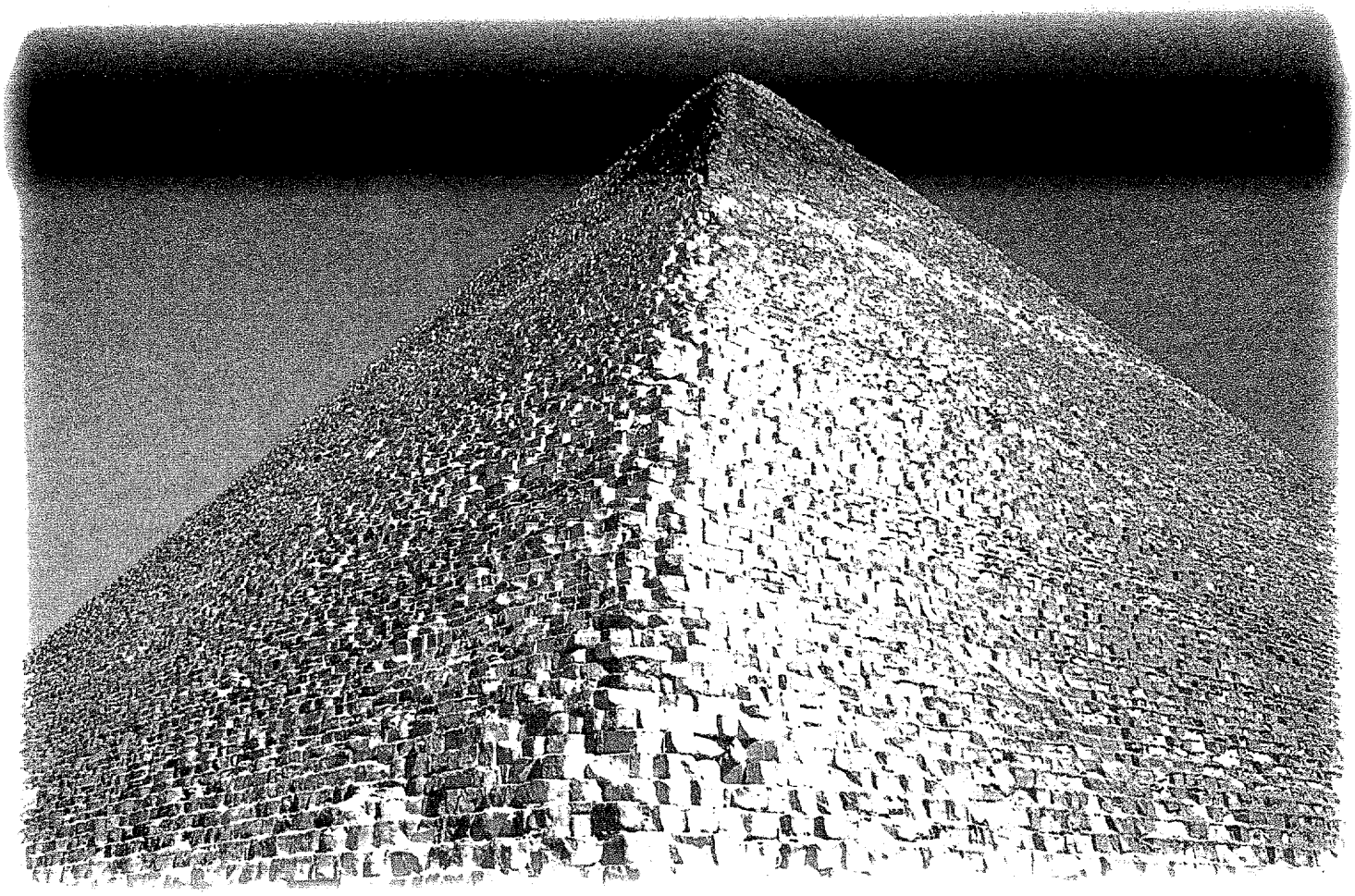
Outcomes in Brief

ABSP is not just another biotechnology project. It is designed as a partnership in which biotechnologists interact as a team with other disciplines of agricultural science to produce specific products in close collaboration with developing countries. Its purpose is to enhance the capacity in both the United States and host countries to use and manage biotechnology research for the development of environmentally compatible, improved germplasm—specifically, germplasm with genetically engineered pest and pathogen resistance.

ABSP became the first and only comprehensive biotechnology program to use collaborative research teams, encompassing both the public and private sectors, field agronomists and breeders, experts in biosafety and intellectual property protection, and a dedicated team of international specialists committed to the equitable use of biotechnology in global agricultural research. In essence, ABSP became a consortium of public and private research institutions committed to the concept of development assistance and the role agricultural biotechnology can play in the development of new goods and markets.

ABSP has been particularly successful in the area of technology transfer—the exchange of personnel, transfer of knowledge and research tools, and introduction of transformed cultivars to its host countries. The project has fostered and nurtured institutional linkages among the scientists and administrators of widely diverse organizations. It has progressed from transforming selected species to field testing and commercialization while accommodating issues of biosafety and intellectual property in the process.

The following pages will focus on the ways in which ABSP built product and capacity through two case studies: development of potato tuber moth resistance in Egypt and training for human capacity in Morocco. In the fourth section, the project's development of innovative partnerships with the private sector is detailed. The final section is devoted to the lessons that have emerged and that will help frame future projects in agricultural biotechnology for sustainable productivity.



EGYPT AND THE POTATO TUBER MOTH

Egypt and the Potato Tuber Moth

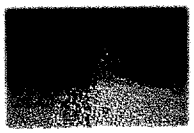
THE POTATO IS THE FIFTH MOST IMPORTANT CROP IN THE WORLD. IT IS NUTRITIOUS AND HIGHLY PRODUCTIVE, HAS A GOOD VALUE WHEN SOLD, AND IS AN EFFECTIVE CASH CROP FOR A DEVELOPING COUNTRY THAT HAS BOTH LOCAL AND EXPORT MARKETS.

This is the case in Egypt, where agriculture accounts for 28% of the national income. Almost 50% of the country's work force is dependent on the agricultural subsector. Rising population and the resulting increase in domestic demand for agricultural products are putting pressure on agricultural exports. In 1996, Egypt produced 2.6 million metric tons of potatoes and exported 411,000 metric tons, valued at nearly $80 million, to Europe and the Arab countries. Small farmers grow 65% of these potatoes. However, the potato tuber moth, which mines the foliage and feeds on the tubers, is a serious pest of potatoes in both the field and in storage (*see sidebar*). Controlling the problem could increase Egypt's export volume by 15%—an additional $12 million in export income by 1996 standards.

The tale of the tuber-moth-resistant potato in Egypt is more than an emerging biotechnology success story. In microcosm, it has nearly—although not all—the elements of a best-case scenario for narrowing the technology gap between a developing country and the industrialized world—a goal of the U.S. Agency for International Development (USAID). The case meets the agency's tests of agricultural sustainability, internalized responsibility for biosafety, assurance of intellectual property rights, and development of human resources and networking opportunities.

THE IMPACT OF THE POTATO TUBER MOTH IN EGYPT

The potato tuber moth mines the leaves of the plants, stunting them and leading to reduction in stand. Infestation occurs mostly in the first growing season (January to May). When pressure is heavy, field losses can be 30%. The pest is also a problem in storing potatoes. Egypt lacks sufficient cold storage for potato production. In traditional ambient-temperature storage structures, called nawallas, losses can be 100% within 90 days. To combat storage losses, potatoes are dusted with large amounts of toxic organophosphates like parathion. Potatoes sold from storage carry substantial pesticide residues. Although AGERI, ABSP, and other organizations in Egypt have been working for five years to develop environmentally safe biopesticides from Bt (which pose no risk to human health) that could eliminate storage losses, currently farmers still apply pesticides four to five times in the field to try to eradicate the pest. The development of potatoes with resistance to potato tuber moth will reduce the need for the wholesale application of pesticides.



Egypt and the Potato Tuber Moth

Egypt—The Need

Traditionally, the potato tuber moth has been controlled in Egypt by means of insecticides. According to Judith Chambers of Monsanto, biotechnology specialist and former ABSP project officer, "In some cases—the Nile Delta is a good example—chemical use has been so intensive and so liberally applied that natural resource degradation has resulted. In fact, insect resistance to pesticides is developing." On the other hand, says Chambers, "Resource-poor rural farmers, who are faced with a multitude of pests, diseases, and soil problems that produce low yields, don't have the foreign exchange to buy insecticides and fertilizers."

Magdy Madkour, director of the Agricultural Genetic Engineering Research Institute (AGERI) in Egypt, points out the problem in cotton, an important economic crop, although one not supported by the USAID collaborative project: "Millions of dollars are spent annually on the purchase of imported pesticides that are applied extensively on cotton-growing areas, causing hazardous effects to the environment and human health."

Developing insect control through genetically engineered potatoes resistant to the potato tuber moth is an answer for increasing yields from the field and the value of the crop, reducing losses from storage and the use of pesticides, and diminishing toxic residues. Genetically resistant potatoes would also reduce the financial burden of insecticides on farmers, while not significantly increasing the price of resistant seed.

A Source of Sustainability

Several factors make Egypt an appropriate partner for the Agricultural Biotechnology for Sustainability Productivity project (ABSP). The Egyptian government has seen the potential of improving agricultural production through biotechnology and is receptive to changing Egyptian policies to foster biotechnology entrepreneurship. USAID also has a well-established office in Cairo dedicated to three objectives: technology generation, technology transfer, and policy reform. The office is in the advantageous position of being able to provide funding to country projects directly, rather than having to cycle fiscal arrangements through its headquarters in Washington, D.C. Finally, as Chambers puts it, "One of the reasons that the project was so well suited to Egypt is that we could train a lot of people instead of just one. A really good research infrastructure already existed in Egypt—a state-of-the-art functional lab and many people who had been trained in the United States."

Chambers is referring to the Agricultural Genetic Engineering Research Institute—AGERI—established jointly in 1989 by the Egyptian government and the United Nations Development Program when it was recognized that genetic engineering would offer an effective means to overcome significant constraints to agricultural productivity.

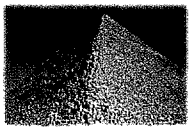
AGERI's first objective in its formative years had been the introduction of state-of-the-art cell culture and molecular biology technologies to solve problems facing Egyptian agriculture that could not be resolved through conventional means. AGERI also began to explore insect-resistant crops and bioinsecticides "projected to have a major impact on the Egyptian economy and environment," according to Madkour. It had established a genome mapping laboratory for developing genetic maps of economically important crops and was also giving priority to research related to drought and salinity, important to the expansion in newly reclaimed lands and to maximizing production. "By the time negotiations started with ABSP to identify areas of mutual interest," says Madkour, "AGERI already had in place tissue culture protocols for potato regeneration and transformation, an ideal match with ABSP's potato tuber moth resistance program."

Adopting and applying the most recent technologies require the dedication of first-rate researchers and research

facilities to perform the highly technical tasks that are demanded. AGERI had successfully put in place the physical and management structures to meet the demand. Further, it had already established an interface with the international scientific community, and its senior scientists had links with Egyptian universities. In short, a structure was in place to assure sustainability of a project that would itself address agricultural sustainability.

The Process

In 1992 a cooperative research agreement was reached between AGERI and ABSP. Its ultimate goal was the production of a variety of elite crops—namely potatoes, maize, cucurbits, and tomatoes—resistant to major pests to render Egypt's agrosystem more economically successful as well as environmentally safe.



Egypt and the Potato Tuber Moth

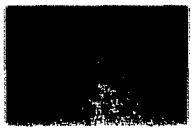
At an inaugural implementation workshop held in Cairo, partners developed work plans to focus tasks for the first year of collaboration. Teams of scientists from both Egypt and the United States were established to address specific commodity constraints and, just as importantly, the policy issues—biosafety and intellectual property rights—and management and networking within the project.

The potato team comprised scientists from Michigan State University and AGERI who came to the table with a good grasp of what to do, according to MSU professor Dave Douches, a breeder and molecular geneticist. Michigan State has an established potato breeding and genetics program with a great deal of experience in field testing transgenic potatoes. It also has a group of entomologists working on control of insects in potatoes and experience in field testing transgenic plants.

The team concentrated on specific goals: to use transgenic potato plants expressing toxin genes from *Bacillus thuringiensis*—known as Bt—as parental material in a breeding program to develop improved populations of potatoes resistant to the moth. The populations would subsequently be used to select improved advanced lines directed toward varietal development. Additionally, important Egyptian potato cultivars would be transformed and laboratory, greenhouse, and field tests of these transgenic plants would be conducted to determine their resistance to the moth and other Lepidopteran insects.

The team identified a gene owned by Garst Seed Company (formerly ICI Seeds)—a codon-modified CryV-Bt gene—as one suitable for use in transformation. A material transfer agreement—a time-consuming but standard process—was signed with Garst allowing MSU to use the gene for research purposes within the ABSP project and to share it with collaborators in Egypt and Indonesia.

"The first step was to make sure that the gene worked," said Douches. "It required us to make vector constructs that allowed us to make the transformation. We had to improve the system so that we could screen a large number of plants. We now have a genotype-independent system that allows us to transform any type of potato."



Egypt and the Potato Tuber Moth

Douches and his MSU colleagues began with greenhouse bioassays using the potato tuber moth to see if they could control it. Field tests were conducted from 1993 to 1996 in Michigan at the Montcalm Potato Farm using the tobacco hornworm (*Manduca sexta*) because potato tuber moths are not indigenous to Michigan.

"In 1995 we were ready to go to Egypt with our material," Douches continues, "but USAID needed more time to evaluate sending transgenic material overseas. Basically, the perception of genetically engineered plants stifled the speed at which we could move to the field." While waiting for USAID's evaluation, the team chose to send the material to California for field tests using the potato tuber moth. Unfortunately, high temperatures destroyed all adult moths before egg laying began.

In 1996, the team began using more vector construct manipulation and, since they knew the gene was "working well," began transformation of the Egyptian potato variety Spunta. By 1997, the MSU lab was able to send its first- and second-generation material to Egypt for a small field test. Now that the results of this small test have proven successful, additional materials have been shipped to Egypt for expanded field trails at AGERI and Centro Internacional de la Papa, or CIP—the international potato center regional office in Egypt.

"CIP is a key player in the next step," says Douches, "because its chief scientist, Dr. Ramzy El-Bedewy, works well with AGERI. AGERI has the entomologists and scientists and Dr. El-Bedewy supplies the field expertise and is in touch with the commercial sector. Having plots at CIP will spread the word among the commercial potato sector."

During the course of the project, many scientists came to MSU to observe and learn what was being done in Douches's lab. "You always want things to go faster when you're doing research," says Douches. "But when you're sharing information and comparing systems with people, it moves more slowly. For things to work, you must have interaction among people and you must build research relationships. Everyone must be on the same page as far as knowledge." He attributes successful relationships to the leadership of John Dodds. "John came from the International Potato Center in Peru. He knew the crop well and had international contacts. He was able to break the ice and establish relationships so work could get done."

> You always want things to go faster when you're doing research, but when you're sharing information and comparing systems with people, it moves more slowly.
>
> *Dave Douches*
> *MSU Breeder*
> *and Molecular Geneticist*

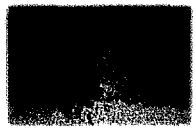
Douches's perception of slowness, however, is tempered by Chambers. "One nice thing about the potato team," she says, "is that they've been very diligent. They keep pushing toward their goals, so they're further ahead than some of the other teams. At one time we thought we might set aside discretionary funding to finance the first couple of teams that came with something either in testing or in commercializing. But that money fell by the wayside as a result of insufficient funding by USAID."

Egyptian scientists were working on genetic transformations using their own Bt gene at the same time research was proceeding at MSU. AGERI's research projects have now reached the stage of evaluating genetically modified organisms and approval has been received from the Egyptian National Biosafety Committee (NBC) for various small-scale field trials, including trials of transgenic potatoes transformed with CryIA(c) and CryV var. kurstaki delta-endotoxin genes to confer resistance to the potato tuber moth.

In-Country Responsibility for Biosafety

In Egypt, as in other developing countries, a national system is necessary to ensure the safe development of biotechnology products and to facilitate collaborative research activities with other countries. According to Madkour, "Until 1995, existing regulations in Egypt did not include guidelines for handling transgenic materials under contained conditions, nor did they cover the release of GEOs (genetically engineered organisms) into the environment."

As the primary institute that deals with agricultural biotechnology in Egypt, AGERI influenced the Egyptian government in moving forward to build a national biosafety policy to regulate such activities. AGERI first gathered



Egypt and the Potato Tuber Moth

information from other countries regarding their regulations, guidelines, and system design and then drafted regulations and guidelines adapted to the Egyptian condition, which were revised and approved by governmental authorities in 1995. AGERI scientists, with training received through support of ABSP (*see "Developing Human Capacity"*), were instrumental in drafting the regulations.

By ministerial decree the Egyptian National Biosafety Committee (NBC) was also established in 1995. This committee is responsible for policies and procedures to govern the use of modern biotechnology in the country. The decree was subsequently strengthened by a series of additional decrees. The NBC, comprising government agency members, private sector members, policy makers, legal consultants, and nontechnical community members, formulate, implement, and update safety codes, assess risks and issue licenses, provide training and advice, report annually to the government, and provide liaison with other national and international organizations. Every organization actively involved in genetic engineering research is mandated to establish its own institutional biosafety committee responsible for inspection, guidelines, assessment, research review, emergency planning, containment measures, monitoring, and reporting.

In 1994, AGERI began construction of a biocontainment greenhouse (*see box below*), with funding from the USAID office in Cairo through an MSU subcontract with the University of Arizona managed by ABSP. The greenhouse was completed and inspected by the U.S. Department of Agriculture in 1995.

An Innovative Containment Facility for Egypt

In both developed and developing countries, the safe application of biotechnology to problems of agricultural productivity requires an appropriate biosafety system that includes both policy and regulations. Countries lacking mechanisms for review and oversight of biotechnology products risk being excluded from accessing important technologies.

When the Agricultural Genetic Engineering Research Institute (AGERI) in Cairo, Egypt reached the stage of evaluating genetically modified organisms there were no guidelines for handling transgenic materials under contained conditions. Nonetheless, AGERI began to plan the construction of a containment greenhouse.

The Containment Greenhouse Complex at the University of Arizona (UA) provided the inspiration for AGERI's facility. In October 1991, Magdy Madkour, director of AGERI, visited the UA facility. Impressed with both its design and suitability for operations in a hot, arid environment, he used it as a prototype. The AGERI complex was built with funding from the USAID office in Cairo through an agreement between ABSP, AGERI, and the University of Arizona, which provided expertise in facility construction and management.

AGERI's facility, based on the UA design by architect Terry Armstrong, far surpasses the basic criteria of the United States federal register for a containment facility: a greenhouse with concrete floors, screened windows, fan intakes with louvers, and an on-site autoclave. AGERI's containment greenhouse consists of eight identical chambers and a head house. Each chamber is of area 52m^2. It has a computer-controlled environment, 8m^2 underground collection tanks for treating drainage effluent from the modules, polycarbonate Exolite (TM) panels that are break proof, double entry doors, a generator for emergency power, and security fencing. It is cooled by evaporative cooling and heated through the use of a steam/hot water exchanger. It is designed to operate in the desert where temperatures may reach 110 degrees Fahrenheit.

The facility was completed in 1995. Sivramian Shantharam, of the U.S. Department of Agriculture Animal/Plant Health Inspection Service and biosafety consultant to ABSP, inspected the facility. Madkour points out that, "His Excellency Dr. Youssef Wally, Deputy Prime Minister and Minister of Aquaculture and Land Reclamation in Egypt and Mr. Edward Walker, former U.S. Ambassador to Egypt expressed their admiration of the facility at its inauguration in 1995. It is considered the most modern facility of its kind in Africa, Asia, and the Middle East."

The Incentive of Intellectual Property Rights

Intellectual property rights are important for biotechnology. They provide incentives for local researchers and firms, they have come to be required by international law, and they can assist in the international transfer of technology. The lack of appropriate intellectual property policies within a country can prohibit the formation of initial partnerships and deter foreign investments.

Managing intellectual properties, or IPs, is a complex exercise. ABSP takes a comprehensive approach to biotechnology generation, exchange, and management. One of the goals of the project is to help build capacity around the world for the legal exchange of intellectual properties.

ABSP tries to assist host country collaborators in developing policies favorable to their particular situation. This has included legal consultations by John Barton of Stanford University Law School to assist policy makers in assessing needs and designing model legislation and policy.

Many of the technologies and innovations developed using agricultural biotechnology are proprietary and must be managed in a different manner than nonproprietary technologies. The ABSP project was initially managed by the MSU Department of Crop and Soil Sciences. It became apparent, however, that that this type of project required management resources outside the purview of a single university department. The project was transferred to the Institute of International Agriculture at MSU, where additional management and administrative resources could be more easily tapped. Further, for aid in the management of intellectual property, the university's Office of Intellectual Property (OIP), under the direction of Frederic Erbish, agreed to assist the project. A technology transfer coordinator, Karim Maredia, was appointed to aid in the management of IPs generated by the project and to serve as a conduit of information between ABSP, OIP, scientists, and administrators.

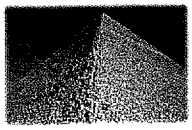
> The technology transfer business is a people-centered process and requires individuals who are technically competent, culturally sensitive, and have business savvy.
>
> *Catherine Ives*
> *Director, ABSP*

Catherine Ives, Managing Director of ABSP, points to the pivotal role of establishing information links in the management of intellectual property: "We cannot stress enough the importance of communication with all parties involved—researchers, administrators, policy makers—from both developed and developing country institutions. The initial lack of a full-time professional assigned to this activity slowed progress in transferring technologies. The technology transfer business is a people-centered process and requires individuals who are technically competent, culturally sensitive, and have business savvy."

Until the ABSP project, Egyptian patent law, dating from 1949, offered no protection to food or pharmaceutical products on the grounds that food did not constitute an invention and that a monopoly over producing such products was harmful to the public's health. As Egypt moved towards genetic engineering, it recognized the need to ensure that the developer of a novel gene could obtain appropriate protection and it began to strengthen its laws regarding intellectual property.

According to Madkour, "As Egypt undergoes major agricultural reform in which the private sector will play an essential role, the government of Egypt is currently modifying its existing patent law. Under a new draft law, agriculture, foodstuffs, medical drugs, pharmaceutical compounds, plant and animal species, and microbiological organisms and products are included as patentable subject matter. This brings Egypt in line with international standards. A new law such as this and expanded understanding of intellectual property should assist Egypt in acquiring technology more readily and in entering into more effective scientific strategic alliances that will help in developing new technologies and strengthening local research capabilities."

Such an alliance has already been forged between Egypt and a multinational company. In 1996 AGERI



Egypt and the Potato Tuber Moth

obtained an Egyptian patent on a biological insecticide from an indigenous strain of the bacterium *Bacillus thuringiensis*. AGERI, with the assistance of MSU's Office of Intellectual Property and ABSP, executed a material transfer agreement to transfer the gene from Egypt to Pioneer Hi-Bred, a large multinational company based in Johnston, Iowa. A patent application was subsequently filed in the United States.

Developing Human Capacity and Networks

The focus of USAID support for biotechnology has always been on the products and processes needed to solve agricultural problems rather than on technology itself. According to the 1990 National Research Council Report, "Cell and molecular biologists are the new partners of plant and animal breeders, agronomists, and pathologists. These new partnerships must be created to ensure integration of the new techniques into agricultural research and development programs." Partnerships are enhanced by people-to-people programs such as doctoral and postdoctoral fellowships and nondegree training. Networks of scientists in developing countries linked to their counterparts through mechanisms such as workshops and electronic networks is, as the report goes on to say, "an effective mechanism to counter problems of isolation of many LDC [less developed country] scientists and the equally difficult problem of adequate access to scientific literature."

> One of the best outcomes in Egypt was the formation of a diverse network of people who had an in-country interest in biotechnology.
>
> *Judith Chambers*
> *Biotechnology Specialist*
> *USAID, Washington, D.C.*

ABSP has been diligent in its efforts to build the capacity to sustain projects through people themselves. "One of the best outcomes in Egypt," says Chambers, "was the formation of a diverse network of people who had an in-country interest in biotechnology." Egypt had a critical mass of policy makers, molecular biologists, entomologists, and plant breeders as well as funds to further training in advanced laboratories. Interns from Egypt participated in both intellectual property rights and biosafety internships and programs sponsored by ABSP.

John Barton of Stanford University Law School, project consultant for intellectual property rights, patents, and licensing, addressed the licensing and intellectual property problems that arose in connection with the transfer and ownership of technologies developed by the project. In 1993 he organized an intellectual property rights internship program at Stanford University. He also conducted a patent rights workshop at AGERI in 1994 that addressed patent issues related to materials used in and generated by biotechnology projects and counted among its participants scientists, legal professionals, and government officials primarily from Egypt.

A major outcome of the workshop was the initiation of communication between scientists working in biotechnology programs and legislators and policy makers in Egypt. "This was their first contact," said Madkour, "to exchange ideas and identify the need to incorporate biotechnology products as patentable subject matter."

Sivramiah Shantharam of the U.S. Department of Agriculture/APHIS (Animal and Plant Health Inspection Service) in Washington D.C. worked with ABSP management to develop an Egyptian biosafety workshop in 1994. Shantharam provided the project with advice on evaluating genetically engineered plants to be used in the Egyptian environment and the biological, physical, and temporal safety factors to be put in place for safe field testing. Resources of Michigan State University were also made available to interns in a planned manner, providing them with training in implementing and documenting the evaluation of genetically engineered organisms. Shantharam also took leadership in the inspection of the biosafety containment facility constructed at AGERI.

With ABSP funding, Egyptians Michael Ghaly and Walid Maaty went first to Jamaica and then to Michigan State University to participate in the first biosafety internship course. In Jamaica they had a chance to share the status of biosafety in Egypt at that time. At MSU and later in Washington D.C. they received training in risk assessment and field test creation and were able to interact with state of Michigan regulators who govern field test permits and with staff and administrators in national regulatory agencies and in USAID. Ghaly used what he learned to help develop a draft of Egyptian biosafety regulation and went on to become the first biosafety officer at AGERI, coordinating, under Madkour's supervision, the construction of the biosafety containment greenhouses. Subsequently, Ahmed Wally received training in biosafety when Ghaly continued his training overseas. Wally currently oversees the field, greenhouse, and laboratory biosafety procedures at AGERI.

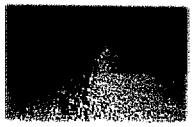
Workshops Support Research Success in Egypt

Since the passage of the Convention on Biological Diversity at the 1992 Earth Summit in Rio de Janeiro, Brazil, biodiversity has become integrally linked to the wider issues of environmental protection, agricultural sustainability, and global food security. The ABSP project addresses these issues in its collaborations with developing countries around the world.

In January 1994, ABSP, together with the Egyptian Agricultural Genetic Engineering Research Institute—AGERI—mounted a set of workshops over the course of eight days in Cairo, Egypt. More than 140 scientists from around the world engaged in discussion of issues associated with access to, protection of, and safe and legal use of agricultural biotechnology—the policies that enable success in biotechnological research.

The monumental effort required to bring together the workshop participants and structure the workshop formats was indicative of the strength of the collaboration between AGERI and ABSP and of their dynamic commitment to the project's success. In an extremely short time, significant progress was made on a wide range of research and policy fronts. The first workshop focused on biosafety: principles, current status in Africa and the Middle East, legal aspects, risk assessment, social consequences and economics, building a framework, tools and models for evaluating risks and benefits, and examples of laboratory, greenhouse, and field testing of transgenic germplasm in other countries. The second workshop on intellectual property rights addressed patent protection, plant breeders' rights, and licensing agreements. Research accomplishments and strategies, communication, and team building in the ABSP/AGERI collaboration were the topics of a final workshop.

In June 1994, ABSP and AGERI organized another workshop in Cairo to create greater awareness in the Egyptian scientific community of the importance of genetic resources for achieving long-term sustainability and food security and to foster cooperation for conserving and managing genetic resources in Egypt and the Mediterranean region. This landmark workshop set the stage for a special issue of the internationally recognized journal DIVERSITY, published in English and Arabic. This special regional issue examined the way scientists and policymakers in seventeen Mediterranean countries are preserving and conserving the very basis of humankind's food and medicinal supply. Distributed to developing countries by means of USAID funds, the journal provided scientists, students, policy makers, and development workers otherwise unavailable information on issues and programs in the field of biodiversity and genetic resource conservation.



Seven Years Later: Project Results in Egypt

Timing

The development of a tuber-moth-resistant potato for Egypt is progressing. Varieties of importance to Egypt have been transformed and are being field tested there. As Douches says, "We've got a good gene that's expressed well in the right variety of potato." The technology has not been implemented as quickly as USAID might have hoped based on its first parameter for the project—that it be of three to five years in duration. "But you can't just put up a sign now and say you're done," continues Douches. "We need some years of field data. Entomological issues will surface. Insects don't disappear off the face of the earth. We must now look at how to keep the potato tuber moth from adapting to the Bt toxins expressed by the inserted genes. A lot of work is being done in Egypt with integrated pest management. A combination of that and our techniques would predict ultimate success."

In short, if the second institutional parameter of USAID is to be met—agricultural sustainability—then the project itself must be sustained to a conclusion.

Commercialization

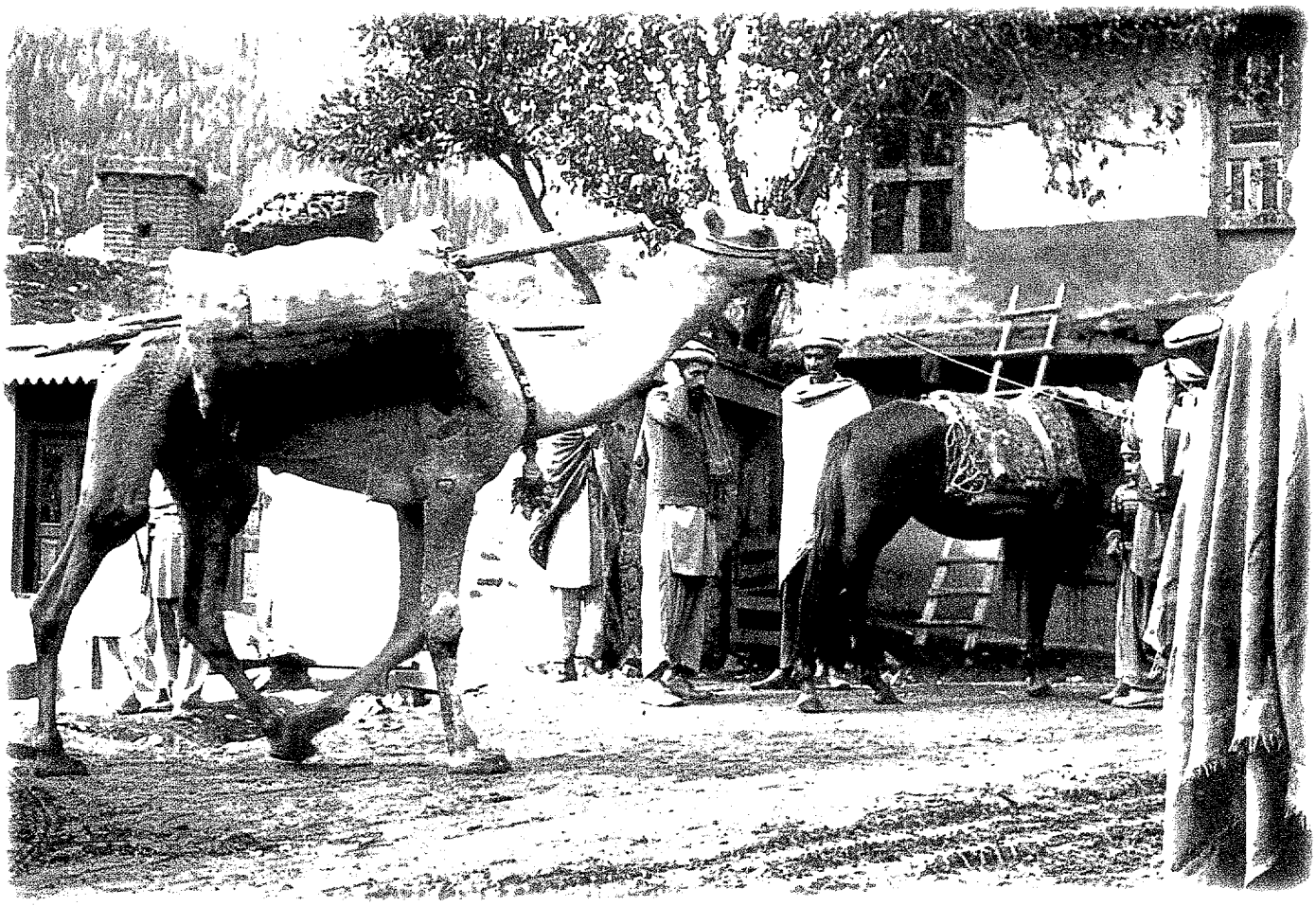
The project in Egypt is at the threshold of commercialization. Because of policy changes in Egypt, a thriving private sector now exists. Private growers are producing potatoes for local consumption and for export. The mechanism to move the tuber-moth-resistant potatoes from the research arena to the commercial arena is still being explored and will be the focus of future efforts.

In getting to this point, ABSP has adhered to the guiding principles initially set forth for the project: it used proven, applied research in attacking the problem; it is benefiting both its U.S. and Egyptian partners; it used multiple routes for development of germplasm—the MSU lab, AGERI facilities, and geographically diverse field tests; and it gave equal weight to innovation as defined in the project guidelines.

Infrastructure and Leadership

In large part the success of the project in Egypt is due to infrastructures already in place in both Egypt and at Michigan State University before the project began. Furthermore, the Egyptian government was receptive—indeed, poised on the edge of policy change. Both AGERI and MSU had a previously established level of technical expertise and both provided expert leaders in negotiating complex administrative and communication matters. Both institutions continue to have much to gain from the project. Besides the ultimate benefit that an insect-resistant potato will bring to the Egyptian economy, AGERI has effected major patent and biosafety policy changes in its home country and has constructed a state-of-the-art biocontainment facility. Potato research at MSU has been the beneficiary of project funding, and MSU now offers, as a spinoff, a course in intellectual property and technology transfer.

Chambers sums it up this way: "Because the project was multidimensional—involving policy, training, research, and business—we drew people from various parts of government and from the science and agribusiness communities. The strength of such an arrangement is that when you're addressing a difficult policy issue you have lots of people with varying vested interests weighing in." This team concept—the first time such a concept has been applied to a biotechnology project—was the ultimate factor leading to the project's success.



Cultivating a Framework for Human Capacity in Morocco

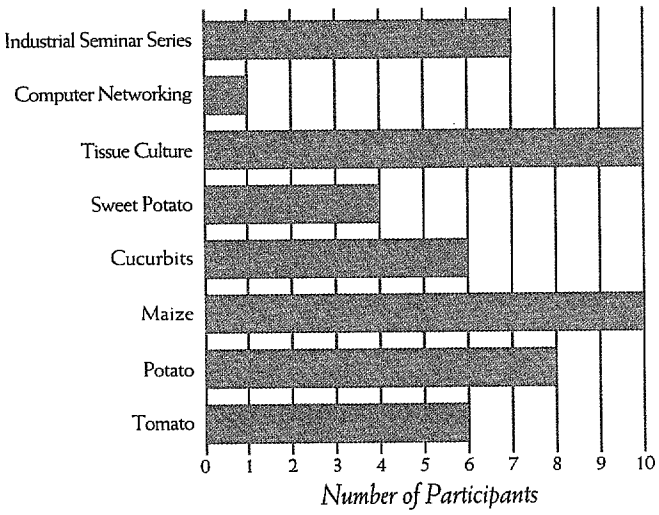
"HAVING A LAW IS ONE THING. IMPLEMENTING IT IS ANOTHER." SO SAYS KARIM MAREDIA, A KEY PLAYER IN ANOTHER PHASE OF THE AGRICULTURAL BIOTECHNOLOGY FOR SUSTAINABLE PRODUCTIVITY (ABSP) PROJECT. WITH ITS EXPERIENCE IN INTEGRATING INTELLECTUAL PROPERTY AND BIOSAFETY ISSUES, BUILDING HUMAN CAPACITY, AND COLLABORATING WITH ITS HOST TO INFLUENCE POLICY AND LEGISLATION, ABSP WAS WELL PREPARED TO APPLY ITS EXPERTISE IN A MORE FOCUSED CONTEXT—THIS TIME IN MOROCCO.

Human Capacity in Morocco

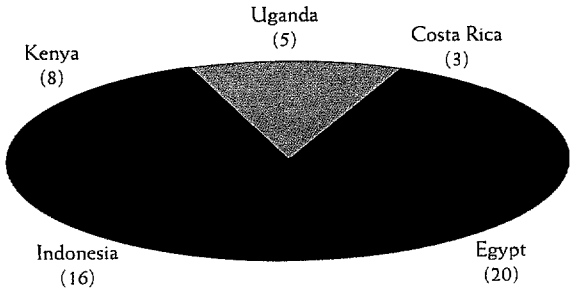
ABSP's successful development of a model for agricultural sustainability using biotechnology is illustrated by the story of the tuber-moth-resistant potato in Egypt. The story of its role in plant variety protection in Morocco illustrates ABSP's ability to adapt these lessons to a discrete issue—the education and training of people—with profound international implications for the host country. In the Moroccan case, ABSP is helping to transform words on paper into a functioning system through a three-step process: building awareness among a large group of people, individualized training for those ultimately responsible for the system, and continued support for information management to sustain the system.

ABSP Training Programs, 1992-97

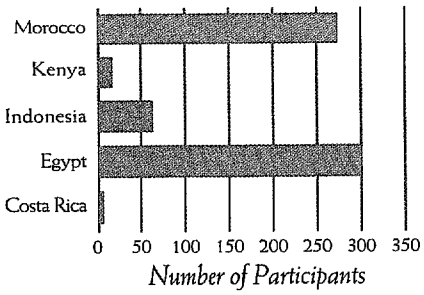
Technical Training by Subject



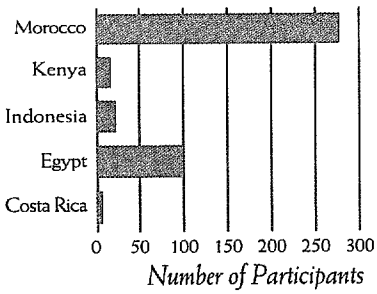
Technical Training by Country



In Intellectual Property Rights



In Biosafety



Human Capacity in Morocco

Morocco—The Need

Morocco, a country of approximately 26 million people, is located on more than 710,000 square kilometers in the northwest of Africa. Its dominant 3,500-kilometer coastline provides a Mediterranean climate to much of the country. Agriculture plays a key role in Morocco's economy, employing about 40% of the labor force and currently contributing about 18.4% to Morocco's gross domestic product. Morocco actively trades fresh and processed agricultural products to European markets. The country expects to export more than 70% of its protected varieties—roses, vegetables, cereals, forage crops, food legumes, and certain tree species—to Europe and is thus dependent upon how Europe regulates and protects crop varieties.

USAID/Morocco Director Michael Farbman stresses Morocco's need to compete in international markets with other exporting countries. To do so, it needs access to "practical and commercial applications of biotechnology that can help quickly introduce selected traits to resolve production problems and accelerate large-scale propagation of disease-free plants."

> We didn't tell Morocco how to do it, but showed them how other countries were doing it.
>
> *Karim Maredia*
> *ABSP Technology Transfer Coordinator*

Until recently, breeding for improved crop varieties was primarily conducted in the Moroccan public sector. USAID, through the Moroccan Agribusiness Project, or MAP, became aware that the private agricultural sector was being denied access to improved varieties by U.S. companies because of a lack of intellectual property protection. Moreover, the private sector within Morocco had developed improved varieties that it could not protect—citrus, for example.

In 1995, faculty members at Michigan State University and others associated with ABSP visited Morocco and learned of the negative effects of the absence of a legal and regulatory framework to access or develop high-quality plant materials. Farbman sums up MAP findings: "We can cite numerous examples which illustrate the high cost imposed upon Morocco's horticultural sector as a result of its being denied access to new U.S. and other plant varieties and genetic materials. Among the well-known examples are strawberries, peaches and other tree fruit, date palm and flowers."

Building Awareness

Although the DPVCTRF (Direction de la Protection de Vegetaux de Controles Techniques et de la Repression des Fraudes)—the division of the Moroccan Ministry of Agriculture that regulates importation and exportation of plants, plant materials, and pesticides—had been aware of the issues for some years, USAID helped to push the issue to the appropriate level within the Moroccan government and organize the private sector growers' associations to apply political pressure to draft legislation.

In the fall of 1996, John Barton of Stanford University Law School, former ABSP Director John Dodds, and Karim Maredia, ABSP technology transfer coordinator, visited Morocco to develop a comprehensive design for and build interest in a colloquium on plant variety protection to be held in Morocco the following March. The colloquium was to assist Moroccan government officials and the agribusiness community in understanding and implementing the draft legislation and the related issue of biosafety in the management of agricultural biotechnology.

In the meantime, says Maredia, "The law passed in December 1996, between our consultation and the colloquium, building even greater momentum for implementation." Farbman reinforced this point in his opening remarks at the colloquium: "I must admit that we could not predict last October that the law would in fact be passed in December—making the timing of this colloquium work out absolutely perfectly!"

The law will protect 68 species of crops initially and within 10 years must extend to all crops. The law conforms to the 1991 convention of the International Union for the Protection of New Varieties of Plants—known by the French acronym UPOV—which established basic principles for protecting the intellectual property of developers of new plant varieties. It extends to all production of propagating material as well as to the harvested material of a protected variety and also extends breeders' rights to essentially derived varieties.

Human Capacity in Morocco

Planning for the colloquium proceeded with the new law in mind. Moroccan participants wanted three specific areas to be emphasized:

- Administrative practicalities of implementing plant variety protection—e.g., how varieties are identified, and what kinds of surveillance are needed to detect unauthorized use of protected materials

- International aspects of plant variety protection, especially as it would affect Morocco's access to varieties and the marketing of varieties and high-value agricultural products in Europe

- Biosafety issues, especially combining the goals of plant variety protection and biosafety

To accomplish this, "We invited experts from the U.S. and Europe to share how laws are implemented in other countries," said Maredia, a principal colloquium planner. "We didn't tell Morocco how to do it, but showed them how other countries were doing it."

The colloquium, co-organized by ABSP and the DPVCTRF, was held March 24-26, 1997, at the Ministry of Public Works Conference Center in Rabat, Morocco and addressed the issues encompassing the implementation and enforcement of the new Moroccan law. Conference planners expected about 100 participants, but more than 250 participants from various public and private sector institutions in Morocco attended, including individuals from the Ministries of Agriculture, Public Health, the Interior, Commerce, Privatization, Finance, Science, and the Environment, as well as the National Association of Biotechnology, various commodity associations, universities, and international organizations. Twelve international experts from the United States, Europe, and Latin America shared their knowledge and experience with the Moroccans.

Rachid Lakhdar, director of the DPVCTRF, and Farbman opened the colloquium. The keynote address was given by Barry Greengrass, the Vice Secretary-General of UPOV, and introductions to the Moroccan law were given by Mohamed Tourkmani of the DPVCTRF and Amin Hajji of the University of Casablanca. Representatives from Spain, Argentina, and the U.S. shared experiences in the implementation of plant variety protection legislation. Additionally, issues relating to access, trade, and licensing of protected varieties were explored by representatives from Morocco, Europe, and the U.S. Proceedings of the colloquium have been published and distributed in Morocco and elsewhere.

Training Those Responsible

Emerging from the workshop was the recommendation that five Moroccans come to the United States for training in intellectual property rights and plant variety protection. Amar Tahiri, Mohamed Belhadri, Lahlou Mouanis, Fatima Zine el Abidine, and Lahcen Abdane visited three U.S. sites with three objectives in mind. At Michigan State University, they attended an internship course in intellectual property rights management and its importance to technology transfer to provide them with a more in-depth, general understanding of intellectual property and how it changes the management of research within the public and private sectors. In Washington, D.C. they visited the U.S. Department of Agriculture Plant Variety Protection Office, the office that accepts applications for new plant varieties and then analyzes them to determine whether or not they are unique and worthy of a PVP certificate. There the participants gained hands-on experience in PVP application, review, cost, certification, and databases. Finally, they visited APHIS, the U.S. Department of Agriculture Animal and Plant Health Inspection Service, which regulates new agricultural products including biotechnology-based products, and is one of the arms of the U.S. government that is responsible for setting national biosafety policy as it relates to transgenic crops. Participants became familiar with the organization of the regulatory system in the United States, the process to approve a new transgenic release, and the import and export of genetically modified organisms.

Mouanis, Tahiri, and Belhadri subsequently returned to Morocco to set up a plant variety protection office within DPVCTRF. Each has been positive in his response. Mouanis commented that "the training was very important and made me concerned about intellectual property rights at levels beyond my own position." Tahiri was enthusiastic about his visit to APHIS and "came to appreciate that both plant variety protection and biosafety go together and need to be addressed." For Belhardri, the most important thing was "how the U.S. government has addressed the issue of

Human Capacity in Morocco

biosafety" and how they have "moved materials through the private sector to commercialization. I am impressed with the flexibility of the legislation and how the system allowed for the relaxing of rules as more information became available regarding the safety of material."

Sustaining Plant Variety Protection in Morocco

The new law, though passed, has not yet been implemented, although approval of the articles for implementation has been granted. Because the colloquium and training took place on the heels of the passage of the law, Morocco has people in place with the understanding and training to respond effectively. Additional tools are still needed, however. Lakhdar believes that "the human resources are present, but modern management methods are necessary"—information management tools such as computer access and networking which are key short-term priorities.

The chief of the Moroccan division responsible for plant variety protection, Mohamed Tourkmani, expects some 1,000 applications from both the public and private sector under the new act. He points out that because the private sector has not invested in plant breeding, "farmers do not have access to the best varieties." While he hopes that the new law will change this equation and encourage private sector participation, others are less certain. Mohamed Aaouine of the Domaine Agricole, a private-sector agribusiness company involved in citrus, date palm, dairy, and vegetables, believes the new law will stimulate private sector investment in plant breeding in the area of cereals, but not in areas where they already have successful joint ventures with primarily European countries that already give Morocco access to improved varieties and markets. He believes, however, that investment may be forthcoming for exports to other regions. For example, this year Morocco exported between 100,000 and 120,000 tons of citrus to Russia—a potentially important market if Russian economic conditions improve. There may also be

Building Human Capacity in Indonesia

Whereas ABSP's focus in Morocco was building capacity to ensure intellectual property protection, in Indonesia it was biosafety. Beginning in 1995, ABSP began providing Indonesia with assistance in developing its national biosafety guidelines. Patricia Traynor from the USDA National Biological Impact Assessment Program worked as a special consultant for the ABSP project and assisted the committee formed by Indonesia's Central Research Institute for Food Crops (CRIFC) in drafting these guidelines.

Three experts in each of three research sectors—plants, animals, and microorganisms—were selected as the writing committee with the approval of Indonesia's Ministry of Agriculture. The first draft was entitled "Guidelines for Planned Introductions into the Environment of Organisms Genetically Modified by Recombinant DNA Techniques."
In order to improve the first draft, CRIFC and ABSP organized a biosafety workshop, held in Cisarua, West Java in May 1996. A total of 45 participants from both the public and private sector attended. At the workshop, the participants were divided into three groups to discuss and develop the appropriate biosafety guidelines for Indonesia. The groups corresponded to the three areas of concern—plants, animals, and microorganisms.

Based on the workshop, the first draft was redrafted, the guidelines for biosafety were proposed as the basis of a decree from the Minister of Agriculture, and a second workshop was held to finalize the second draft and reviewed by Indonesian officials and the Bureau of Law at the Indonesian Ministry of Agriculture. National guidelines were passed by ministerial decree on September 2, 1997. With funding from the World Bank and the Indonesian government, construction of a biosafety containment facility began that year.

Progress formulating policy can be limited if the host government does not take the lead. In preparation for drafting Indonesia's plant variety protection law, ABSP sponsored a Plant Variety Protection and Patents Workshop in Jakarta in 1996 at which Indonesia's Vice Cabinet Secretary Bambang Kesowo (far left) clearly articulated what he needed, established a deadline for completion of a draft law, and conferred upon the group gathered at this workshop (some of whom are shown) the responsibility for getting it done.

Building Human Capacity in Kenya

Kenyan participants at the first biosafety internship course at Michigan State University view curcurbits in an MSU greenhouse. L to r: Francis Nang'ayo of the Muguga Station, Kenyan Agricultural Research Institute (KARI) and Glen Madumadu of the Thika Station, KARI with Walid Maaty of AGERI (Agricultural Genetic Engineering Research Institute in Egypt) and Rebecca Grumet, MSU professor of horticulture. Madumadu wrote the early drafts of the Kenyan crop biosafety policy on the basis of his internship.

potential in the U.S., to which Morocco ships tomatoes, citrus, and cut flowers.

Aaouine also perceives that there is still a lack of understanding within the Moroccan private sector about the necessity for biosafety guidelines—one reason why the government has not progressed as far on this issue as it has in addressing plant variety protection. "The lack of biosafety guidelines," he says, "may be blocking Morocco from using technology that may be very useful."

Breeding new varieties of plants requires a substantial investment of skill, labor, material resources, money, and time. Obtaining intellectual property rights for a new variety enables those making an investment to have a better chance of recovering costs and accumulating the funds necessary for further investment.

Morocco's new plant variety protection law is an important milestone for the country in that it demonstrates Morocco's commitment to legally protecting the rights of breeders—whether they reside within Morocco or are from other countries with which it trades. It is a significant step for the Moroccan agricultural sector.

When the new law is fully implemented, it will provide substantial benefits to varied players in the agricultural sector, including Moroccans involved in research and development, farmers, and exporters. Moreover, the law is designed to open doors to the newest and most productive crop varieties and germplasm, previously unavailable, that can be used to increase yields, diversify production, and develop crop varietal mixtures to exploit more fully the full range of micro-climatic production zones and international market niches available. Ultimately, it can lead to increased research collaborations for scientists, improved agribusiness opportunities for farmers and processors, and greater options and cheaper prices for the Moroccan citizen. "ABSP played an important role," says its Director Catherine Ives, "in assisting Morocco to develop general awareness, specialized technical expertise, and the necessary management tools to implement the new PVP law. Our collaboration with Morocco shows what can be accomplished in a short time, with limited funds, when all parties are working towards the same goal."

Converting Ideas into Business: Unexpected Spinoffs of Building Human Capacity

In 1997, a seminar in intellectual property rights grew out of the ABSP project as a fee-based course, after project administrators noticed the demand for this type of educational opportunity. The ten-day internship program in intellectual property rights and technology transfer, organized by the Institute of International Agriculture in cooperation with the Office of Intellectual Property and the ABSP project at Michigan State University, drew 17 participants from Brazil, Egypt, Indonesia, Kenya, Morocco, the Philippines, South Africa, Uganda, and Zimbabwe.

Participants engaged in interactive sessions in various aspects of intellectual property rights and technology transfer including patents, plant variety protection, trademarks, copyrights, and trade secrets. They also gained insight into U.S. and international patent laws, patent processes, licensing, infringement, litigation, and other legal areas. The seminar emphasized the exchange of technologies within the context of the recent changes in the GATT/WTO and other global treaties.

During the second week of the course, interns attended the regional meeting of the Association of University Technology Managers (AUTM) in Ann Arbor, Michigan, where they interacted with technology managers from universities, private companies, and private law firms in the U.S. and Canada. In addition, they visited the Great Lakes Patent and Trademark Center in Detroit, Michigan, established by the U.S. Patent and Trademark Organization, and the Detroit Public Library, which provides patent and trademark services for the region. On the final day of the program, interns met with representatives of a venture capital firm and learned how "ideas" are converted into "business."

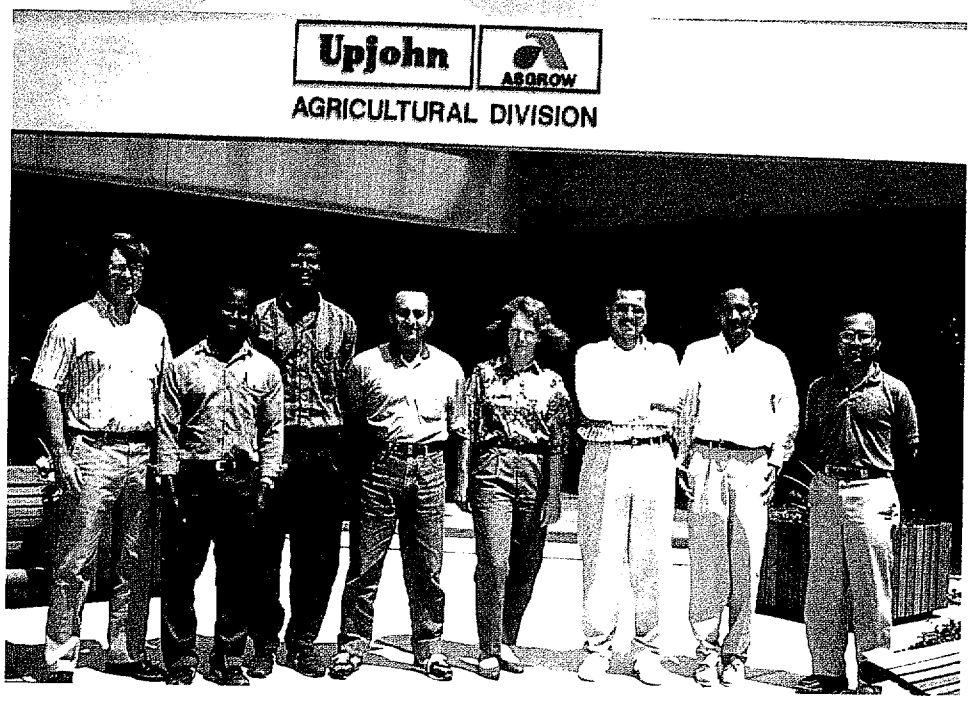
Through the internship program, an informal network has begun to develop that in turn fosters global cooperation in technology exchanges. Many of the participants will assist in the establishment and management of technology transfer offices in their home institutions. Others will establish in-country training workshops and courses designed to educate and create greater awareness among scientists and policy makers in technology transfer issues.

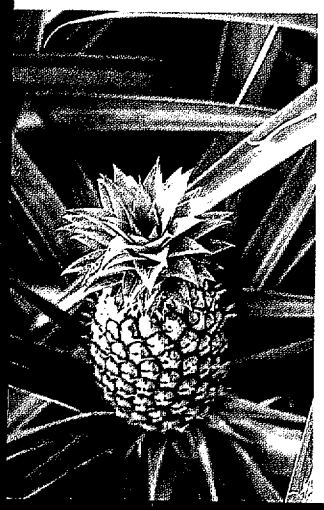
Two examples illustrate the spin-off effects that such exchanges can have. In 1996, Silvia Salazar, an attorney from Costa Rica, visited MSU under sponsorship from ABSP. During her internship she became interested in sharing the knowledge she acquired with the countries in Central America. With support from USAID, she organized a two-day intellectual property rights (IPR) seminar for the countries of the Central America Region to create greater awareness and educate the scientists and policy makers in various issues of IPR as they relate to technology transfer and biodiversity. More than 125 participants from various Latin American countries attended the seminar, held in San Jose, Costa Rica, February 12-13, 1998.

Sponsored by a fellowship from the Brazil Ministry of Science, Claudia Chamas undertook an internship at MSU in 1997. Chamas is a chemical engineer working in the Division of Technology Management of the Oswaldo Cruz Foundation, an agency of the Brazil Ministry of Health that conducts biotechnology research, education, production, and quality control. Her interest was in learning how intellectual properties are managed in the U.S. so that she can help refine the technology transfer procedures and intellectual property rights policy at the foundation. Her fellowship also allowed her to continue for three months as an intern in MSU's Office of Intellectual Property.

DEVELOPING INNOVATIVE PARTNERSHIPS

BIOTECHNOLOGY WOULD BE AN ACADEMIC EXERCISE WITHOUT A MEANS OF IMPLEMENTING OR APPLYING IT FOR THE BENEFIT OF THE WORLD AT LARGE. TO DATE, THE COMMERCIALIZATION OF BIOTECHNOLOGICAL PRODUCTS HAS BEEN THE PURVIEW OF PRIVATE-SECTOR COMPANIES, PRIMARILY IN THE UNITED STATES. PRIVATE BIOTECHNOLOGY RESEARCH OFTEN IGNORES COMMODITIES IMPORTANT TO DEVELOPING COUNTRIES, AND THE CULTURE OF PRIVATE INDUSTRY IS NOT ALWAYS A GOOD FIT WITH PUBLIC SECTOR CONCERNS.





Developing Innovative Partnerships

From its inception, the Agricultural Biotechnology for Sustainable Productivity (ABSP) project incorporated the private sector as an integral component to have access to the most current proprietary technologies and to encourage the private sector approach to research and development and product delivery. In essence, ABSP took an integrated approach by establishing linkages between developing country public and private sectors and the U.S. private sector as well as between these three sectors and the U.S. public sector, which has a long and distinguished history of technology and human capacity development.

In the United States, Pioneer Hi-Bred, Monsanto, DNA Plant Technology, and Garst Seed Company have been the principal private collaborators with ABSP, some by means of formal contractual arrangements and some informally. Elsewhere, Agribiotecnología de Costa Rica (ACR) in Costa Rica and Fitotek Unggul in Indonesia became major private-sector players.

In the seven years of the project, ABSP has built significant expertise in developing public/private sector partnerships aimed at moving products into the marketplace. Besides providing seed money and negotiating research and licensing agreements for biotechnological products, ABSP's role in such relationships is twofold: to keep USAID informed about how its projects are meeting USAID's objectives and to develop contacts and relationships that give host countries the information and knowledge they need to move forward. In particular, host countries need to know which private companies are suited to their needs and how best to articulate the benefits that they can bring to a partnership in terms that interest those private companies. The varying success of these partnerships illustrates important lessons "in how public research has been conducted historically," says Bruce Bedford, ABSP associate director, "and what changes in perspective and relationship are required on both sides for public sector institutions to function in business partnerships with the private sector."

Private vs. Public: An Uneasy Meeting Ground

In biotechnology, the private sector has access to technology, has invested considerable sums in the research and development of the technology, and has the necessary ancillary expertise to bring a product to the marketplace. The competitive edge of a private company is dependent upon the proprietary nature of its research and development and the protection offered by intellectual property laws. In the United States, the private sector spends far more than the federal government in agricultural biotechnology, and its expertise in regulatory, managerial, and legal affairs is extremely sophisticated. Industry is fast-moving, entrepreneurial, free of internal management constraints, and committed to a goal.

Public institutions generally function through layers of bureaucracy designed to provide accountability and perpetuate human capacity in addressing an issue of public concern. Their processes are often a response to government agencies, which design and implement funding programs as well as regulatory affairs. Regulations can be cumbersome, flexibility is not often seen as a benefit, and funding can be uncertain or slow in coming. Alleviating a human problem and training others to do so rather than selling a product may be a principal goal.

A private company might engage in development of a product in conjunction with a developing country because it addresses a technical problem critical to its own product development; it presents an opportunity to enhance its public relations; it provides a window to an important market, technology, or germplasm of interest; or it allows access to influential people within the government of a country of interest. As Judy Chambers, former ABSP project officer now with the Monsanto Company, puts it, "We recognize that technology provides an opportunity to address a whole range of problems and that some of the most difficult are in tropical agriculture. The capacity of technology to make a difference is greater in developing countries than in industrialized countries. In an industrialized country you turn to biotechnology because it is precision agriculture, it's more environmentally friendly, and it has the ability to create niche products. In developing countries we are interested in applying biotechnology because it provides an opportunity to deal with significant yield problems."

Developing country institutions may be interested in working with private companies to gain access to important technology, develop managerial and business expertise, build intellectual capacity, or form a partnership with an entity that has an existing capability of bringing a product to market.

Types of Linkages

Over the course of the project, ABSP has facilitated four types of innovative contractual relationships: private companies with private companies, private companies with public institutions, product-oriented public-to-public relationships, and informal linkages. Michigan State University has been the lead academic institution. Developing country public institutions are the Central Research Institute for Food Crops (CRIFC) in Indonesia; the Agricultural Genetic Engineering Research Institute (AGERI) in Egypt, and the Kenyan Agricultural Research Institute (KARI) in Kenya. Collaborations have focused primarily on the application of plant biotechnology to production constraints in banana, cucurbits, maize, pineapple, potato, sweet potato, and tomato.

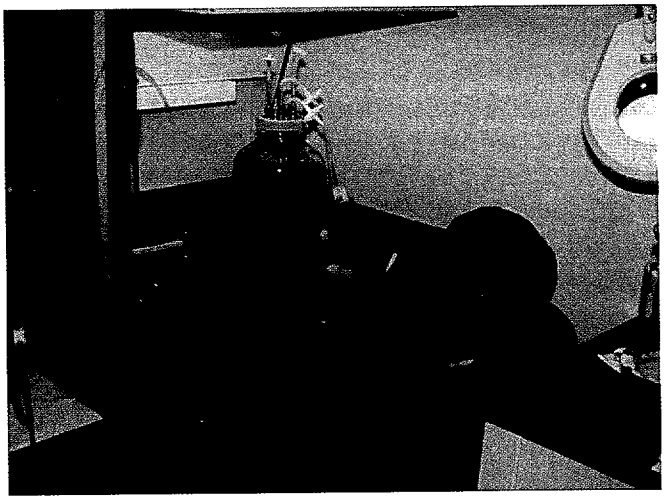
Transcending Bureaucratic Constraints

A Private-To-Private Linkage: DNAP and ACR

ABSP's initial private sector collaborator was DNA Plant Technology, or DNAP, a plant biotechnology company in Oakland, California, which came to the project with a host country partner in place—ACR in Costa Rica, a micropropagation company with laboratory and farm facilities in Costa Rica and an export business in tropical crops and ornamentals. Initially, relatively few other companies bid on ABSP's project proposal, largely because of the bureaucratic regulations imposed by USAID. (Later, DNAP also had an agreement with Fitotek Unggul in Indonesia—see page 35.)

The agreement between ACR and DNAP was initiated in 1992 with the general goal of implementing more efficient methods of micropropagation of banana, pineapple, coffee, and ornamental palm for high-quality commercial planting stock. ACR was to provide the

germplasm of all the target crops. DNAP was to develop the micropropagation technologies, transfer to ACR the processes and material for field trials, and commercialize the final product. The agreement stipulated that technical training be provided for ACR staff. ABSP provided seed money to support the project.

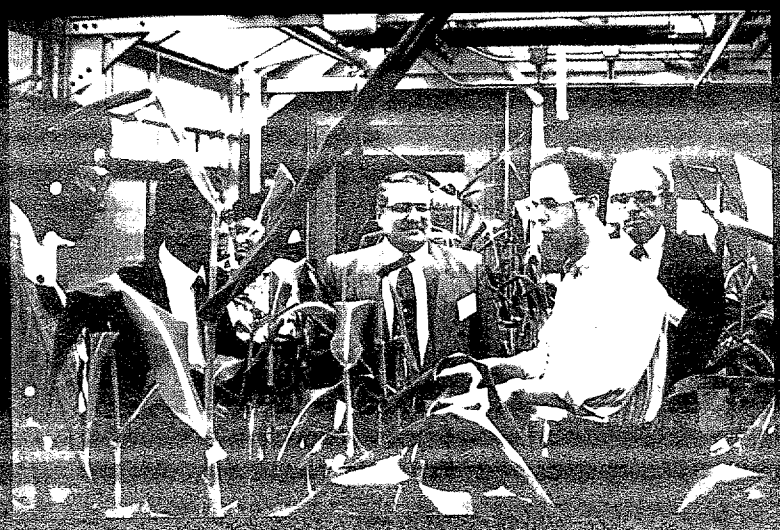


Although the project was disrupted by significant ownership, location, and personnel changes at DNAP and a decrease in ABSP funding of the project midstream, the private-to-private linkage had a number of positive outcomes. ACR now has a practical pineapple micropropagation system and is following some promising lines in banana regeneration. Oscar Arias, president of ACR, says that "the collaboration with the ABSP project has improved our efficiency in producing banana and pineapple planting materials. We are very successful." ACR scientists, through the training component of the agreements, have become important participants in their countries' biosafety and plant protection policy efforts. Professional liaison and mutual respect established among scientists at DNAP, ACR, and Fitotek are likely to result in future cooperative efforts.

Although ABSP's mid-project funding decrease, due in part to changes in the United States political climate, was typical of the vagaries that afflict public institutions as reliable business partners, the project worked well because DNAP and ACR had a common private sector culture that included a level of trust and a similar understanding of contract law and confidentiality. The final project assessment report points out that the venture was also successful because it supported co-learning rather than one-way technology transfer. Staff at ACR report that the work they have carried out with ABSP's involvement has enhanced the reputation of their company.

A Private-To-Public Linkage: Pioneer Hi-Bred and AGERI

In private-to-public linkages, contractual regulations imposed by a contractor such as Michigan State University (MSU) are less easily accommodated. In the six years of its history, ABSP has learned a lot about adjusting to the private sector's wariness of bureaucratic regulation—for example, the trepidation of private industry about federal auditing requirements. In 1997, Pioneer Hi-Bred became



FACILITATING EXCHANGE THROUGH ABSP PARTNERSHIPS: THE INDUSTRIAL SEMINAR SERIES

In April 1993 ABSP sponsored an Industrial Seminar Series to provide opportunities for senior scientists, administrators, and government officials from ABSP partner countries to see biotechnology as an industry and experience the complex relationships among the research, management, finance, regulatory, and marketing functions in this new high-tech industry. Here participants inspect transgenic maize at Garst Seed Co. L to r: Florence Wambugu of Kenya, Ibrahim Manwan of Indonesia, Magdy Madkour of Egypt, Garst scientist Jim Register, and George Wilson of Jamaica.

the most recent private sector participant to join the ABSP project. Pioneer was awarded a subagreement from MSU to work with AGERI in Egypt to transform maize with resistance to stem borers. The subgreement includes the training of Egyptian scientists and the development of Egyptian lines of maize that are resistant to stem borers. AGERI will support in-country capacity development from funds outside the ABSP project.

The relationship between AGERI, an Egyptian public sector institution, and Pioneer, a U.S. private company, was forged through a personal relationship that involved common business interests. It is the first time Pioneer has been involved in a project in a host country. In setting up the agreement, ABSP brought assurances of confidentiality that encouraged Pioneer. John Dodds, then director of ABSP, insisted that intellectual property protection would have to be in place before research was begun. Magdy Madkour, head of AGERI, also announced to his entire work group that respect for intellectual property was imperative to the project. Without such assurances, Pioneer would not likely have become a collaborator.

At first daunted by the extent of the federal regulations governing the project, Pioneer has nonetheless gone forward with the research agreement. It established an innovative bookkeeping system to overcome one of the major concerns— federal auditing of project finance—by assigning special accounting codes that identify purchases associated uniquely with the project. Thus, both government requirements and Pioneer's need for fiscal confidentiality were satisfied. Pioneer has been pleased with the ability of ABSP to provide them with a "comfort level" about federal regulations, and ABSP learned the importance of informing partners about such regulations at the very inception of such a project.

The importance of co-development of technology as opposed to technology transfer is especially pertinent in the case of Pioneer's relationship with AGERI. In this collaboration, a public-sector institution was able to bring a significant contribution to the table: AGERI had isolated a number of strains of *Bacillus thuringiensis* that had pesticidal activity of interest to a private sector company. AGERI also has a state-of-the-art biosafety facility and a cadre of trained scientists. Finally, AGERI could provide access to

the local Egyptian market and the broader Middle East market, both of which are sufficiently developed to be attractive. In turn, Pioneer came to the table with technology as well as with marketing, regulatory, and legal expertise of value to AGERI. Finally, ABSP offered funding that would defray some of Pioneer's costs in training AGERI scientists, and without which Pioneer might not have entered such a collaboration.

The collaboration between AGERI and Pioneer, which came late in the project's history, supports ABSP's experience that co-development of technology provides important incentives on all sides to move a project forward. The host country must see itself as more than a technology recipient, and the private sector partner must be willing to accept this concept. Success is more likely achieved when all parties feel ownership in the project.

Different Visions and Goals

Links between private sector companies and developing country research institutes or universities must accommodate cultural differences—both national and organizational. Basic goals and objectives are likely to be perceived as very different. The private sector company is usually looking to develop and sell a product. The institution may be looking to alleviate food insecurity, obtain needed training and equipment, or address some other concern. Furthermore, protocol, tradition, and personal ways of interacting in business settings vary greatly from country to country.

ABSP has learned the importance of negotiation and facilitation skills in accommodating such differences. Its experience suggests that private-to-private sector collaboration is less complicated because partners generally share similar business goals and business can be conducted under trade secret and contract law. Issues of confidentiality and ownership are less complicated. However, private-to-public collaborations are critically important because, in developing countries, most of the technical personnel and extension are within the public sector. These institutions must be encouraged to learn how to work with and encourage the development of the private sector.

The relationship between DNAP and ACR, as has been shown, was a successful private-to-private collaboration. The companies came to ABSP as a team. They had common goals: to develop high-quality plants for a reasonable price and, through the partnership, to defray risk. They had already built a degree of trust and had agreed on confidentiality in advance. This lesson was especially important in forging the private-to-public collaboration between Pioneer and AGERI.

Intellectual Property Rights—A Major Factor for Success

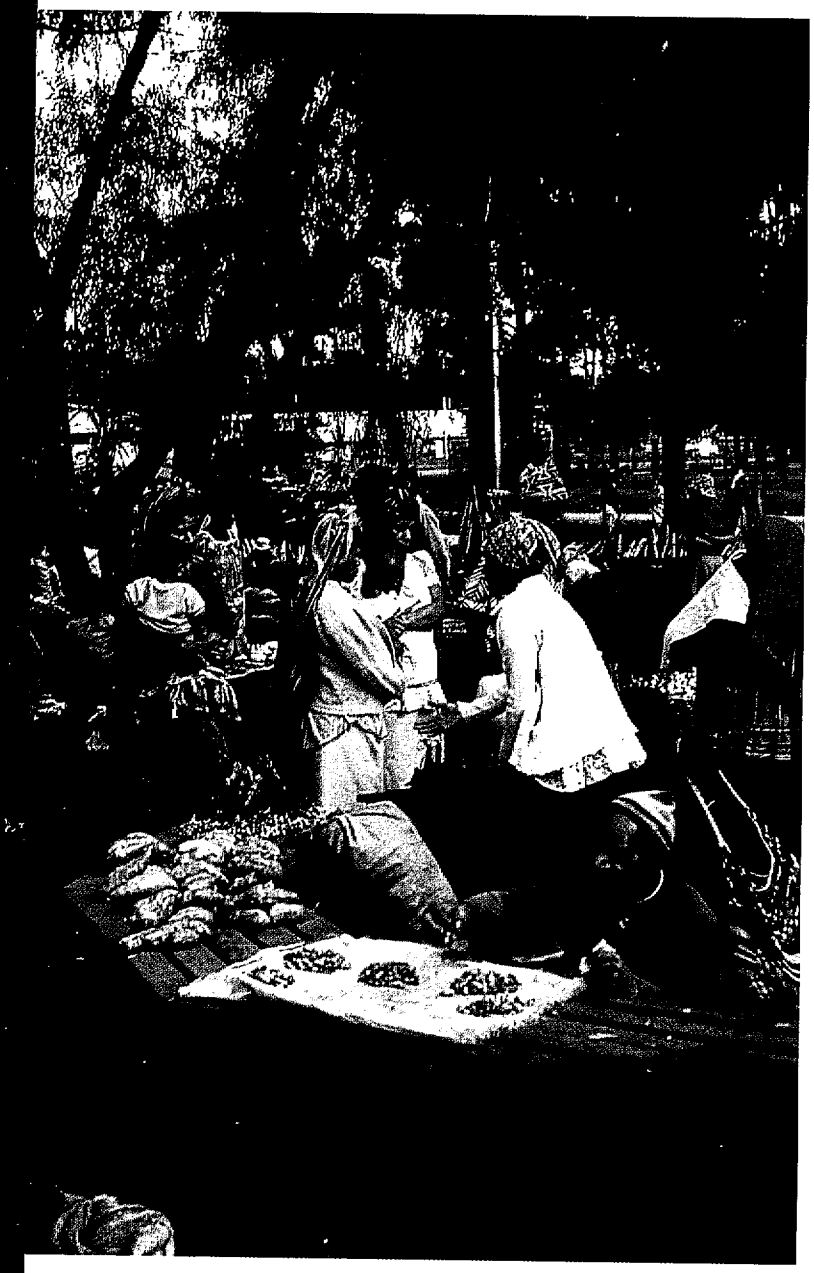
In agricultural biotechnology, intellectual property rights are a critically important issue. Who owns the initial inputs in a project, who will own new inventions, and how potential benefits will accrue are all important questions to be addressed up front. ABSP now requires the negotiation of research agreements before funds are subcontracted for a collaborative project that clearly details these items. This process, while time consuming initially, paves the way for smooth implementation of research results into viable products. In the case of the two collaborations already discussed, issues of intellectual property were handled in advance. In the case of another private-to-public collaboration developed early in the project, the omission of this important step has resulted in a so-far unresolvable dilemma.

A Public-To-Private Linkage: Garst Seeds and CRIFC

In 1993, through ABSP, ICI Seeds—now Garst Seed Company—began an applied research project with the Central Research Institute for Food Crops, or CRIFC, in Indonesia to transform maize for resistance to Asian stem borer, an important tropical pest. The initial contract covered training of Indonesian scientists at Garst and technology development. After the scientists returned to Indonesia, a separate agreement between MSU and CRIFC was initiated to support development of in-country capacity.

At that time, when intellectual property and biotechnologically produced products were still in their infancy, CRIFC's experience had been with freely traded products. Indonesia did not and still does not have in place patent or plant variety protection laws that protect hybrid seed and transgenic plants. The maize line in question belonged to Garst. None of these issues were brought to the table when the initial collaboration was undertaken—that is, when the playing field was most level. Partners were reluctant to

make commitments until the results of the research were known. The training component of the project proceeded with great success, but when the scientists returned home, no mechanism existed for them to transfer to their own country the genes and varieties with which they had worked at Garst. The material is still being held in trust until the policy and legal environment in Indonesia can support the protection required by Garst.



An Informal Linkage: Monsanto, KARI, and ABSP

In an arrangement between Monsanto and the Kenyan Agricultural Research Institute—or KARI—a contract that was limited strictly to research blossomed into a private sector learning experience. Monsanto previously had been awarded a grant from the USAID Office of Agriculture to assist KARI in producing genetically engineered sweet potato for resistance to Feathery Mottle Virus, a virus that can act synergistically with others to decrease yields of sweet potato from 20% to 80%.

Because ABSP had identified Kenya as its focus country for Africa and had also focused on sweet potato as an important crop for both Kenya and Indonesia, it teamed up informally with Monsanto to help develop the procedures and assist in the transfer of materials for testing in Kenya. ABSP supplied Monsanto with information about technology transfer to developing countries. In the process, ABSP supported a postdoctoral researcher at Monsanto and short-term visits of Kenyan and Indonesian scientists to Monsanto. It also funded a biosafety consultant to assist Kenyan scientists in developing a proposal for review by the Kenyan Biosafety Committee and USAID's Biosafety Committee and supported a direct subagreement with KARI to assist in in-country capacity development and technology transfer. At the end of the initial grant, Monsanto continued to support the project from its own resources and from funds provided by several other organizations. Although no formal agreement exists, Monsanto continues to keep the ABSP project informed about progress. A possibility exists for a more formal link with Monsanto to address other constraints to sweet potato production in the developing world. The result would be a truly innovative partnership. In short, this informal private-to-public sector arrangement may progress in a manner advantageous to all parties involved.

Judy Chambers of Monsanto comments that "with changes in trade policy and liberalization of seed markets around the world and with stronger intellectual property regimes, this kind of a project is very attractive. Monsanto, for example, would now consider it essential to be involved in developing countries. It's still a risky business environment in some countries; having the federal government leverage that risk is an incentive to private companies."

Marriage of Method and Market: A Partnership in Indonesia

The canned and concentrate pineapple industries rely on a continuous supply of pineapple fruits as their main raw material. Only a few years ago, the world's import of canned pineapple was increasing at the rate of 27% in a four-year period. Conventional production of pineapple, although less costly than other means, could not keep pace with demand. Tissue culture offered a cost-effective method to provide disease-free seedlings year around.

Fitotek Unggul, a propagation company in Jakarta, Indonesia, began in 1987 as a tissue culture research and development group for a forest and timber products company. Fitotek's initial work in reforestation evolved into propagation of higher-value crops such as vanilla and tobacco under the guidance of its management team of five women. "An interesting quality of this all woman team," according to Managing Director Elda Adiningrat, "is their camaraderie, their feeling of ownership in the business, and their attention to such concerns as the company childcare policy." When ABSP offered Fitotek the opportunity to become a project collaborator, the team was ready to accept the challenge of identifying a market for pineapple clones and developing programs to meet customer demand at a profit.

DNA Plant Technology Corporation—DNAP—in Oakland, California, had developed a bioreactor micropropagation method that appeared to be Fitotek's answer for further growth in anticipation of a demand for more than 15 million plants per year. Maro Sondahl, formerly the tropical crops research director for DNAP, saw advantages in a collaboration with Fitotek: "DNAP has extensive experience in tissue culture/regeneration in a large number of plant species, including major tropical plantation crops. Fitotek...[has] been in the business of plant propagation for several years and can contribute expertise in commercial micropropagation and sales networking for the target crops. The companies will cooperate to maximize the benefits of advanced micropropagation methods and to actively market the products of these ventures."

In its first uses of the bioreactor for mass propagation, Fitotek was able to use 32 initial shoots to produce 3,400 harvestable plants with greater consistency of size and color. The bioreactor system appears to be feasible for commercial production with the potential of producing pineapple plants 40% more cheaply than previous methods. With these encouraging results, Fitotek added several bioreactor units with the capacity of producing 12 million plantlets a year. Recently, however, the demand for pineapple has declined, while demand for ginger has been rising. Fitotek has been able to adapt its micropropagation techniques to produce ginger—an example of applying knowledge and technology developed through ABSP to a new and important crop.

LESSONS FOR SUSTAINABILITY

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THE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID), SPONSOR OF THE AGRICULTURAL BIOTECHNOLOGY FOR SUSTAINABLE PRODUCTIVITY (ABSP) PROJECT, HAS A RESPONSIBILITY TO SHOW THAT THE PROGRAMS IT SUPPORTS HAVE REAL IMPACT. MATERIALS MUST BE TESTED, MUST BE EFFICACIOUS, AND MUST BE MOVED INTO THE DISTRIBUTION STREAM BY THE MOST APPROPRIATE MEANS. OR, AS ABSP PROJECT DIRECTOR CATHERINE IVES PUTS IT, "WE NEED TO SEE OUR PRODUCTS PICKED UP BY THE PRIVATE SECTOR OR DISTRIBUTED BY THE PUBLIC SECTOR, PUT INTO THE HANDS OF FARMERS...AND CONSUMED."

Lessons Learned

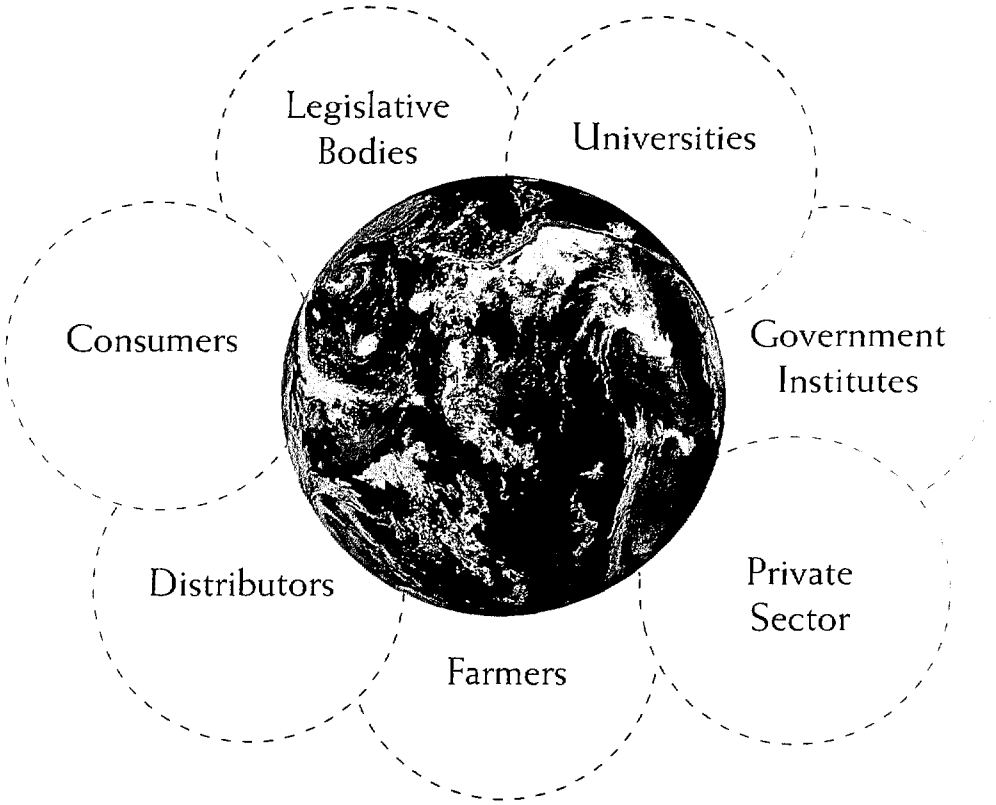
ABSP has learned many lessons in creating an international web to support the transfer of agricultural biotechnology into useable products. Over the course of its seven-year history, the project focus has evolved from developing the technologies themselves to building the human capacity necessary to support an environment conducive to adopting those technologies. "As far as I know," says Ives, "the integration of policy and research under one umbrella is not being done anywhere else in the U.S. government, at least in the related areas of agriculture, biotechnology, biosafety, and intellectual property rights. We are filling a very important niche."

Many of the lessons learned were distilled from ABSP's varied experiences in host countries. Although the learning process was transferable from country to country within the project, *how* lessons were applied varied greatly by country and political climate. The project built its knowledge base by integrating common issues with the individuality of cultures. Relationships were built along nontraditional lines that connected people who needed to communicate but heretofore had not. The resulting body of knowledge and experience has left ABSP with an understanding of a number of broad conditions that must be met if such international collaborations are to be successful.

These include:

- *Government Influence and Responsibility.* When there is a strong mandate from host government officials, work moves along at a quicker pace. This is especially true in the policy area, where progress can be limited if the host government does not encourage its development and use. Examples include Indonesia's drafting of their plant variety protection (PVP) law: Bambang Kesowo, the Vice Cabinet Secretary, clearly articulated what he needed, established a deadline for completion of a draft PVP law, and conferred upon the group gathered at a planning workshop the collective responsibility for getting it done.
- *Character of Culture.* Although lessons learned may be widely transferable, how those lessons are implemented varies greatly on the basis of the unique culture of each country. Indonesia and Egypt, for example, have very different cultures and personality types. The implementation process must be sensitive to these differences and accommodate the uniqueness of each country.
- *Right Mix of Technical Expertise.* Tapping many sources of technical expertise across disciplinary boundaries and pulling these experts together in team settings have been critical to the success of ABSP projects. In the case of training Indonesian scientists at Garst Seed Company, for example, a molecular biologist and an entomologist—who might not have had the capacity or inclination to

PARTNERS IN AGRICULTURAL BIOTECHNOLOGY



make the necessary connections to move a product into the field—were brought together with a plant breeder, whose job it is to carry the technology forward. Similar collaborations must be encouraged to move policy and commercialization to fruition.

• *Breaking Down Institutional Barriers.* While ABSP has been successful in bringing different groups of people to work together, it has not always been easy. Relationships among different disciplines, in developing countries as well as across different U.S. academic institutions, must be actively encouraged through co-learning opportunities—for example, by bringing both scientists and intellectual property experts together in a course setting so they can exchange ideas and gain a deeper understanding of each other's goals. When research progresses faster than policy and implementation of results is thus retarded, scientists often come to appreciate the role that policy plays in biotechnology development programs. This is the case in instances where implementation of the technology came to a standstill because approved biosafety policy was not in place.

• *Early Identification of Policy in Material Transfer.* The Egyptian project was the first in which ABSP transferred transgenic materials. Because proprietary material was involved, many legal issues in the areas of intellectual property and biosafety requirements emerged. The ways in which ABSP handled these issues became an important framework for similar technology transfer issues in other projects. Ultimately, these policy issues came to the forefront in all project planning and now guide project development rather than arise after products have been produced.

• *Timing.* Policy changes such as those required to ensure intellectual property rights and biosafety come about slowly. Overall policy is set at the national level; regulations or guidelines must then be developed and implemented at the ministerial level. Institutions need to take the lead from ministries and develop their own policies and implementation procedures to meet overall

national policies. Lack of control over the timing of these critical factors can be frustrating. ABSP has found it effective, however, to provide educational opportunities for people who will be responsible for implementing new policies so that they can "hit the ground running" when the policy changes are finally made.

• *Dimensions of Capacity Building.* Host country collaborators must have a clear vision of why they want to access and use biotechnology and how it will fit into and enhance their overall agricultural research strategy. A clear overall national strategy for agricultural research should include how the research results are going to be implemented and by whom. Whereas screening for technical expertise is relatively easy, screening for effective implementers is not. Given fiscal constraints, host countries must also decide whether they want to train a number of people broadly or a few people in depth.

• *Foresight.* Agricultural biotechnology projects are highly complex, comprising distinct upstream (technology development) and downstream (technology transfer and product delivery) components that must flow smoothly together. It is critical to such projects that goals and objectives be well articulated and legally formulated at the beginning and yet remain flexible to inevitable changes and obstacles. Although envisioning developments is not always possible in research, in applied research, such as that conducted by ABSP, outcomes can be fairly well predicted and plans developed. To aid in this process, it is important to bring the implementing and product delivery partners onto the team as early as possible. Private companies are particularly driven by outcomes and can help other partners focus on the downstream portion of the project. Building relationships with particular people is also extremely important to a project's success, but because such projects are usually long term, written goals will help transcend inevitable changes in personnel.

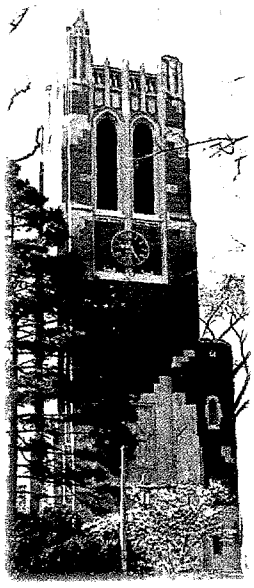
Value Added: Partners' Perspectives

The ABSP project, led by Michigan State University, has developed complex partnerships involving the public and private sector in the United States and in host countries. The benefits of such collaborations to these partners are instructive in considering ABSP as a model for future projects.

Michigan State University: The Lead Institution

Michigan State University has a long and distinguished history of commitment to working in developing countries and takes great pride in its tradition of collaboration with international partners. MSU's Institute of International Agriculture, headquarters for ABSP, has a mandate to participate in efforts in developing countries. The ABSP project allows both the institute and MSU to look at international agricultural development from yet another angle. Through ABSP and similar projects, MSU researchers receive funding for projects of great interest but perhaps not fundable by other U.S. sources because the problems addressed by such projects do not exist in this country. Researchers and the university as a whole form new contacts and collaborations.

MSU President Peter McPherson, Administrator of USAID from 1981 to 1987, is keenly aware of the benefits of ABSP. "Innovative projects like ABSP provide obvious benefits to their host country partners and to the United States. Developing countries derive benefits from education and training, an increase in the capacity to manage and apply technologies, and from research products. Those developments lead to economic growth in those countries and the subsequent opening of lucrative markets for U.S. producers and agribusiness. Collaborating in international agricultural research has resulted in excellent benefit/cost ratios for U.S. investment, especially through increased productivity from improved crop varieties.



"The ABSP project is an important player in applying biotechnology to the development of improved germplasm that can reduce the use of pesticides and increase the yield and marketability of crops. The project has built strong relationships between the private and public sectors in developing countries and the United States. Michigan State University can use the links forged by ABSP to further international connections and develop partnerships."

Private Companies

When a private sector company can readily identify an interest that will provide adequate return on investment in a potential collaboration with the public sector—for example, a particular technology or market—it is more likely to become a partner. Supplemental funding, such as that offered by ABSP, may be a critical motivator for a private company if the collaboration occurs in a country with economic or political uncertainty.

Although private companies have internal requirements such as quarterly reports and forecasting, they are answerable by-and-large to themselves rather than to an outside agency. Private companies certainly consider the reporting requirements of public-sector institutions a burden of such partnerships. However, many private companies now recognize important markets in developing countries and know that they need to find innovative ways of transcending barriers to develop linkages.

For instance, it is not in the purview of most private companies to train developing-country scientists. Private companies expect that visiting scientists chosen to work in their laboratories will be self-sufficient and flexible enough to adapt to the pace of the company. This expectation must be considered by international collaborative projects when choosing scientists to send to a private company.

Developing Countries

A developing country often has many problems to solve, a litany of goals to fulfill, and more than one vision of what are in its best interests. Such countries usually need to build human capacity in both technology and policy areas and address many agricultural constraints. USAID, which has invested in agriculture in the developing world for thirty years, has recently reduced that support in many locations, assuming that its host countries can now take the lead in such enterprises. Of all the partners in a collaboration, the developing country probably has the most to gain. To be effective in a partnership, however, a developing country needs to focus its vision and frame its goals to appeal to the interests of the other collaborators.

New Directions

Of the projects undertaken by ABSP since its formation, the development of transgenic potatoes for resistance to the potato tuber moth in Egypt is the most fully evolved: A biotechnological product has been produced and field tested, intellectual property and biosafety issues have been addressed and procedures implemented, and trained people are in place to sustain the project. Soon transgenic curcurbits will be tested in Egypt using material and technologies actually developed in Egypt.

Other ABSP projects are in various stages on this same continuum in other countries. ABSP's future challenge will be getting products now under development into the commercial stream. Future tasks will include:

- Finding the right channels (if one has not yet been identified) to move products into commercialization
- Framing negotiations with private sector partners
- Advancing important policy areas, e.g., food safety
- Coordinating with appropriate in-country agencies that regulate policy
- Developing multilocation field testing of products
- Assisting in setting up intellectual property core groups in host countries
- Building regional consensus in countries currently not supported by ABSP
- Developing a framework to guide the allocation of resources between capacity development and spreading technology as widely as possible
- Measuring the impact of capacity and linkage building
- Bridging personnel changes in partnerships

Sustainability

Sustainability, an agricultural buzzword as ABSP Director Ives calls it, is key to the title of ABSP and is the ultimate goal of the project. Ives defines it this way: "To be properly called sustainable, a project must produce some component or elements that fundamentally change the way a country, institution, or individuals conduct themselves so that they can continue to operate either by garnering public sector funds, linking with the private sector, or actually moving into the private sector."

The projects supported by ABSP are clearly meeting this test.

ABSP

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