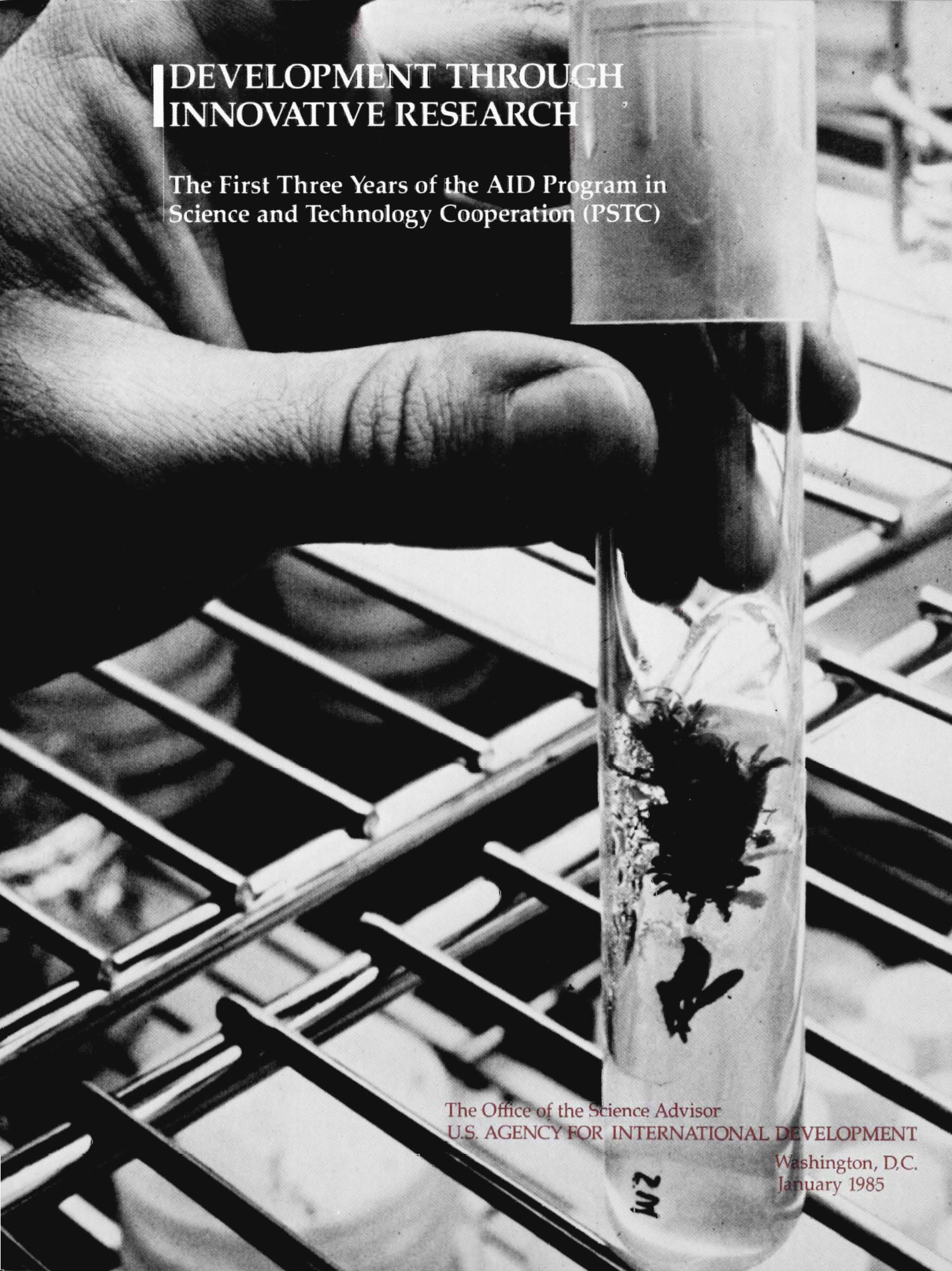

# DEVELOPMENT THROUGH INNOVATIVE RESEARCH

## The First Three Years of the AID Program in Science and Technology Cooperation (PSTC)

The Office of the Science Advisor
U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D.C.
January 1985

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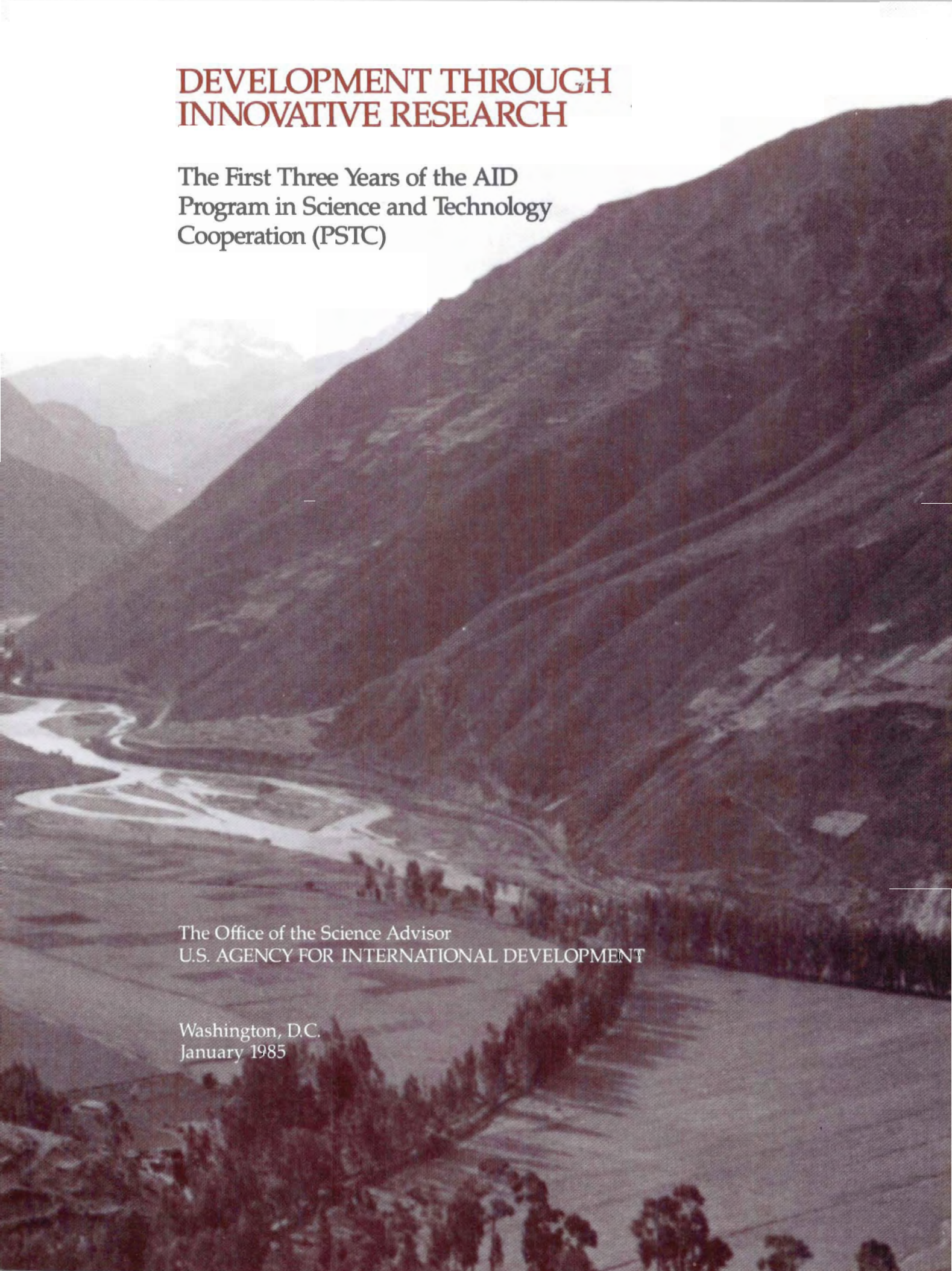

The Office of the Science Advisor
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Washington, D.C.
January 1985

*AID Office of the Science Advisor*
Howard A. Minners, M.D., *Science Advisor*
Irvin M. Asher, Ph.D., *Science Program Director*
John A. Daly, Ph.D., *NAS Program Coordinator*
Miloslav Rechcigl, Jr., Ph.D., *Review Coordinator*

*Cover: Recent advances in biotechnology hold significant promise for solving many current problems of developing countries. Here a small clump of pine tree plantlets, regenerated by individual plant cells in tissue culture, grow in a test tube.*

*Overleaf: El Valle del Calca, near Cusco, Peru, is the site of PSTC-sponsored research to improve grain amaranth. This native American grain has more protein and lysine (an essential amino acid) than rice, wheat or maize.*

*Photo Credits:* All photographs are from the files of AID/XA, AID/SCI, NAS/BOSTID or their grantees unless otherwise noted.

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# INTRODUCTION

AID's overall objective, as mandated by Congress in the Foreign Assistance Act, is to assist countries in achieving self-sustaining economic growth and to improve the well-being of the poor majorities of their populations. I believe that the application of science and technology to development over the last three decades has been perhaps the single most important source of sustained and broadly-based economic and social progress among less developed countries (LDCs). Drawing upon its unparalleled technical resources, the United States has demonstrated a comparative advantage in providing assistance for the application of science and technology to development and for the creation of indigenous scientific institutions that give countries the capacity to solve their own development problems. This assistance has created lasting, mutually beneficial economic and scientific relationships between the U.S. and other countries.

AID's Program in Science and Technology Cooperation (PSTC), administered by the Office of the Science Advisor, is an important part of this process. Mandated by Congress in 1981, PSTC encourages an innovative and collaborative approach to development research and technology transfer. This unique program utilizes recent breakthroughs in frontier sciences to solve development problems resistant to more traditional approaches.

The best way to learn "to do good research" is to do good research. The Program strongly encourages this among LDC research institutions and their American counterparts. The dramatic response from the international scientifc and development communities — over 1700 proposals within the first three calendar years — and the high caliber of the new ideas and approaches submitted suggest that scientists here and abroad are ready, willing, and able to take advantage of this opportunity.

Over two-thirds of the Program's requests now come directly from researchers in developing countries. This is a particularly encouraging sign. Such problem-oriented scientists represent the cutting edge of responsible development in emerging nations. We must continue to help them to help themselves. To do less betrays our mutual aspirations for a better tomorrow.

M. PETER MCPHERSON
*Administrator*
*U.S. Agency for International Development*

# I. THE AID PROGRAM IN SCIENCE AND TECHNOLOGY COOPERATION (PSTC)

DR. HOWARD A. MINNERS
*AID Science Advisor*

By the year 2000 the human population of our planet will exceed 6,000,000,000. Over three-quarters of these people will live in less developed countries (LDCs). Where will they get the food, energy, jobs and health care they need? The rising costs of fuels, rising personal expectations and the continuing trend to urbanization — nearly 1500 cities will have over a million inhabitants — exacerbate these already serious problems.

During the last 20 years, science and technology have made tremendous strides, especially in the biological sciences and electronics. These advances have already had a major impact on meeting basic human needs. In parts of Southeast Asia, the growth of food production already exceeds population growth, thanks to the "Green Revolution." Yet, in the next 40-50 years, world food production must exceed all that achieved from the dawn of agriculture 12,000 years ago until the present. Similar challenges will be faced in energy and health.

The answer lies not in any one country, nor in any one technology or approach. The best minds throughout our interdependent world must be encouraged to tackle these problems. In particular, less developed countries (LDCs) must be assisted in their crucial transition from consumers to producers of technologies appropriate to local conditions and needs. This viewpoint gained wide acceptance in the international scientific community during the 1970s.

## HISTORY OF THE PSTC

At the 1979 UN Conference on Science and Technology for Development (UNCSTD) in Vienna, developing countries placed a high priority on building an institutional capacity to apply modern science and technology to development problems. In response, Congress in 1981 appropriated $12 million to establish an innovative new Program in Science and Technology Cooperation (PSTC) to be administered by the Agency for International Development. This new program was to:

1. assist developing countries to strengthen their own scientific and technological capacity . . . to undertake the research and experimentation necessary for development.

2. support research, in the United States and in developing countries, on critical development problems. . . .

3. foster the exchange of scientists and other technological experts with developing countries. . . .

According to the initial conference report[1]: "The purpose of establishing a separate account for these activities is to encourage the Agency for International Development to take a more innovative and collaborative approach to the problems and processes of development research and technology transfer. The Conferees agree that this distinction between the regular AID research budget and the new, more experimental activities contemplated under this account is a healthy one and should be preserved both institutionally and operationally."

AID created the Office of the Science Advisor to the Administrator (AID/SCI) in late 1980. It serves as the focal point for more innovative and collaborative approaches to development research, technology

*By the year 2000, the human population of our planet will exceed 6,000,000,000. Innovative scientific technology can help provide the food, energy, jobs and health care they will need to live with dignity. PSTC's primary objective is to promote the development of such technology.*

[1] Conference Report 96-787 (27 February 1980) on H.R. 4473, incorporated by reference in H.J.R. 610 and H.J.R. 644 (as amended).

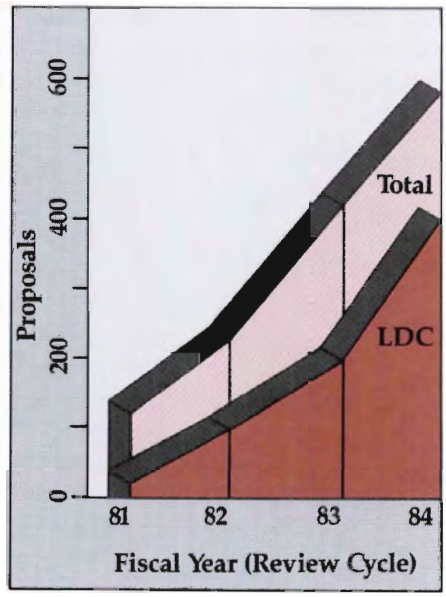
transfer and related capacity building. The Office identifies scientific and technological needs and opportunities in developing countries and maintains an effective liaison with the scientific leadership in both developed countries and LDCs. The first Science Advisor, Dr. Howard A. Miners, took office in early 1981.

PSTC's subsequent success was only possible because of the support it received throughout the Agency. At the highest levels, Administrator M. Peter McPherson and Senior Assistant Administrator for Science and Technology Nyle C. Brady enthusiastically championed this approach to technological innovation, self-help and cooperation. USAID missions abroad stimulated and forwarded several hundred meritorious research proposals each year and provided management support for local grants. The AID Science and Technology Bureau and the geographically-oriented Regional Bureaus provided technical backstopping and management support for other projects. This pan-Agency cooperation remains a hallmark of the program. Indeed, one valuable side benefit of PSTC has been the enhancement of the Agency's science consciousness and involvement.

## PSTC PROGRAMS

AID/SCI took its mandate to involve LDC scientists — to *listen* — quite seriously, and began a world-wide search for new ideas and innovative approaches worthy of support. It met with LDC science attaches, with LDC scientists and institutions, and with U.S. leaders in science and development. It also developed new mechanisms for soliciting, reviewing and managing research.

The AID/SCI Competitive Grants Program invites scientists around the world to submit research proposals directly to AID for careful consideration and rigorous technical peer review. The response from LDC scientists and institutions has been enthusiastic. Over 1700 proposals have been received to date. The number of submissions increased from 120 in the FY 1981 grants cycle[2] to almost 600 in FY 1984, while the number of research projects funded annually has increased from 20 to about 50. The submissions have also improved significantly, both in scientific quality and development relevance. Several AID/SCI grants have already stimulated an increased interest in research at the highest levels of LDC national governments (see Page 6). More then 60 countries now participate in this innovative program (Table 1). AID/SCI Science Program Coordinator, Dr. Irvin Asher, reports on this program in Chapter 2.




*The number of submissions to the AID/SCI Competitive Grants Program — especially those from less developed countries (LDCs) — has risen rapidly. Rigorous review procedures and budget constraints limit the number of new research ideas actually funded.*

PSTC's first funding allocation was a long-term grant to the U.S. National Academy of Sciences, Board on Science and Technology for International Development (NAS/BOSTID). About two-thirds of those funds provide financial and other support to LDC research projects. The NAS identifies well-defined topics through a series of meetings involving both U.S. and LDC experts, and then solicits proposals from specific LDC institutions to carry out various parts of the overall research strategy. The first four NAS/BOSTID research areas were selected (and proposals solicited) in late calendar 1981, and by late 1984, over 60 grants had been made in six areas and seven meetings had been held to coordinate and strengthen grantee research. The remainder of the funds awarded by PSTC to BOSTID are used to convene workshops, organize advisory teams, and issue study reports on selected research opportunities. NAS Grant Coordinator, Dr. John Daly, reports on this program in Chapter 3.

In FY 1981 AID/SCI proposals were sent to the Agency Research Advisory Committee (RAC) for a technical peer review. In FY 1982 AID/SCI pioneered a peer review system in which panels of 7-12 external experts in such specific areas as plant tissue culture, the immunology of tropical diseases, or biomass conversion technology provide a rigorous technical peer review. Subsequently

[2] This report covers PSTC's first three calendar years (May 1981-May 1984). Since the Federal fiscal year (FY) begins in October, this corresponds to four review and funding cycles (FY 1981 to FY 1984). The first grants cycle (FY 1981) was thus only five months long. The program now tries to complete all reviews just prior to the year in which money becomes available; for example, over 430 preliminary submissions were received by February 1984 for review for possible funding in FY 1985.

## TABLE 1. COUNTRIES PARTICPATING IN PSTC

**Grants Funded (FY-81 to FY-84)[1]**

| | AID/SCI COMPETITION | | NAS/BOSTID |
|---|---|---|---|
| *Country* | *Grantee* | *Collaborator* | *Grantee* |
| Argentina | | | 1 |
| Bangladesh | 1 | 1 | |
| Barbados | 1 | | |
| Belize | 1 | | |
| Bolivia | 1 | 1 | |
| Brazil | 2 | 3 | 2 |
| Burma | 5 | 1 | |
| Cameroon | | 2 | |
| China (PRC) | | 2 | |
| Chile | 1 | | 3 |
| Colombia | 1 | | 1 |
| Congo (PRC) | | | 1 |
| Costa Rica | 1 | 1 | |
| Dominican Republic | | 1 | |
| Ecuador | 1 | | 1 |
| Egypt | 1 | 2 | 2 |
| Guatemala | 6 | 1 | 8 |
| Haiti | | | 1 |
| Honduras | 1 | 1 | |
| India | | 5 | 3 |
| Indonesia | 2 | 2 | 1 |
| Israel | 5 | 1 | |
| Jamaica | 1 | | |
| Kenya | 1 | 2 | 6 |
| Lesotho | | 1 | |
| Liberia | | 2 | |
| Malawi | | 1 | 1 |
| Malaysia | | 1 | 3 |
| Mexico | 3 | 5 | 4 |
| Nepal | 6 | 1 | |
| Nigeria | | | 1 |
| Pakistan | 1 | | 1 |
| Panama | 1 | 1 | 2 |
| Papua New Guinea[1] | | | 1 |
| Peru | 9 | 6 | 3 |
| Philippines | 4 | 5 | 3 |
| Portugal | 1 | | |
| Senegal | 2 | 3 | 3 |
| Sierra Leone | 2 | | |
| Somalia | 1 | | |
| Spain | | 1 | |
| Sri Lanka | 8 | 4 | 1 |
| Sudan | | | 1 |
| Swaziland | | 1 | |
| Tanzania | | 1 | |
| Thailand | 9 | 3 | 6 |
| Togo | 1 | | |
| Tunisia | | 1 | |
| USA | 72 | 26 | |
| Uganda | 1 | | 1 |
| Uruguay | | | 1 |
| Venezuela | 1 | | |
| West Indies | 1 | | |
| Zambia | | 1 | |
| Zimbabwe | | 1 | |
| International[2] | 5 | | |
| Total | 159[3] | 75 | 63 |

[1]The first three calendar years of program activity (May 1981-1984) span four Federal funding cycles. The Federal fiscal year begins in September.

[2]International organization (e.g. the Organization of American States).

[3]Includes 12 small assistance grants, most less than $10,000 (see Chapter 4).

Considerably more countries and institutions participate in the competition as contestants. Only about one submission in 10 achieves funding.

other Agency subunits adopted this approach to technical review. The previous RAC has been restructured and now advises on science policy. At the same time, NAS/BOSTID developed a two-stage technical review process, managed by its Committee on Research Grants. AID/SCI Review Coordinator, Dr. Miloslav Rechcigl, Jr. discusses these review procedures in Chapter 4.

The PSTC has awarded over $26 million in research grants to date — about $20 million through the AID/SCI Research Grants Competition and $7 million through the NAS/BOSTID Grants Program. Scientists in more than 80 countries are using these funds to apply recent technological breakthroughs to today's development problems. This publication describes their efforts, while providing a look at the results of this new program's first three years.

*Artemio Gonzales won top prize at the first national Panamanian Science Fair for his project on the use of corocita fruit as a renewable source of oil for rural lighting.*

*Involvement in research helps lead LDC students toward technical careers. Here Panamanian President Ricardo de la Espriella listens to a high school student explain his original research at the AID/SCI-sponsored Science Fair.*

*At the first Equadorian National Science Fair students from Tulcan High School (Carchi, Equador) describe how to produce tannins and alcohol from agricultural waste to Vice President Roldos.*

# SCIENCE FAIRS . . . A RESOURCE FOR TOMORROW

You won't find Santiago de Veraguas in your atlas. It's just too small. Nestled in the northern highlands of Panama's Chiriqui province, its few thousand inhabitants would not be suprised at the omission. Recently Artemio Gonzalez, son of a local farmer, changed all that by becoming the first prize winner in Panama's first national Science Fair. Artemio wanted to develop an indigenous energy source for rural illumination from a local oil-producing plant called corocito. With the help of his high school teacher, Artemio did the necessary original experiments and entered his local Science Fair competition, the first step on the road to national recognition.

Funded by a $50,000 grant from AID/SCI, the Panamanian Science Fair program was organized by the Organization of American States' Office of Science and Technology, with the help of the Science Service, which has long sponsored similar competitions among U.S. high school students. Such projects help build an indigenous science base in developing countries by actively involving students in development-oriented scientific research.

Panama's response to this challenge was enthusiastic. Some 450 local fairs were set up and traveling teams from the Ministry of Education visited even the smallest communities to facilitate their participation. President Richardo de la Espriella declared the final week of the national fair "National Science Week", and personally attended the fair with his entire cabinet. Winners in all six scientific areas received a $3000 scholarship and their schools received $2000 worth of scientific equipment. Another attraction was the presence of U.S. NASA astronaut Dr. Frank Chang, a native of Costa Rica and an effective advocate of technology for development.

Over 50,000 people attended the final competition of a companion fair in Ecuador. Starting two years before, the Ecuadorian National Science Council (CONACYT) prepared a wide variety of manuals in Spanish and taught 1300 high school teachers how to supervise student research. The winning project demonstrated the need for physics training in the primary schools and developed 220 simple experiments using only local materials. Ecuadorian Vice President Roldos attended the fair and discussed the research with students. At a third successful fair, held in Jamaica, first prize was awarded to a study of the effects of fertilizer on fresh water shrimp.

The project helped encourage LDC interest in science education, technical careers and indigenous science base development. Its impact is spreading. The Inter-American Development Bank will provide funding to start a similar fair in Chile for all South American countries. In response to similar requests, AID/SCI and OAS are developing a Regional Science Fair for the Caribbean Basin.

# II. AID/SCI COMPETITIVE GRANTS PROGRAM

## THE PROGRAM

DR. IRVIN M. ASHER
*Science Program Director*

The AID Office of the Science Advisor (AID/SCI) directly manages the highly popular competitive grants component of PSTC. We seek new research ideas in the natural sciences and engineering that can be readily adapted to serious problems facing less-developed countries (LDCs). Much of our current research centers on *biotechnologies* related to food and energy production and to human and animal health.

PSTC primarily supports the initial, particularly innovative phase of an investigation, usually the first two to three years. The grants are thus not renewable, and currently range from a few thousand dollars up to $150,000, a considerable sum for most LDC investigators. The funds may be used for salaries, equipment, travel, training and consultants; but they must be directly related to attaining a specific research goal. The annual budget of the AID/SCI Competitive Grants Program varies between $5-7 million a year. The remaining PSTC funds support a large grant to NAS/BOSTID (Chapter 3).

The AID/SCI Grants Competition has grown rapidly since its inception in May 1981. The first four review cycles show almost exponential growth (Page 4). Late in 1983, specific areas of emphasis (research modules) were announced to moderate this expansion. We also asked USAID missions to forward no more than 20 proposals per country. These measures did decrease the total number of annual submissions to about 430 (from almost 600), while the number of proposals in research module areas continued to increase.

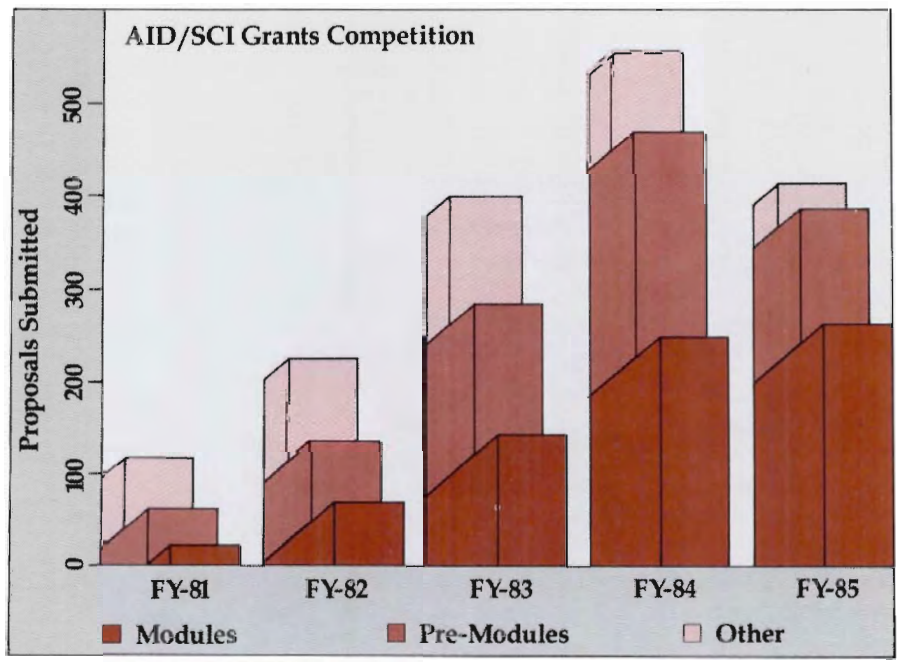
About 40-50 projects are funded each year. All proposals pass through a rigorous two-stage peer review process (Chapter 4). Funding decisions are based on four criteria:

- scientific merit,
- relevance to development,
- innovation
- potential to enhance LDC research capabilities.

Over 1700 submissions have been received to date, approximately two-thirds of them from abroad. The remainder come from U.S. researchers working with LDC collaborators. We particularly encourage submissions from LDCs with USAID missions or representatives. AID/SCI grantees are well distributed by country. Only seven LDCs have more than five projects, out of 159 projects funded to date. Only three — Thailand, Peru, and Nepal — have more than seven projects. This broad geographical distribution seems to confirm that no one country has a monopoly on good new ideas!

Applicants may be affiliated with LDC universities, government laboratories or the private sector. Proposals from the U.S. or in middle income countries must have a strong linkage with LDC institutions or research needs. AID/SCI will occasionally provide limited assistance grants to facilitate such linkages when necessary.

Because of its emphasis on laboratory and field research, the Competitive Grants Program does not usually fund planning and policy studies, international conferences, core support for institutions, travel grants, surveys, baseline data collection, or the preparation of books or courses. It does not continue projects previously funded by — or more appropriate to — other parts of AID, such as the transfer and application of conventional technology. Rather, PSTC represents the Agency's scientific *venture capital* to develop new technologies for subsequent adaptation and application.




*Several thousand scientists participate in the highly popular AID/SCI Competitive Grants Program. Specific priority areas (research modules) were announced in FY 1984 to focus the program and keep the number of submissions manageable. The number of high-priority submissions, however, actually increased in FY 1985.*

Similarly, PSTC does not support projects whose potential benefits are limited to a single country. These are more appropriately part of AID's bilateral programs, which are administered by a worldwide network of USAID missions.

Appendix A provides a complete listing of the AID/SCI grantees selected during our first three calendar years, which correspond to our first four funding cycles (FY 1981 to FY 1984).

*AID/SCI grantees use recombinant DNA techniques to discover new ways of diagnosing tropical diseases at ever-earlier stages of infection. One disease under study is onchocerciasis, or river blindness, a major parasitic disease in West Africa.*

## RESEARCH MODULES

AID/SCI currently emphasizes five areas of investigation (research modules). Their selection was based on an analysis of the numerous pre-proposals received during the first three cycles of open competition, and on several in-depth U.S./LDC meetings on specific new technologies. Since FY 1984, we have allocated about $1 million a year to each area. Growth in the biotechnology modules was particularly robust. Investigators, most from LDCs, submitted over 100 biotechnology-related preproposals in FY 1984 alone! Of these, 25 were eventually selected for funding.

### 1. Biotechnology/Immunology

Recent advances in biotechnology offer developing countries dramatic new hope in combating some of mankind's oldest and most tenacious diseases. The human immune system can recognize foreign proteins (antigens) from invading parasites and microorganisms and produce special defensive proteins (antibodies) that bind to the antigens, effectively neutralizing them. Vaccines stimulate this natural defense by first challenging the body with such antigens in a safe form. In 1975, scientists discovered a way to fuse antibody-producing cells with myeloma cells, which can multiply rapidly in artificial media. The resulting hybridoma cells are a plentiful source of highly-specific *monoclonal antibodies* to diagnose and treat new diseases. Another recent breakthrough links such antibodies to enzymes, whose presence in an antigen-antibody complex can be readily detected. Such ELISA (enzyme-linked immunosorbant assay) tests are exquisitely specific and sensitive.

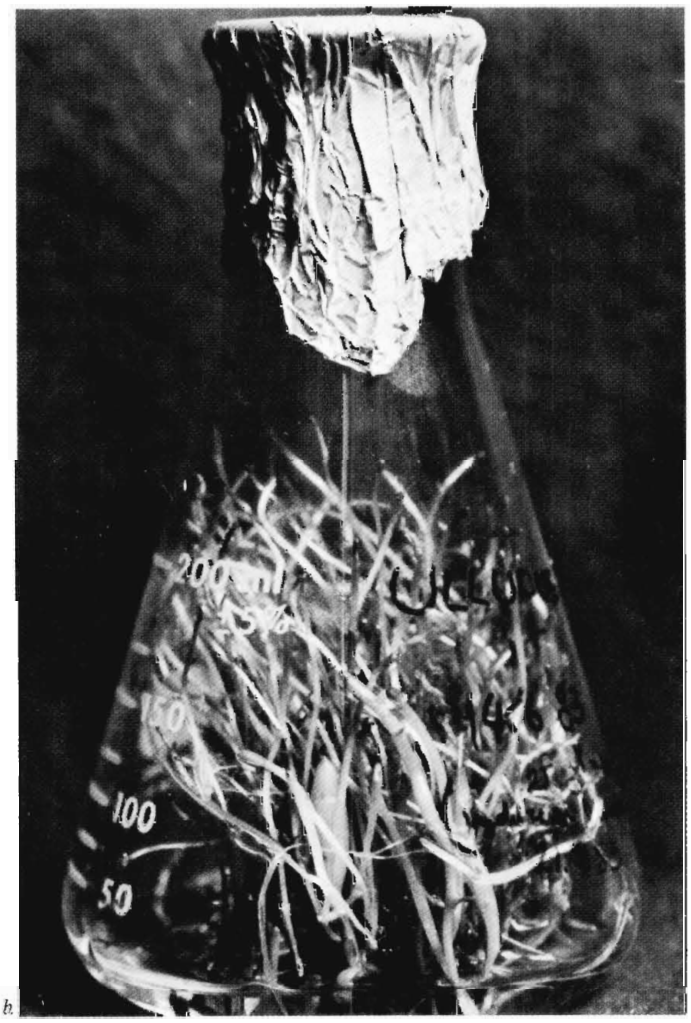
AID/SCI currently funds 22 projects out of the 168 proposals submitted in this exciting area. AID/SCI grantees are developing antigens, monoclonal antibodies and ELISA tests for the parasites that cause such important tropical diseases as sleeping sickness (trypanosomiasis) and river blindness (onchocerciasis). Other investigators are using molecular biological techniques like DNA hybridization to study vector-parasite relationships in schistosomiasis and leishmaniasis (human diseases spread by certain tropical snails and black flies respectively). Dr. Tun Pe of the Burmese Department of Health is using hybridoma techniques to develop an anti-serum to Russell viper snake venom. A major scourge of Burma's rural rice paddys, this dangerous snake bites over 10,000 — and kills over 1000 — Burmese each year!

### 2. Biotechnology/Plants

The need for major breakthroughs in the genetic engineering of plants is acute. In 1977 each acre of arable land produced enough food for one person; by the year 2000, it will have to feed one and a half people. Recent advances in *plant tissue culture* offer unique opportunities for such progress. Single cells can now be grown in artificial culture media to form an undifferentiated mass of plant tissue (callus). Powerful plant hormones, called auxins and cytokinins, can stimulate the formation of plant rootlets and shoots respectively, and regenerate whole plants from the cells of such a culture. More recent techniques can strip the walls from plant cells, and fuse the resulting bare protoplasts to form totally new species (e.g. the "pomato"). Such procedures can be used to develop and rapidly propagate new varieties of plants more tolerant to disease, pests and adverse environments.

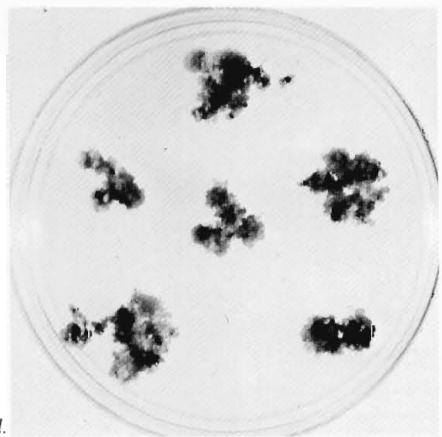
If LDCs are to benefit from such advances, their application to tropical crops — often ignored by developed country scientists — must be a high priority. AID/SCI has already

a.



b.

c.



d.

*Plant tissue culture techniques allow whole plants to be grown (cloned) from single cells. AID/SCI grantees are using these techniques to improve tropical crops of current or potential importance. Shown here are: (a) plaintain, (b) olluco, (c) winged bean and (d) sorghum.*

awarded 15 grants in this module area (out of 89 submissions). Grantees in Costa Rica, Indonesia, Guatemala, Israel, Philippines, Colombia, Sri Lanka, Peru and the United States are all carrying out LDC-oriented plant tissue culture research.

For example, Dr. Ludwig Muller of CATIE in Costa Rica and Dr. A. Krikorian in the U.S. are exploring ways in which tissue culture can help Latin American farmers overcome black sigatoka disease. This destructive fungus is decimating the plantain trees of Central America, a major food source for local subsistence farmers. Dr. S. Karunaratne of Sri

Lanka is trying to improve the coconut palms of Southeast Asia by developing tissue culture techniques for preserving and exchanging superior germplasm. Her ultimate aim is to clone palms with superior crop uniformity, disease resistance and tolerance for extreme environmental stress. Using other new techniques, Dr. H. Hibino of IRRI in the Philippines is trying to develop monoclonal antibodies (see previous module description) to trace the spread of rice viruses in the tropics.

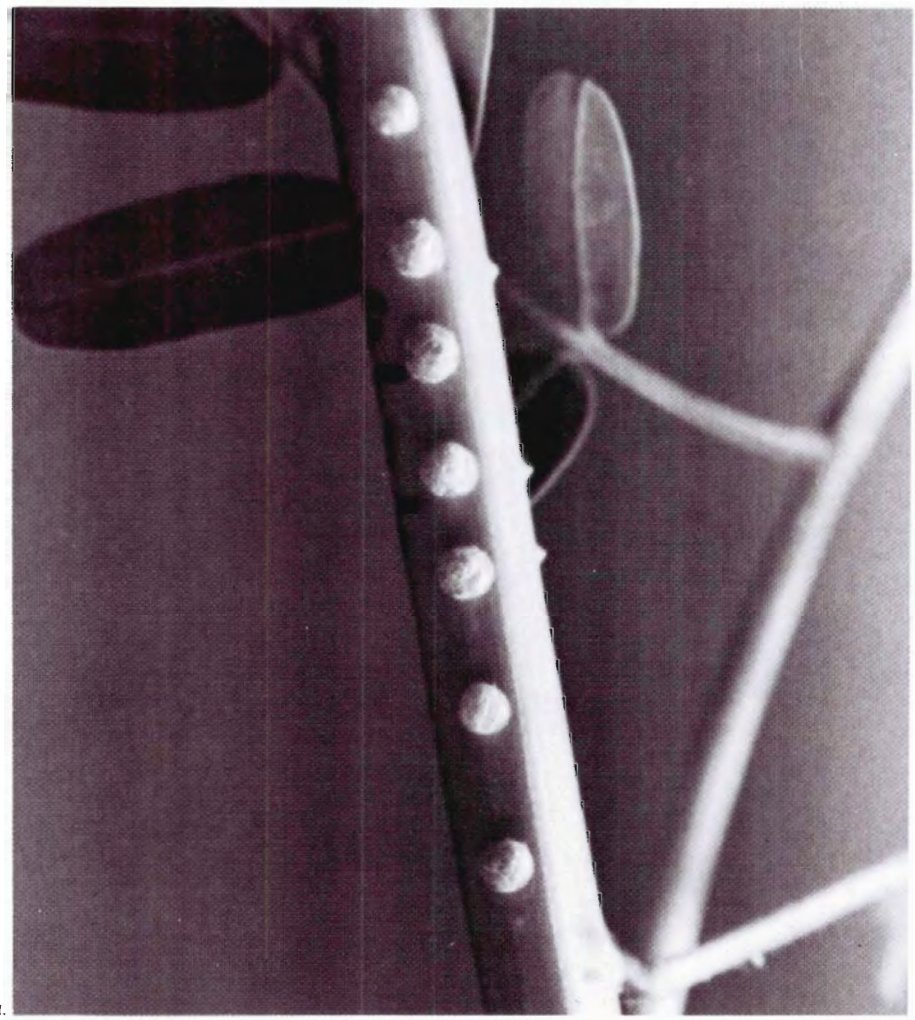
### 3. Chemistry for World Food Needs

Chemical fertilizers and pesticides have had a beneficial impact on modern food production, but the difficulties of acquiring and using them safely in LDCs necessitate an exploration of alternatives. This was underlined at CHEMRAWN II, a major international conference on chemistry and world food supplies, held in the Philippines in December, 1982. AID/SCI coordinated U.S. public and private support for the conference and funded a multinational follow-up workshop conducted by the National Academy of Sciences (NAS) to recommend specific research priorities for further development.

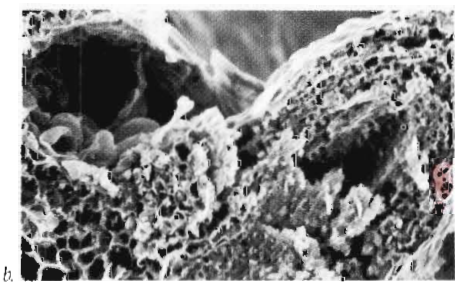
AID/SCI supports 18 projects in this area, selected from the 206 proposals submitted. Several grantees are studying how certain microscopic fungi (mycorrhizae) and bacteria (rhizobia) can form mutually beneficial partnerships with specific plants. These symbionts convert inorganic phosphorus and nitrogen into organic forms useful to plants. For example, Senegalese and U.S. scientists are studying the unique *stem* nodules of *Sesbania rostrata.* Rhizobia in these nodules differ from those in the more common root nodules of the same plant — in particular, their nitrogen-fixation ability is not inhibited by organic nitogen (fertilizer) in the soil. Other investigators are probing the chemical properties of acid-sulfate soils, common throughout the tropics. Still others are using chemistry to develop new foods.

### 4. Biomass Resources and Conversion Technology

Lignocellulose is the most abundant renewable, natural resource on earth. It comprises about 95% of all terrestrial biomass. About 100-150 billion tons are produced yearly. It is particularly plentiful in tropical



a.



b.

*Senegalese scientists recently discovered that the* stem *nodules of a local plant, (a)* Sesbania rostrata, *contain rhizobia bacteria which can convert nitrogen in the air into a biologically useful form. This system differs in many useful respects from the more common root nodules of this and other legumes. (b) Scanning electron micrograph of an emerging stem nodule (x100). Rhizobia infection is not necessary for nodule formation.*

# RESTORING THE MEADOWS OF THE SEA

In the shallow waters lining Jamaica bay, swaying seagrasses cast shadows on four divers in scuba gear. Far from being casual tourists, the divers are Dr. Anitra Thorhaug of Florida State University and her collaborators from the University of the West Indies and the National Resources Conservation Department of Jamaica (NRCD). Their mission is to develop new ways of preserving one of the Caribbean's most precious resources — the seagrasses themselves.

With a large, rapidly growing population, Jamaica depends heavily on its traditional coastal fisheries for affordable protein. Seagrasses provide food and shelter for the eggs, larvae and juveniles of most of these species. They are also eaten directly by turtles, sea urchins and several varieties of fish. Other organisms, like scallops and sponges, anchor themselves to the seagrasses. Seagrasses rival mangrove forests in biomass productivity, producing four times more biomass per square foot than free-floating plankton. The massive root system of the dominant Caribbean seagrass *Thalassia testudinum* (turtle grass) — which can burrow through sediments four feet deep — also prevents erosion. In all, UNEP estimates the resource value of seagrass at $86,000 per acre.

When seagrasses disappear — victims of pollution and urban development — so do the fish. Seagrasses are particularly vulnerable because they are benthic plants, living in shallow nearshore waters, firmly attached to the sea bottom. Unlike the free-floating deep water seaweeds, they can not escape nearby effluents or readily repopulate distant areas which have become depleted.

AID/SCI grantee Thorhaug and her collaborators set out to identify methods and seagrass species that could be used to replant and rehabilitate 20 different test sites in Jamaica Harbor. The project stimulated considerable local interest. Soon the front page of the *Jamaica Daily News* headlined the welcome news: Pilot Seagrass Project a Success! "Already crab and shrimp, as well as fish, are returning to these sites," Dr. Thorhaug reported, "Grunt, snapper, conch, all in their young stages, are returning. There is now hope of correcting the mistakes of the past."

Others apparently agree. The NRCD is now planning a five year underwater rehabilitation program, with projected restoration costs eventually as low as $500 an acre. USAID/Jamaica has already provided funds to restore 6-10 acres near Kingston, while providing jobs for 25 unemployed fisherman. The fishermen themselves now have a chance to bring back the seagrass and the fish upon which their livelihood depends.

*AID/SCI grantee Dr. Anitra Thorhaug and her Jamaican collaborators developed successful underwater reforestation techniques for restoring environmentally damaged nearshore areas. Here* Thalasia testudinum *is planted in a test plot.*

*The scientists enlisted the cooperation of local unemployed fishermen in their efforts to bring back Jamaica's seagrasses, marine nurseries vital to coastal fisheries. UNEP estimates the resource value of seagrass at $86,000 an acre.*

LDCs, which often lack other energy resources. However, the same chemical forces that link cellulose and lignin together in strong structural materials like wood impede their subsequent separation and processing into chemicals like ethanol. Lignin is particularly hard to degrade.

AID/SCI has already funded 20 of the 141 preproposals received in this area. Some grantees are exploring novel processes for producing fuels, fodder and more valuable chemicals from biomass. For example, Dr. Carlos Rolz and Sheryl de Caberera at the Instituto Centroamericano de In-

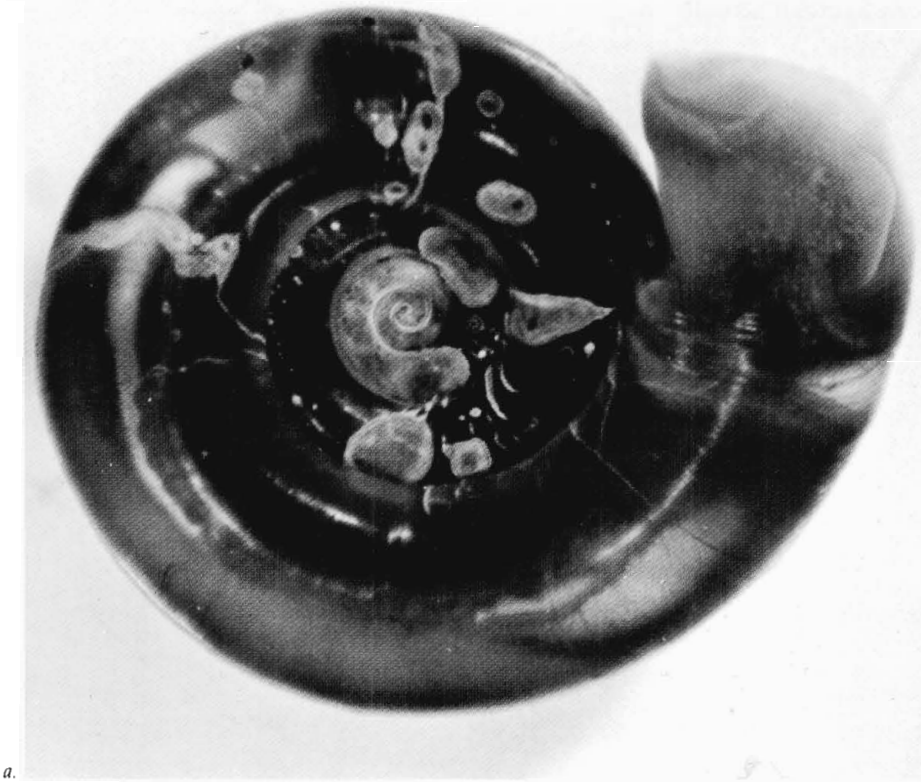
vestigacion y Tecnologia Industrial (ICAITI) in Guatemala are using various pre-treatments and fermentation with a mixture of anaerobic bacteria to convert lignocellulose from tropical wastes into organic acids useful in industrial paint and varnish production. This simple fermentation process requires neither oxygen nor sterility. Other investigators seek to develop underutilized biomass resources, such as prosopis, sesbania, duckweed, jatropha and Caribbean pine.

Dr. Milena Stosezek and colleagues at the University of Idaho are trying to mimic the unique ability of the sewellel, a native American rodent, to degrade lignin. They have achieved 25% degradation in the laboratory using sewellel gut preparations, although the precise bacteria, enzymes and mechanisms involved remain unknown. Dr. Harry Osore at the International Center for Insect Physiology and Ecology in Kenya is conducting a search among the fungi, bacteria and protozoans found in certain African termites for similar lignin-degrading agents. In both cases, success could provide a simple way of converting woody wastes into animal fodder.

### 5. Biological Control of Selected Vectors

Fighting the pests that endanger his health and agriculture, man sometimes forgets these pests have their own diseases, competitors and enemies. Biological control methods can be remarkably efficient, environmentally safe and cost effective. This module originally considered the whole gamut of LDC disease vectors. It currently focuses on just two: the snail vectors of schistosomiasis and insect vectors of plant viruses. AID/SCI has already funded 16 research projects, from among the 113 proposals submitted.

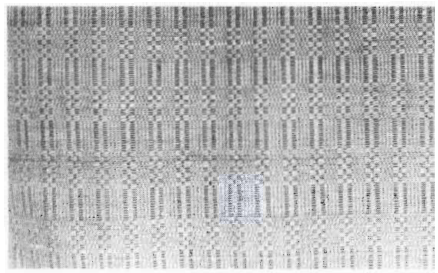
Schistosomiasis (bilharziasis) affects nearly 200 million people worldwide. The parasites develop in certain freshwater snails and emerge weeks later to invade human bathers and workers through their skin. Eggs and eventually adult worms reach the liver and other organs where they cause considerable damage. Finally their eggs are ejected via human feces



a.

b.

*AID/SCI grantees in Thailand are evaluating the ability of harmless fresh water snails like (a) Brotia costula costula (6.8 cm) to out-compete and thus displace more harmful snails like (b) biomphalaria glabrata (1.5 cm), which can carry schistosomiasis parasites between human hosts.*



*From (a) roadside weed to (b) marketable product. PSTC grantees in Thailand have found a way to turn rux, a local milkweed, into high-quality hand-woven cloth.*

or urine back into the water where they seek new snail hosts. LDCs with poor water sanitation are obvious targets and such development projects as irrigation schemes can exacerbate the problem. Dr. Suchart Upatham and his collaborators at Mahidol University in Thailand and David Woodruff at the University of California/San Diego will test the effectiveness of five species of Asian insect larvae and four species of innocuous competing snails in controling eight species of snails that transmit schistosomiasis in Asia. Dr. Frederico Barbosa of the Universidade Federal de Sao Carlos is studying similar competing species in Brazil.

### Pre-modules

In addition to the above research modules, AID/SCI also supports selected, innovative proposals — up to an aggregate total of $1 million a year — in the following three broader areas of secondary priority (pre-modules).

**Engineering:** including structural, mechanical and electrical engineering research, materials science, computer science and micro-electronics.

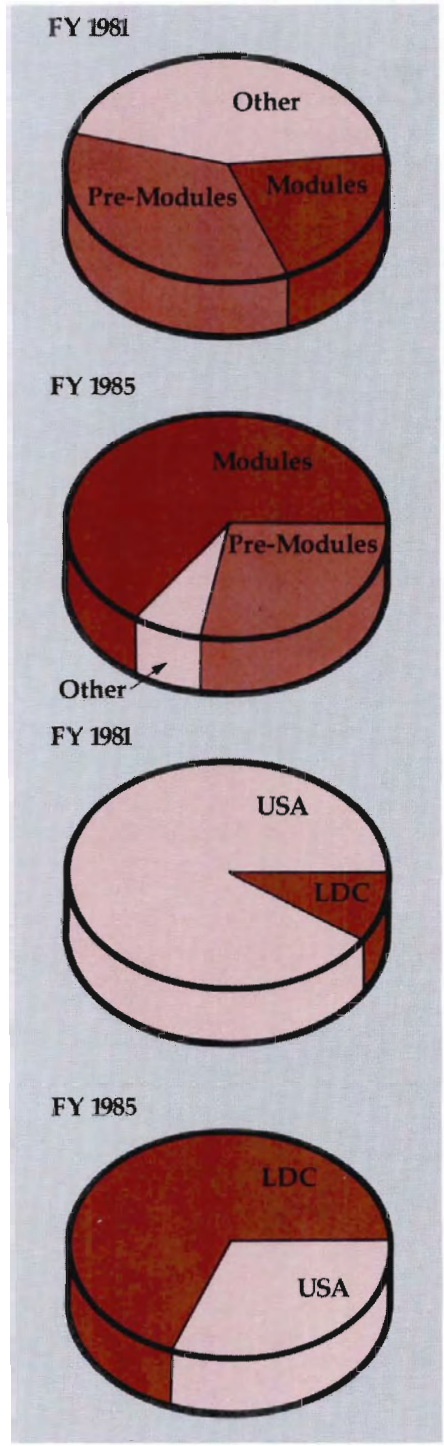
**Earth and Marine Sciences:** including meteorology, hydrology, geology, seismology (especially improved hazard prediction), remote sensing of natural resources, and the development of marine resources and new aquatic species.

**Genetic Resources:** including germplasm collection and preservation, development of underexploited terrestrial animals, plants and microorganisms, and research on habitat maintenance and enhancement.

## EVOLUTION OF THE PROGRAM

The AID/SCI Competitive Grants Program has evolved considerably over the last three years in terms of scientific priorities, increased focus, development impact and LDC participation. For example, in the FY 1981 cycle only 12% of the initial submissions were in research modules. In the FY-85 cycle, over two-thirds were in research modules (Figure 16). Since individual research projects generally last 2-3 years, those funded in the FY 1984 cycle are most typical of our present orientation. This should be kept in mind when reading our cumulative list of grantees (Appendix A) or those boxed "highlights" which report past accomplishments.

The percentage of LDC submissions has also risen sharply, from 15% in FY 1981 to over 65% in FY 1985. This dramatic increase in LDC participation is far from accidental. AID/SCI staff regularly visit USAID missions and LDC scientific institutions to explain and promote the program. AID missions manage all AID/SCI grants abroad and often utilize the research results in subsequent bi-




*A deliberate emphasis on priority areas and LDC participation has dramatically affected the composition of the AID/SCI Competitive Grants Program during its first 3 calendar years (4 Federal funding cycles).*

lateral programs. The number of participating countries has trebled in the first three years. Scientists from over 60 countries have submitted proposals and grants have been awarded in over 30 countries.

The competition's attitude toward capacity strengthening has also evolved. In FY 1981,82 several projects were funded to strengthen LDC technological capabilities by directly transferring U.S. expertise to LDC institutions. For example, biomedical engineers at the National Institues of Health (NIH) helped develop indigenous centers for repairing and maintaining scientific and biomedical equipment in Jamaica and the Eastern Caribbean (inoperative equipment is a major constraint to LDC research). Department of Commerce computer experts explored the feasibility of using microcomputers with special software to alleviate widespread LDC data processing problems. FDA scientists helped Tunisia develop laboratories and methods for surveying levels of pesticide and heavy metal contamination in local foods.

The success of these projects often led to their acceptance and expansion by other, more traditional, institutions. For example, AID's Latin America and Caribbean Bureau (LAC) contributed $300,000 to continue the NIH equipment repair program, and added $90,000 for a similar program in Grenada. The widening impact of the AID/OAS Science Fair project is highlighted in Chapter 1. Despite such successes, the PSTC now emphasizes "learning research through doing research". AID/ SCI capacity strengthening activities — training, travel, equipment and expert consultation — are now an integral part of specific innovative research projects.

***

AID/SCI has been able to administer this sizable program with only two full-time professionals by developing its own microcomputer database and user-friendly computer software. All routine record keeping, office procedures, and correspondence have been automated. Country-specific lists of PSTC proposals are regularly sent to the corresponding USAID missions abroad and to AID desk officers in Washington. This informs them of local scientific capabilities and aspirations, and provides a chance to consider new technologies for other AID needs. In general, the PSTC database, with almost 2000 research ideas (less than 10% of which can be funded by AID/SCI), represents an Agency-wide resource. NAS/BOSTID has a similar automated data-base.

## TABLE 2. DISTRIBUTION BY RESEARCH AREA

**AID/SCI Competitive Grants Program**

| | *FY-84 Funded* | *Total Grants Funded*[1] | *Total Proposals Received*[2] | *Total Funding ($1000)* |
|---|---|---|---|---|
| Biotechnology/Immunology | 14 | 22 | 172 | $ 2,989 |
| Biotechnology/Plants | 11 | 16 | 110 | 2,167 |
| Biomass Resources & Conversion | 8 | 19 | 147 | 2,521 |
| Chemistry for World Food Needs | 5 | 17 | 212 | 1,938 |
| Biological Vector Control | 8 | 13 | 117 | 1,922 |
| Pre-Modules | | | | |
| Earth and Marine Sciences | 2 | 9 | 216 | 1,082 |
| Genetic Resources | 3 | 15 | 165 | 1,964 |
| Engineering and Computers | 3 | 16 | 223 | 2,051 |
| Other Research | 1 | 9 | 251 | 1,338 |
| Capacity Strengthening | 1 | 11 | 141 | 1,912 |
| Total | 56 | 147 | 1754 | $19,885 |

[1] Does not include 12 "Assistance Grants" (most under $10,000). See text.
[2] Includes FY-85 cycle submissions (deadline 1 February 1984).

## FOR FURTHER INFORMATION . . .

Although no official forms are required for submissions to this program, AID/SCI distributes a brief information statement to prospective PSTC participants, which explains how to submit preproposals (see Appendix C). This brochure is updated several times a year and may be obtained without charge from:

AID Office of the Science Advisor
AID/SCI, SA-16, Room 311
Washington, D.C., USA 20523

Telephone: (703)-235-3666
Telex: Western Union 892703
AID/SCI

Overseas investigators can also request copies from their local USAID mission.

Although preproposals can be submitted at any time, the deadline for a given review cycle is the first of February of the preceding year. For example, the deadline for the FY-86 cycle is 1 February 1985. Submissions received in Washington after the deadline will be considered in the next annual cycle. AID/SCI staff limitations preclude having more than one grants competition a year.

# BUILDING BLOCKS FOR THE FUTURE

First the ground began to shake. Then, collapsing buildings provided a percussion accompaniment to the rising clouds of dust. The time: 3:25 PM, 31 May 1970. The place: 152 towns and over 1500 villages in Peru. More than 60,000 people were killed and a half-million were left homeless. Some 80% of the houses in the earthquake area were destroyed. Houses made from traditional materials like adobe were particularly susceptible. Yet elaborately carved adobe walls in the Chimu temple at Chan Chan, Peru are still standing after eight centuries of neglect — mute testimony that it is possible to develop durable earthen buildings in areas of seismic risk.

Using modern technology, AID/SCI grantee Eng. Julio Vargas and his collaborators at the Pontifica Universidad Catolica del Peru have found simple ways to increase the earthquake resistance of adobe constructions by 300%. Strength depends on reducing small micro-cracks that form in the mortar during rapid drying and on improved workmanship. The addition of straw — or even coarse sand — helps considerably. Watering the soil about two days before mixing, and wetting the adobe bricks before mortaring, also significantly increase the strength of adobe masonry walls.

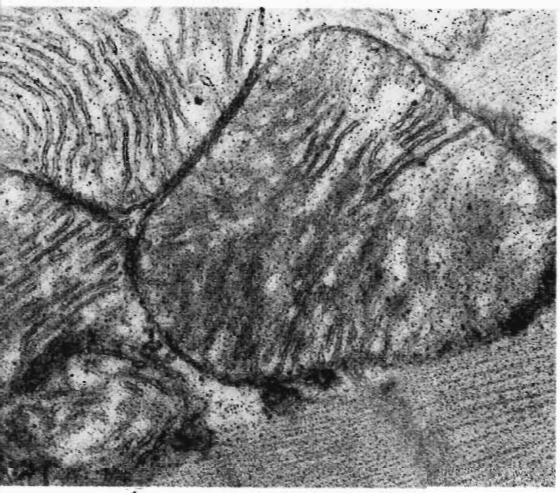
Improving mortar-brick bonding is critical to resisting earthquake-induced shear stress. Dr. Vargas also evaluated a variety of Peruvian soils to develop simple field tests to rate their suitability for adobe masonry. These findings are being disseminated to local builders and further research is now underway with support from AID's Office of U.S. Foreign Disaster Assistance (OFDA).

A joint team of AID/SCI grantees at the Honduran Escuela Nacional de Ciencias Forestales (ESNACIFOR) and the University of Idaho is taking a different approach to indigenous construction materials. Their "perfect" building material would be cheap, millable, nailable, fireproof, termite-proof, rotproof, and water and earthquake-tolerant. Unlike particle and gypsum board, it would be strong enough to bear full structural loads. Yet, it would be lighter and less brittle than concrete. They have developed such structural panels from a careful mixture of Portland cement and wood particles, a plentiful by-product of Honduras' forest industry, where 60-70% of whole harvested trees currently goes to waste.

The researchers found that cement-wood particle adhesion is highly species specific, although even such poor materials as sugarcane bagasse can be improved by boiling to remove the water-soluble chemicals that retard bonding. They found that several common species of Honduran pine give excellent results without any pre-treatment. Already the Honduran government and private industry are expressing interest in the process. This research has also produced a spinoff of importance to the U.S. — America's lodgepole pine has been identified as another promising species.

*Dr. Julio Vargas performed over 250 diagonal compression tests on building walls made from Peruvian adobe in the course of developing simple new construction and soil testing techniques to prevent dangerous "microcracks" from forming.*


*These results are being disseminated in a form readily accessible to LDC builders in earthquake-prone LDCs.*



a.

b.

*PSTC grantees at the Weizmann Institute and the Centro Internacional de la Papa will use (a) mitochondria, self-replicating cell components, to transport useful new DNA into (b) potatoes. Deceptive look-alikes, mitochondria are several 100,000 times smaller than potatoes.*

# GENES FOR DEVELOPMENT

Look under the microscope at a typical plant cell and you will notice that it contains several smaller components. The largest of these is the nucleus, containing the genetic blueprint of the plant in the form of long molecular coils of DNA (deoxyribonucleic acid). The smaller chloroplasts contain bright green packets of chlorophyll to convert sunlight into chemical energy, while the potato-shaped mitochondria concentrate the chemical energy of food molecules into a universal stored form (ATP). Surprisingly these organelles also contain their own distinct DNA, which they pass on to future generations. Many scientists believe that mitochondria and chloroplasts were once separate creatures that formed a lasting partnership with nucleated cells at the dawn of life. Organelle DNA can control such valuable traits as photosynthetic efficiency and resistance to thermal stress, pathogens and pesticides.

Recent advances in recombinant DNA techniques allow scientists to splice useful pieces of foreign DNA into carriers (vectors) and transport them into target cells, where the foreign DNA can be made to function normally. Despite considerable success in animal systems, few effective vectors for plants are known (none for corn, rice and wheat). AID/SCI grantees from the International Potato Center in Peru and the Weizmann Institute in Israel are joining forces to use chloroplasts and mitochondria as vectors to transfer useful traits from one potato species to another. Such cybrids (cytoplasmic hybrids) could represent a breakthrough in obtaining significant new cultivars of important food crops.

A different approach to exploiting genetic resources concentrates on the genetic riches already present in nature. For example, the babassu palm, a native of Brazil and Bolivia, is a highly promising "everything" tree. It bears several hundred half-pound fruits at a time. The powdery outer layer can be made into flour, while the central woody shell makes an excellent, low-ash charcoal for home or industrial use. The kernels provide an edible oil (5% the weight of the fruit), while the remaining seed cake is an excellent, high protein animal feed. Other products include soap, fertilizer, cosmetics, alcohol, acetic acid and tar. The trunk and leaves are used for rural construction and thatch.

"The exploitation of babassu is currently at an impasse," according to AID/SCI grantee Dr. Michael Balick of the New York Botanical Garden. Because the fruits are harvested from wild plants — some 250,000 tons of kernels annually in Brazil alone — there is no control over quality. Together with collaborators at CENARGEN-EMBRAPA, the Brazilian National Center for Genetic Resources, Dr. Balick is trying to domesticate the babassu by selecting and breeding valuable superior strains suitable for plantation agro-forestry. Their collections now include varieties with jumbo fruits weighing more than a pound each, shells that crack easily, early maturity or a high percentage of fruit-bearing female inflorescences. The search for a versatile, tropical "superpalm" is on.

*AID/SCI investigators in the U.S., Brazil and Bolivia are collecting and improving the germplasm of the Babassu palm. The highly versatile half-pound fruit provides starch, edible oil and seedcake for a high-protein animal feed. The hard outer shell makes excellent charcoal.*

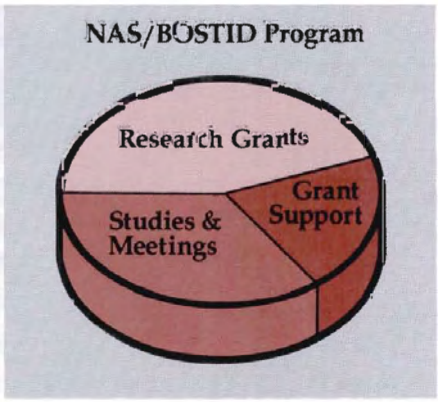
# III. NAS/BOSTID GRANTS PROGRAM

DR. JOHN A. DALY
*NAS Program Coordinator*

The National Academy of Sciences (NAS), together with its sister organizations the National Academy of Engineering and the Institute of Medicine, have several thousand of this country's most distinguished scholars as members. For more than 100 years the Academy complex, through its operating arm, the National Research Council (NRC), has provided advice on scientific and technological issues of public importance. In 1969 the NRC established a Board on Science and Technology for International Development (BOSTID) to help developing countries tap the scientific expertise of their own and U.S. scientists. In the 1970s it organized a number of studies and workshops involving both U.S. and less-developed country (LDC) scientists, and was deeply involved in formulating the U.S. position for the UN Conference on Science and Technology for Development (UNCSTD/79).

During Congressional deliberations on PSTC in 1980, BOSTID suggested that the new initiative was important enough that the NRC should become involved in implementing a significant research program. Based on their prior LDC experiences, BOSTID developed a detailed proposal for applying science and technology to development which it presented to AID. When a PSTC program was established in 1981, the NAS program was its first grant. In 1982, based on consultations with the relevant Congressional committees, the grant program focused substantially on identifying research priorities and funding developing country researchers.

The BOSTID program funds research in six areas (Table 3) that were chosen by a Committee on Research Grants, consisting of distinguished U.S. and LDC scientists. The areas were subsequently approved by an AID-wide Advisory Committee on the NAS. Special workshops are held in each area to determine what research needs to be done and to suggest which LDC institutions should do it. Proposals are solicited from these organizations and reviewed further before funding. BOSTID funds only developing country research projects (AID occasionally funds complementary work by U.S. investigators). This process creates six specific research networks and complements the more open AID/SCI grants competition in both method and intent. Under the terms of the grant, BOSTID also supports and publishes studies and holds international meetings to identify underexploited technologies of potential economic value to developing countries, or to identify topics for further research and development.




*NAS/BOSTID uses its PSTC grant for providing research grants to LDC investigators, for linking these investigators in netwoorks and for meetings, studies and publications relevant to development problems and opportunities. Current plans call for a $36 million grant spread over 8 years.*

1981 was occupied with organizing the BOSTID Grants Program and selecting the initial research topics. The first four topics were chosen by January 1982, and field work began. The final two topics were approved in July 1982 and March 1983. The program had reached 63 approved grants by June 1984 (see Appendix B). An additional 20 approvals are expected by the end of the calendar year. These were selected from some 259 solicited proposals. More than 1200 contacts were made with LDC scientists, which the NAS has developed into a computerized database/mailing list for its six research topics.

## RESEARCH AREAS

### 1. Grain Amaranth

One of the fastest growing of all terrestrial plants, amaranth was a major grain crop of the pre-Colombian Inca and Aztec empires. Although the Spanish discouraged its cultivation in the New World, perhaps because the grain was used in Indian religious rites, it survived as a traditional crop in the highlands of Central and South America. It was also introduced to Africa and Asia as a forage and leafy vegetable. Amaranth holds promise as a major food crop for a number of reasons. It grows quickly, thrives in relatively dry soil, has high protein grain, and has a history of acceptability in several cultures.

Nine grants have been approved to date for this program. For example, Luis Sumar of the University of Cusco is investigating Andean varieties of amaranth, as well as varieties from other collections. He is attempting to breed better varieties for Andean conditions and is experimenting with the traditional use of amaranth. With more experience in amaranth breeding than other participants in the NAS network, Sumar is providing valuable insights to his African and Asian colleagues. Rodale Research Laboratories, the leading U. S. center for amaranth research, is complementing this international effort through a grant from the AID/SCI Competitive Research Grants Program.

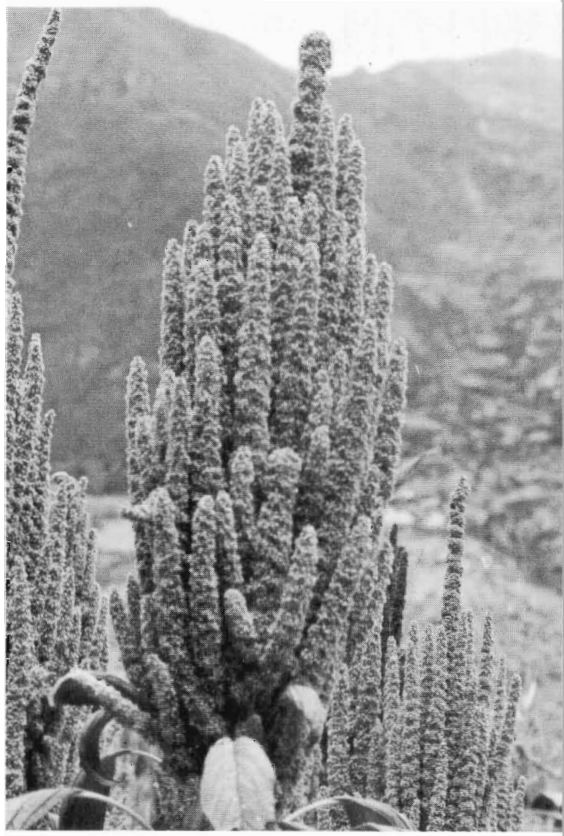
# AMARANTH: MODERN PROSPECTS FOR AN ANCIENT CROP

The massive Spanish colonial palaces and cathedrals of Cusco, in the Peruvian Andes, are built from and on top of the massive stone blocks of their Inca predecessors, a suitable symbol of the amaranth plants that grow there. Once a staple of the Inca Empire, amaranth was displaced by larger-seeded grains such as maize after the Spanish arrived. Yet the foundations for a resurgence of this versatile plant remain, and new generations may well be grateful for its survival in local traditional agriculture.

About the size of large maize plants, amaranths are fast-growing cereal-like plants that produce high-protein grains in large sorghum-like seed heads. Grain amaranth is exceptionally high in lysine, a critical amino acid usually lacking in vegetable proteins. Still grown in the tropical highlands of South America, its native habitat, amaranth has become increasingly popular among Asian hill tribes and in India. Amaranth grain is usually parched and milled and the dough formed into pancakes. It can also be cooked for gruel, popped and made into confections, or powdered and made into a drink. Young plants are often gathered as potherbs.

Many varieties of amaranths are known, differing in color, taste, range and uses. Rodale Organic Gardening and Farming Research Center, one of the first U. S. institutions working to popularize amaranth, maintains a germplasm collection with over 500 varieties, including 192 Nepalese, Indian and West Asian varieties collected by Rodale's own researchers. Amaranths grown for grain are generally pale-seeded. Dark seeds are culled before planting because they often produce vigorous weedy plants, with seeds of inferior flavor and popping capability. Although amaranths grow in a wide range of climates, varieties differ in their day-length responses, and experimentation is required to find varieties best suited to a given site.

The NAS/BOSTID identified grain amaranth as a promising crop in its 1975 publication *Underexploited Tropical Plants with Promising Economic Value.* With PSTC funding, NAS/BOSTID is now able to help meet the outstanding research needs outlined at that time and further elaborated in its new publication on this useful plant. Grantees in Peru, Guatemala and Thailand have been selected to collect germplasm and study the nutritional characteristics of amaranth. Peruvian, Mexican and Thai investigators have been asked to study amaranth agronomy. Kenyan researchers are studying ways to introduce amaranth into dryland farming, while Mexican researchers are probing grain amaranth's industrial potential. An *Amaranth Newsletter,* published in Guatemala with BOSTID funding, links these researchers and other interested scientists.



*BOSTID grantees in Peru are developing new varieties of grain amaranth. This particular high-yielding hybrid was named after NAS staff member Noel Vietmeyer, a pioneer in bringing such underexploited tropical crops to world attention.*

*Investigators in the BOSTID amaranth research network met to exchange preliminary data at the Rodale Research Center in Pennsylvania. Rodale maintains an amaranth germplasm bank with over 500 distinct varieties, supported in part by AID/SCI.*

*Dr. N. Boonkerd in Thailand is trying to induce spore formation in a wide variety of azollas, aquatic ferns which contain nitrogen-fixing algae. This would simplify over-winter storage and transport of this source of natural fertilizer for rice culture.*

## 2. Biological Nitrogen Fixation

Nitrogen is a necessary element for plant growth and protein production. While nitrogen is the most abundant ingredient of the atmosphere, plants derive their nitrogen from more complex nitrogen compounds in the soil. The most expensive component of commercial fertilizers is nitrogen, which replaces that lost from the soil through runoff, volatilization and incorporation in crops. Some microorganisms have the capacity, however, to fix gaseous nitrogen, and make it available to higher plants. Great savings could be realized in developing countries through the effective agricultural utilization of such microorganisms in conjunction with major crops.

Eleven grants have been approved in as many countries to do specific research projects. For example, Johanna Dobereiner of EMBRAPA in Brazil is studying the association of freeliving, nitrogen-fixing bacteria with grasses and cereals. Mamadou Gueye, of the Institute of Agricultural Research in Senegal, is seeking to improve the nitrogen fixation in the bambarra groundnut, a promising legume crop little-known outside of Africa. Re-

*This 18 foot tall leucena tree in Kerala, South India is only about one year old! Several such fast-growing tree species are being studied by BOSTID grantees.*

searchers from this program recently met to compare experiences and review methodologies for carrying out the difficult experimental measurement of nitrogen fixation and uptake. Advisors at the meeting included several U.S. researchers funded by the AID/SCI Competitive Research Grants Program.

### 3. Fast-growing Trees

Deforestation is a major problem in developing countries, leading to environmental damage as well as an acute shortage of firewood. An obvious solution is to identify and develop trees that grow quickly under LDC conditions. Ideally these trees would grow on lands not suited for food crops and produce a variety of useful products including firewood, forage, compost, food and other commodities.

Thirteen grants have been approved in this research area, most of which involve the collection and study of native species and their comparison with exotic varieties. Good cooperation exists between this program and the "Biomass Resources and Conversion Technology" research module of the AID/SCI Competitive Grants Program. Several U.S. investigators serve as resources to the NAS network. For example, AID/SCI grantee Dr. Peter Felker of Texas A & M is conducting trials of native prosopis (mesquite) in Texas and Haiti, while Orlando Balboa, funded by BOSTID, is studying prosopis in Chile.

### 4. Mosquito Vector Field Studies

Mosquitos are developing an increasing resistance to chemical pesticides in much of the Third World. Mosquitos carry such diseases as malaria, yellow fever and dengue fever. Detailed knowledge of the behavior of

## TABLE 3. DISTRIBUTION BY RESEARCH AREA

| NAS/BOSTID Grants Program | *Grants Funded* | *Funding ($1000)* |
|---|---|---|
| Grain Amaranth | 9 | $ 950 |
| Biological Nitrogen Fixation | 12 | 1,277 |
| Fast-Growing Nitrogen-Fixing Trees | 12 | 1,140 |
| Mosquito Vector Field Studies | 14 | 1,557 |
| Rapid Epidemiological Assessment | 8 | 894 |
| Acute Respiratory Diseases | 8 | 1,378 |
| Total | 63 | $7,196 |

## TABLE 4. NAS/BOSTID STUDY PROGRAM

| Title | |
|---|---|
| Underexploited Village Resources of Southeast Asia:[1] | |
| Butterfly Farming in Papua New Guinea | |
| Crocodiles as a Resource for the Tropics | |
| Calliandra: A Versatile Small Tree for the Humid Tropics | |
| Little Known Asian Animals with a Promising Economic Future | |
| Mangium and Other Fast-Growing Acacias for the Humid Tropics | |
| Firewood Crops: Shrub and Tree Species for Energy Production, Vol. II | |
| Casurinas: Nitrogen-Fixing Trees for Adverse Sites | |
| Producer Gas: Another Fuel for Motor Transport | |
| Alcohol Fuel: Options for Developing Countries (2nd edition) | |
| Amaranth: Modern Prospects for an Ancient Crop[1] | |
| Leucaena (Update of previous study)[1] | |
| Marine S&T in Developing Countries | (in process) |
| Jojoba (Update of previous study)[1] | (in process) |
| Revegetating Arid, Semi-Arid and Marginal Lands | (in process) |

[1] Partially funded by other sources.

## TABLE 5. NAS/BOSTID MEETINGS

| Title | |
|---|---|
| Interciencia Symposium on Biomass Substitutes | |
| Food Production Systems and Environmental Rehabilitation in Somalia | |
| Conference on Biological Diversity | |
| ECOWAS Workshop on Energy Strategies for West Africa[1] | |
| Manpower Needs in the Field Aspects of Vector Biology | |
| Training for S&T Personnel in Developing Countries | |
| Opportunities for Control of Dracunculiasis (English and French) | |
| Coastal Zone Management Assistance for Developing Countries | |
| Priorities in Biotechnology Research for International Development | |
| Four Workshops on Micro-Computers for LDCs | (in process) |
| Lignocellulose Conversion Computer Conference | (in process) |
| Energy and Agricultural Production (funded by other AID sources) | |
| Chemistry and World Food Supplies: Research Priorities for Development (funded separately by AID/SCI) | |

[1] Partially funded by other sources.

these disease vectors may help develop alternative approaches to their control. This requires field studies of a kind that were de-emphasized in the past, due to the prevailing reliance on insecticides. In particular, we need new and innovative approaches to the differentiation of species that are genetically and behaviorally distinct, but are morphologically indistinguishable.

The BOSTID program has approved 14 grants in this area. For example, it is funding Dr. Sakol Panyim of Thailand to develop DNA probes to differentiate morphologically indistinguishable species of *Anopheles dirus* and *Anopheles maculatis*, both important vectors of malaria. Researchers in Columbia and Peru are studying geographical differences in related species. Others in Senegal and Sri Lanka are studying the effect of large human resettlement programs on the incidence of mosquito-borne disease. Margaret Dix and her associates at the Guatemalan University of Valle are investigating the anti-mosquito properties of an aquatic plant, *Salvinia auriculata.* Mosquito larvae are not found in nature in close proximity to this plant, although the reasons for this are unknown.

### 5. Rapid Epidemiological Assessment

Severe health problems are very prevalent in LDCs, yet resources are scarce. Health data is widely collected by governments, yet most of it is not analyzed. Health services delivery must thus be particularly well planned, managed and evaluated to meet pressing health needs with low-cost, effective interventions. To accomplish this, adequate epidemiological information must be available in a timely fashion — a condition seldom met. Using advanced technology, new low-cost epidemiological methods can improve the management of LDC health systems. New data collection, statistical procedures and data processing techniques are stressed, and all projects must be related to public health decisions.

The NAS has approved 8 grants to develop such methods. Several projects seek simple indicators to predict which individuals are most at risk of certain diseases. For example, Dr. Osman Galal in Egypt is developing a predictor of fetal malnutrition to determine appropriate prenatal care, a major factor in perinatal and infant mortality. Dr. Claudio Laneta in Peru is applying modern quality assurance methods borrowed from industry to evaluate childhood health status in a poor barrio of Lima. Ernesto Domingo of the Philippine University is developing low cost methods to identify hepatitis B carriers.

The AID/SCI Competitive Grants Program complements this effort through its Biotechnology/Immunology module, by developing a variety of advanced new diagnostics involving DNA probes and monoclonal antibodies. Such breakthroughs could greatly facilitate future epidemiological efforts.

### 6. Acute Respiratory Infection

Lower respiratory infections are a major cause of death in children under five years of age in LDCs, in part because of the poor nutrition of the children and because the incidence of such diseases is high. Although scores of agents cause respiratory diseases, their relative prevalence in developing countries is unknown. Those diseases common in the U.S. and Europe may not be common in the Third World. Nor are the factors determining prevalence well understood. WHO is sponsoring a worldwide effort to improve treatment of respiratory diseases, but without prevalence information serious errors may be made in determining the norms and standards for national programs.

BOSTID has approved eight grants to date to study the etiology of acute respiratory diseases in children. This methodologically difficult research requires the collaboration of multidisciplinary teams, which are rare in developing countries. Grantees and potential grantees have met to review existing laboratory and epidemiological methods, with U.S. and European scientists acting as resource personnel. BOSTID is preparing laboratory manuals and organizing training courses at their request.

In addition to the above research programs, PSTC also funds BOSTID participation in the International Foundation for Science (IFS), a nonprofit consortium of 64 national academies of science and comparable organizations. IFS provides very small grants — up to $10,000 a year for four years — to LDC scientists in the biological sciences. It is extremely efficient in helping younger scientists start productive research careers. In 1983 IFS awarded 96 new grants and 61 renewals, on the basis of 385 applications reviewed by its own scientific advisors. BOSTID represents the U.S. on the Sponsor's Committee of IFS, headquartered in Stockholm. This U.S. support represents 12.7% of the total IFS budget.

## STUDIES AND MEETINGS

About two-thirds of the NAS/BOSTID grant supports the LDC research networks described above. The rest funds a series of expert studies and meetings on scientific problems and opportunities related to development. This portion of the NAS grant builds on a series of some 50 BOSTID publications on science and technology for developing countries. Over

# BIOTECHNOLOGY: POWERFUL IMPACT SEEN

Biotechnology will have the same impact on society over the next few decades as electronics has had in the last few, according to Nobel laureate David Baltimore of MIT. He was one of 60 scientists from 20 countries attending the 1982 Conference on Priorities in Biotechnology Research for International Development, conducted by BOSTID with PSTC support. Conferees predicted that within a decade biotechnology will provide important tools for increased LDC food and energy production and will contribute to the reduction of disease.

AID Administrator M. Peter McPherson and NAS President Frank Press opened the meeting, and emphasized the importance their institutions assign to biotechnology for development. The conferees then held three days of small group discussions. Working far into the night, scientists from Boston and Kuwait City, Puerto Alegre and Taipei, Nairobi and Beijing and 50 other cities, grappled with key questions: What specific development problems can benefit from biotechnology approaches? Which can be attacked by developing country scientists in their own countries within five to ten years?

The monoclonal antibody panel recommended a vigorous program to develop monoclonal antibodies suitable for disease identification and diagnosis in man as well as in animals and plants. In a review of 48 human and animal diseases by the panel on vaccine development, 14 major illnesses were identified for which biotechnology offers potential new or improved vaccines. The plant tissue culture panel classified generation of plant genetic variation and variant selection as a mid-term goal in their area. Plant cell and tissue culture can speed up the selection of plants resistant to specific stresses, such as salt or bacterial toxins.

An energy panel considered processes for the conversion of biomass to fuels, feed and other useful chemicals. One short-term research priority involves the conversion of cellulose from waste materials — such as sugarcane residues and corn and rice husks — to syrups, which then are converted to alcohol and bioprotein. The panel on biological nitrogen fixation identified several areas that would pay off in the near-term in rice and legume cultivation.

The conferees agreed that many LDC scientists and laboratories are already capable of biotechnology research on problems important to their regions. There is, however, an urgent need to increase the number of such scientists and institutions. Copies of the conference proceedings may be obtained directly from NAS/BOSTID.

a.

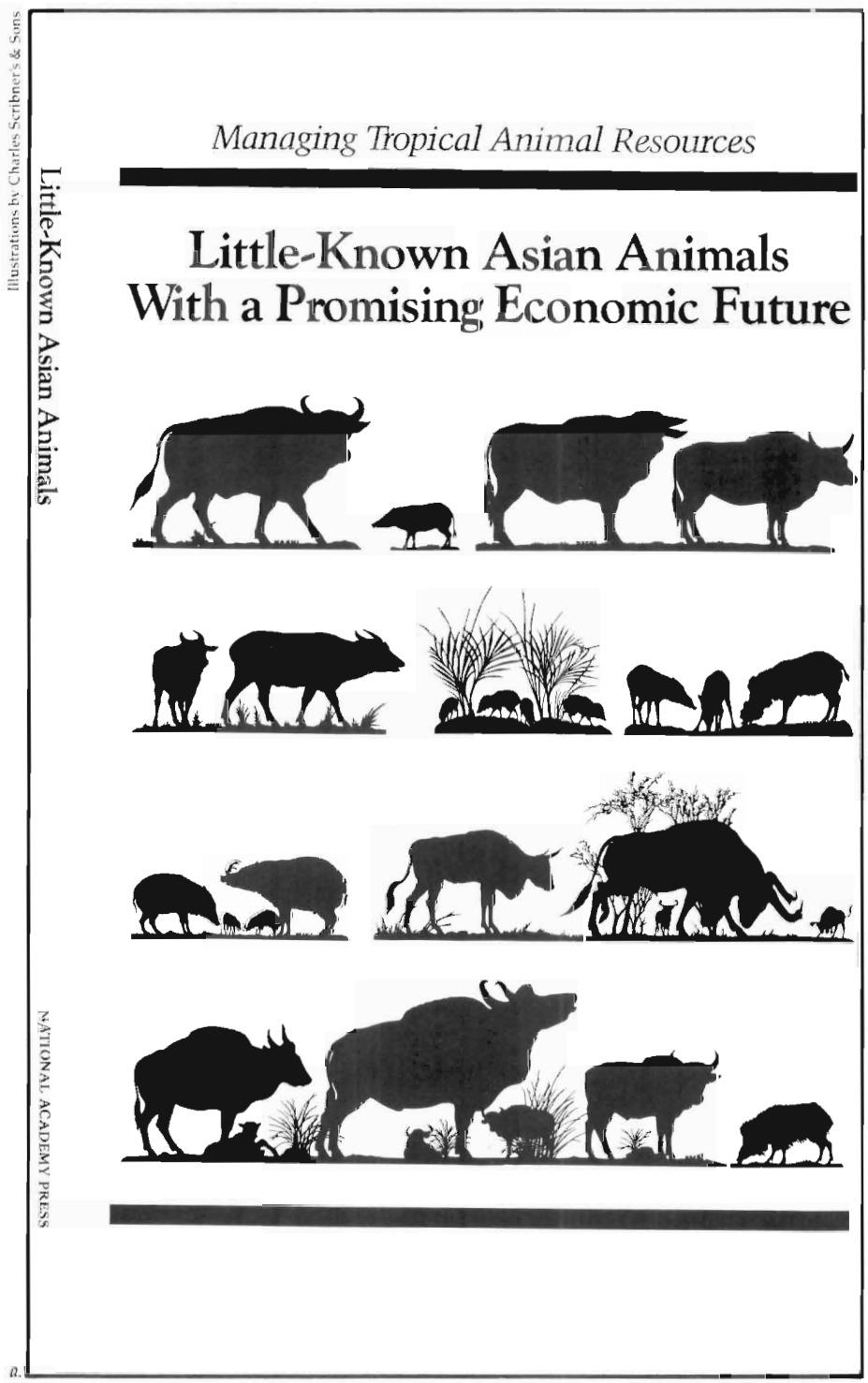
b.

*(a) AID Administrator M. Peter McPherson and (b) Nobel Laureate David Baltimore underscored the potential of biotechnology to solve many LDC problems at BOSTID's meeting on Priorities in Biotechnology Research for International Development. Sixty experts from twenty countries participated.*

600,000 copies of these publications have been distributed; and they have had a large and influential readership. Previous publications in the series — such as those on the winged bean and leucaena — have stimulated international interest and considerable independent research. The new publications in this series, will benefit from the popularity of their predecessors.

Tables 4 and 5 list the BOSTID studies and meetings authorized to date. The studies are principally conducted under the guidance of the NAS Advisory Committee on Technological Innovation, with reviews by both the study panel and an independent NAS review panel. The meetings frequently result in less formal published proceedings that are distributed more rapidly to a more limited audience.

The studies on *Acacia mangium, Calliandra, Casuarina, Leucaena* and *Firewood Crops, Volume II* continue a series of NAS publications on fast-growing tropical tree species, and are relevant to that research area. The amaranth study is similarly linked to its research program. On the other hand, studies on marine science and technology and the revegetation of arid lands provide an overview of relatively unexplored technologies of increasing importance to AID. The meetings program, which initially ex-




a.

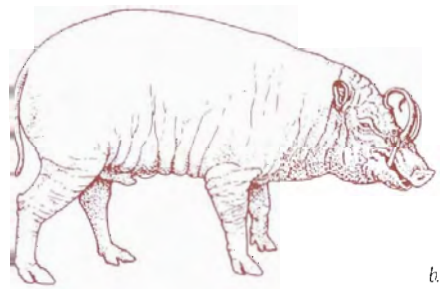
*BOSTID devotes about a third of its PSTC funds to studies, meetings and publications related to scientific opportunities of interest to LDCs. Its monograph (a)* Little-known Asian Animals with a Promising Economic Future *introduced thousands of readers to the (b) the babirusa, a ruminant pig found in Indonesia, and the (c) guar, a muscular bovine threatened with extinction.*

plored the technological needs of individual LDCs, has been reoriented to explore research. For example, the recommendations of the Biotechnology Research Priorities Workshop (July 1982) were instrumental in planning the corresponding AID/SCI Competitive Grants Program research modules. Similarly the series of meetings on microcomputer technology was authorized to meet an increasing need for AID and LDC insight on priorities for research and technology transfer in this rapidly developing field.

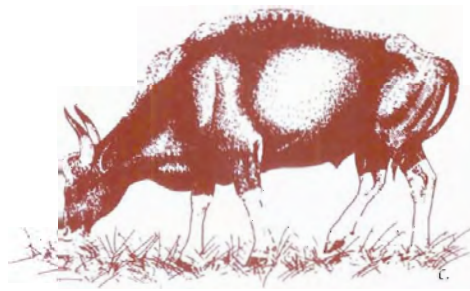
## FURTHER INFORMATION . . .

For further information on the NAS/BOSTID program or associated publications please contact:

Board on Science and Technology for International Development
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418.



b.

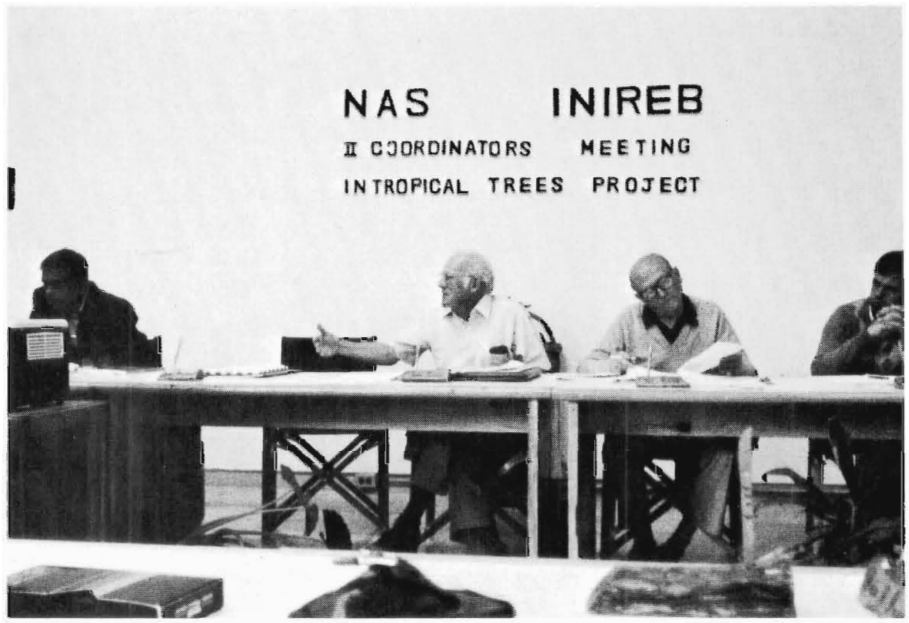


c.

# IV. PROPOSAL REVIEW PROCEDURES

DR. MILOSLAV RECHCIGL, JR.
*Review Coordinator*

The concept of impartial technical peer review is central to all aspects of AID's Program in Science and Technology Cooperation (PSTC). In both the AID/SCI Research Grants Competition and the NAS/BOSTID Grants Program, potential grantees must submit proposals to be reviewed by independent panels of experts in their scientific field. These panels rank proposals by scientific merit and make recommmendations regarding funding.




*Both the AID/SCI and BOSTID components of PSTC rely heavily on external, expert peer review panels to assure high scientific quality in all the projects selected for support.*

## THE AID/SCI COMPETITIVE GRANTS PROGRAM

The AID/SCI Competitive Grants Program welcomes innovative ideas from the widest possible spectrum of scientists. Indeed, one of its goals is to maximize Agency contact and involvement with LDC scientific institutions. Information brochures describing the competition — its goals, priority areas and application procedures — are distributed through AID's overseas network of field missions. AID/SCI also distributes several thousand copies a year in response to direct inquiries and during field visits by AID/SCI staff. The program has proven very popular, and the scientific competition is intense. LDC investigators particularly seem to appreciate our willingness to consider their ideas with an open mind. In turn, we provide impartial, expert feedback to LDC applicants regarding the strengths and weaknesses of their research plans.

More than 1700 pre-proposals were submitted during the competition's first three calendar years. About 400 preproposals are received in each fiscal year, although current resources only permit funding the best 10% of them. We first ask for a brief two page "preproposal" summarizing the project's objectives, work plan and relevance to international development. Only about 100 principal investigators are subsequently asked to prepare full proposals for further AID/SCI review. These semifinalists thus have roughly a 50% chance of final approval and funding.

### Internal Review

After an initial pre-screening by the USAID mission abroad and AID/SCI in Washington, the preproposals are sent to the Agency Sector Councils for internal review. These six internal councils advise the Agency on agriculture, nutrition, population, health, human resources, and energy and natural resources. Members of the councils are chosen from the senior technical officers of the four geographical regional bureaus and from two central bureaus: Program and Policy Coordination and Science and Technology. We also make use of the Agency's engineering council and its microcomputer task force for internal reviews.

These internal reviews are not in-depth technical evaluations. Rather, they seek to determine the relevance of proposed research to development and its potential usefulness to the Agency. Since PSTC seeks new research ideas whose results may not be applicable in the field for 3-10 years, these may not directly coincide with current Agency priorities. Duplication, complementarity and synergy with other Agency-funded projects is also considered. Research that does not attract interest from a relevant technical unit within the Agency is unlikely to be funded. Successful investigators are given the reviewers' comments and asked to submit detailed proposals for subsequent external review.

### External Review

A series of specialized *ad hoc* expert panels provides an external peer review of all full proposals. They evaluate the scientific and technical merit of grant applications. Identifica-

tion of potential reviewers involves consultation with leading scientists in academia, industry and government. Although the composition of the panels varies yearly, depending on the specific scientific areas represented by the proposals, they generally conform to the PSTC research module structure (Table 6).

Each of the 8-10 panel members reviews all the applications assigned to the panel. Primary and secondary reviewers are chosen, on the basis of specific expertise, to provide a written in-depth review of one or more projects and to initiate their discussion at the panel meeting.

Each panel member privately records a numerical rating for each of the competition's four criteria:

- scientific merit
- relevance to development
- innovative character
- ability to improve LDC research capacity

Reviewers scrutinize the scientific strengths and weaknesses of the proposed research and the probability of obtaining significant new findings. Originality is particularly important. Simply providing new data does not make a project innovative. The panel also assesses the competence of the principal investigators (including their academic credentials, training and research experience and publications) and the adequacy and availability of their research facilities and collaborative arrangements. Compliance with NIH recombinant DNA guidelines, AID human subject regulations, and environmental safeguards is also reviewed. If the panel recommends consulting additional specialists, AID/SCI seeks such opinions by mail. The panel also determines if the budget is realistic and reasonable.

Panel approvals are often conditioned by specific technical provisos or caveats. The panel also encourages the resubmission of some proposals — rejected as submitted — that contain worthy ideas.

It is occasionally difficult for LDC investigators, even those with excellent scientific ideas, to express their research plans adequately in the form of a Western-style grant proposal. In order not to lose truly exceptional ideas through a lack of grant writing skills or experience, a panel may recommend awarding a Technical Assistance Grant. These assistance grants provide limited funds, usually less than $10,000, to allow U.S. scientific experts to advise and collaborate with such LDC investigators. The result is a more detailed and competitive proposal for further peer review, and often the beginning of a fruitful long-term U.S.-LDC scientific relationship. These awards are few (only 4-6 a year) and they are given only to investigators submitting full proposals containing novel ideas that deserve further development.

All grants require the concurrence of various other AID units, including relevant overseas USAID missions.

### Project Implementation

To promote integration of SCI projects into the mainstream of AID activities, the Office of the Science Advisor does not normally manage any of its projects. LDC proposals are usually managed by staff in the relevant USAID mission overseas. U.S.-based proposals are managed by staff in the AID Bureau for Science and Technology or the appropriate Regional Bureau within AID/Washington. The AID project manager becomes the main point of contact between the principal investigator and the Agency. If a USAID mission wishes, the Office of the Science Advisor arranges for additional technical backstopping from Washington to assist with questions that may arise.

The AID project officer receives semi-annual progress reports from the investigator and can refer questions of policy to the Office of the Science Advisor. Project officers may schedule site visits to review the research findings and ascertain their potential for utilization; or they may ask AID/SCI to arrange site visits by an expert. The AID project officer is thus in an excellent position to gauge the potential for integrating the results into ongoing AID programs.

## NAS REVIEW PROCESS

As an independent institution, the National Academy of Sciences (NAS) has its own review criteria and procedures. Its reviews are conducted by its own staff and reviewers, and AID/ SCI is not directly involved in the review, selection or implementation of individual BOSTID research grants (although the local USAID mission is querried regarding foreign policy sensitivities).

BOSTID generates a request for proposals for each of its research areas. Through referrals from U.S. scientists, field visits by NAS staff and extensive correspondence, some 1300 LDC scientists have been identified and provided with requests for proposals. To date, 259 have responded with proposals for further review.

Proposals requested from developing country researchers are initially screened by NAS staff and then sent for evaluation to several peer scientists on its roster of specialist reviewers. On the basis of the initial written peer reviews, BOSTID's Committee on Research Grants (CRG), a multidisciplinary group of distinguished U.S. and LDC scientists, selects proposals for further consideration. The next step is a site visit by

a BOSTID staff member or by an expert external consultant. In addition to discussing questions raised by the reviewers, the site visit also permits review of the equipment, financial procedures and general quality of the laboratory. Contacts are also made with the local USAID mission to ascertain their general impression of the institution and the proposed research. In response to these comments, a revised proposal is resubmitted to BOSTID for a second written peer review.

The CRG meets three times per year to consider individual proposals and the overall development of the program. At first, subcommittes of the CRG met to discuss proposals and made recommendations to the full CRG. This year the CRG dealt with each proposal as a committee of the whole. Proposals can be approved, approved with modifications, disapproved, or referred back to the principal investigator with recommendations for resubmission. Proposals with potential ethical considerations are further reviewed by an NAS Committee on Research on Human Subjects, which includes scientists from a number of disciplines in the social and biomedical sciences. The committee may reject a research protocol or require additional procedures to protect human subjects.

The grantees in each technical area meet annually with selected U.S. experts to review progress and to plan cooperative activities for the coming year. In addition, ad hoc expert committees are convened at the request of the CRG to examine the specific research programs. Expert consultants may be contracted to provide written overviews of the work in a program area in preparation for such a meeting. Based on the recommendations of these meetings, the CRG may modify selected aspects of the research program.

**TABLE 6. AID/SCI AD HOC TECHNICAL PEER REVIEW PANELS**

| |
|---|
| Biotechnology/Immunology |
| Biotechnology/Plant Sciences |
| Chemistry for Food Needs |
| Biomass Conversion Technology |
| Biological Vector Control |
| Genetic and Biological Resources |
| Marine and Fishery Sciences |
| Engineering Sciences |
| Computer Science and Communications |
| Earth Sciences and Remote Sensing |

# APPENDIX A. AID/SCI RESEARCH GRANTS (1981-1984)

## BIOTECHNOLOGY/ IMMUNOLOGY

**Papua-New Guinea Institute of Medical Research**
*M. Alpers*
$71,100
Transmission Blocking Immunity and Infectivity of Human Populations to Mosquitoes During Malaria Transmission. *To determine how anti-malarial immunity affects the transmission of malaria.*

**Venezuelan Institute for Scientific Research**
*J. Azocar*
$143,314
Development of Monoclonal Antibodies Against *Trypanosoma Cruzi. To undertake research on Chagas disease using monoclonal antibody techniques.*

**Ohio State University with the Ministry of Agriculture (Dominican Republic)**
*O. Barriga*
$153,551
Control of Ticks and Tick-Transmitted Diseases by Vaccination of the Host. *To develop an anti-tick vaccine that would give cattle partial immunity to tick infestation and thus reduce risk to tick-borne diseases such as babesiosis.*

**Universidad Peruana Cayetano Heredia (Peru)**
*J. Bauer Cuya*
$124,062
Development of *T. Ferrooxidans* Strains Resistant to High Metal Concentration. *To study ways of strengthening this bacterial agent for leaching minerals such as iron and copper from low-grade ores.*

**University of Missouri with the Instituto Nacional de Investigaciones Pecuarias (Mexico)**
*G. Buening*
$172,468
New Approaches to the Control of Bovine Babesiosis. *To test the feasibility of using avirulent clones of babesiosis parasites as vaccines against this disease, which is a major impediment to cattle production in LDCs.*

**University of Missouri**
*C. A. Carson*
$14,000
Development of Modified Live Vaccine Against Bovine Babesiosis. *To isolate and clone babesia parasites and identify those that produce minimal side effects while eliciting protection against challenge infection.*

**Ministry of Public Health (Thailand) with Chiang Mai University**
*U. Chitprarop*
$60,100
Comparison of Two In Vitro Techniques for Culture of *Plasmodium Falciparum. To determine the most effective way to increase supplies of malaria parasites for use in an expanded Thai malaria research and control program.*

**University of Maryland with the International Center for Diarrheal Disease Research (Bangladesh)**
*R. Colwell*
$147,075
Environmental Microbiology Studies in Bangladesh. *To study the distribution, growth and survival of pathogenic bacteria in the aquatic environment.*

**Case Western Reserve University with the Instituto Nacional de Laboratorios de Salud (Bolivia)**
*T. Daniel*
$127,332
ELISA Diagnosis of Tuberculosis in Bolivia. *To determine whether enzyme-linked immunoabsorbent assay (ELISA) techniques can be used under LDC field conditions to quickly identify people with active tuberculosis. Existing skin tests do not recognize the active infection.*

**University of California at San Diego**
*C. Davis*
$169,475
Immunization Against Trypanosomiasis: Potential of a Non-Glycoprotein Surface Component Approach. *To overcome the two major obstacles to an effective trypanomiasis vaccine — antigenic variation and immunosuppression — by finding antigens free of the glycoproteins which give rise to these problems.*

**Hebrew University with the Ain Shams University (Egypt)**
*C. Greenblatt*
$158,000
New Technology in Biochemistry and Molecular Biology for Studying Parasite/Vector Relationships in Leishmaniasis. *To better understand the relationship between the Leishmania parasite and its sandfly vector.*

**Hebrew University with the Ministry of Health (Kenya)**
*J. Hamburger*
$149,703
Detection of Snails Infected with *Schistosoma Mansoni* by the Use of Molecular Probes. *To develop simple, rapid procedures for detection of snails infected with Schistosoma mansoni by the use of recombinant DNA technology.*

This list does not include $10,000 "assistance grants" (see text).

**Uniformed Services University of the Health Sciences**

*K. Holmes*

$151,160

Pathogenesis of Viral Diarrhea, a Toxin Recognition Approach. *To apply new methods which have been used successfully in studying bacterial diarrheas to the study of two important groups of diarrhea viruses: rotaviruses and coronaviruses.*

**Eastern Virginia Medical School with the All India Institute of Medical Sciences**

*A. Johnson*

$143,981

Purification of Mycobacterial Antigens for Potential Use in Serological Diagnosis of Tuberculosis. *To develop an enhanced serological test to screen for human tuberculosis. Such a test would be more rapid and more sensitive than existing skin-testing techniques.*

**Johns Hopkins University with the University of Yaounde (Cameroon)**

*D. Levy*

$150,000

The Production of Antigens of *Onchocerca Volvulus* by Recombinant Microbiology. *To produce with recombinant microbiological techniques large amounts of a panel of antigens of Onchocerca volvulus for application to the diagnosis of onchocerciasis, a major parasitic disease that can cause blindness.*

**Johns Hopkins University with the University of Yaounde (Cameroon)**

*D. Levy*

$156,250

Onchocerciasis in the Cameroons: Development of an ELISA Test for Immunodiagnosis. *To develop a sensitive and specific enzyme-linked immunosorbent assay (ELISA) test for indicating onchocerciasis infection in humans by identifying onchocercal antigens in blood, urine or saliva.*

*Russell's viper, or the* tic polonga, *is an extremely poisonous snake found throughout Southeast Asia. PSTC grantees in Burma plan to use monoclonal antibody (hybridoma) techniques to make an antivenom against the poison, which kills about 1000 Burmese farm workers each year.*

**Universidad Peruana Cayetano Heredia (Peru) with Baylor College**

*H. Lumbreras*

$155,000

Proteolytic Enzymes of *Fasciola Hepatica* as Markers of Human and Animal Infection in Cattle-Raising Areas of Peru. *To develop a diagnostic tool for the early detection and monitoring of the parasitic liver disease fascioliasis.*

**University of Guadalajara with the Universidad Nacional Autonoma de Mexico**

*L. Ortiz-Ortiz*

$100,000

Immunology of Amebiasis. *To develop a reliable diagnostic test for amoebic dysentery.*

**Harvard University with the Ministry of Health (Indonesia)**

*W. Piessens*

$150,000

Speciation of Infective Larvae of Filarial Nematodes and Identification of Species-Specific Antigens of *Brugia Malayi. To improve our understanding of the biology of host-parasite interactions in filariasis.*

**Uniformed Services University of Health Sciences with the Tropical Disease Research Center (Zambia)**

*M. Stek*

$193,885

Specific Circulating Antigens in Malaria and Schistosomiasis. *To develop sensitive and specific assays to identify and quantify malarial and schistosomal circulating antigens.*

**Department of Medical Research (Burma) with Johns Hopkins University and the U.S. Center for Disease Control**

*D. Tin Aye*
$148,634

The Application of Microbial Genetics to the Study of Transmission and Pathogenesis of Infantile Diarrhea in Rangoon. *To evaluate more powerful tools for studying the causative agents and epidemiology of infantile diarrhea in Burma.*

**Department of Medical Research (Burma)**

*Tun Pe*
$150,000

Production of Russell's Viper Antivenom Using Hybridoma Cell Lines. *To use hybridoma technology to produce antibodies against the lethal components of Russell's viper venom, which causes about 1,000 casualties annually in rural Burma.*

## BIOTECHNOLOGY/PLANTS

**Lembang Research Institute for Food Crops (Indonesia)**

*A. Azirin*
$152,640

Tissue Culture for Virus-Free Potato Propagation. *To produce and maintain virus-free potato nuclear stock using tissue culture and rapid multiplication techniques, as a means to produce clean, virus-free seed for distribution to local researchers and farmers.*

**New York Botanical Garden with the Amazon Agricultural Research Network**

*M. Balick*
$151,891

Forest Palms as Tropical Tree Crops. *To improve cultivation potential of lesser known native palm species for use as tropical oilseed, subsistance and feed. Research will include the economically important genera Oenocarpus, Jessenia and Orbignya.*

**University of Hawaii**

*B. Bohlool*
$54,530

Genetic Engineering Approach to Improvement of *Rhizobium* for Tropical Legumes. *To improve the effectiveness of symbiotic nitrogen fixation through genetic manipulation of the bacterial partner, Rhizobium.*

**Centro Internacional de la Papa (Peru) with Louisiana State University and the University of Washington**

*J. Dodds*
$147,172

The Use of *Agrobacterium* RI Plasmid Vectors with Synthetic DNA Fragments to Modify the Nutritive Value of Potatoes. *To improve the quality of potato protein by enhancing the content of its essential amino acids, particularly methionine and lysine.*

**Universidad Nacional Mayor de San Marcos (Peru) with IICA and the Centro Internacional de la Papa**

*R. Estrada-Jimenez*
$149,613

Maintenance and Sanitation of the Andean Tuber Crops by Tissue Culture Methods. *To establish a plant tissue culture germplasm bank of the Andean tuber crops, olluco, oca and mashua (isano) which, together with potato, represent major crops of the Andes region.*

**Weizmann Institute of Science (Israel) and the Centro Internacional de la Papa (Peru)**

*E. Galun*
$182,342

The Utilization of Plant-Protoplast Biotechnologies for Transfer of Organelles Having Useful Traits into Crop Plants. *To develop mitochrondia and chloroplasts as vectors to directly transfer selected characteristics (DNA) from cell to recipient plant cells. In particular, the principal investigator will try to integrate male sterility into potato cultivars.*

**Native Plants, Inc. with the Royal Botanic Gardens (Nepal)**

*S. Garton*
$150,000

Tissue Culture and Microbial Inoculation Technologies for the Improvement of *Alnus Nepalensis* Planting Stock. *To develop means of identifying and rapidly propagating superior varieties of this valuable fuelwood crop (alder) for reforestation programs, and to better understand and improve its symbiosis with nitrogen-fixing Frankia.*

**International Rice Research Institute (Philippines) with the American Type Culture Collection**

*H. Hibino*
$150,000

Application of Monoclonal Antibody to Rice Virus Epidemiology in the Tropics. *To use biotechnology to study three viral diseases of the rice plant — tungro, grassy stunt and ragged stunt.*

**Centro Int. de Agricultura Tropical (Colombia) with the University of Wisconsin and INIA (Mexico)**

*H. Hidalgo*
$36,840

Interspecific Hybridization in *Phaseolus* Species Through Embryo Culture Techniques. *To develop new biotechnology for crossing the common field bean, Phaseolus vulgaris, with other Phaseolus subspecies to allow inter-subspecies genetic transfer of useful traits.*

**Coconut Research Institute (Sri Lanka)**

*S. Karunaratne*
$139,700

Culture of Leaf Explants of Coconut In Vitro. *To develop techniques for preserving superior palm germplasm and for cloning superior palms to overcome major problems associated with crop uniformity, resistance to disease and tolerance of extreme environmental stress.*

**State University of New York at Stony Brook**
*A. Krikorian*
$150,000
Meristem Culture for the Multiplication of Disease-Tolerant Clones of Plantains and Cooking Bananas. *To develop a tissue culture procedure which will produce aseptic plantlets of cooking bananas and plantains resistant to Black Sigatoka, a fungal disease which is currently destroying these crops throughout Latin America.*

**University of Florida**
*E. Lincoln*
$148,637
Recombinant DNA in Filamentous Cyanobacteria. *To construct a reliable genetic transfer system for cyano-bacteria (blue-green algae) capable of aerobic nitrogen fixation. Emphasis is on developing conjugation-mediated transfer techniques.*

**Centro Agronomico Tropical De Investigación Y Ensenanza (Costa Rica)**
*L. Müller*
$175,000
Tissue Culture of Plantain for Improving Yield Potential. *To use plant tissue techniques to improve plantains, an important Latin American subsistance crop, especially with regard to resistance to the Black Sigatoka fungus disease.*

**Chulalongkorn University (Thailand) with Colorado State University**
*K. Suwanagul*
$126,600
New Varieties of Rice for Saline and Acid Soil Throughout Plant Tissue Culture. *To use tissue culture techniques to produce two new high-yield rice varieties, one highly tolerant to saline soil, the other to acid soil.*

**Universidad del Valle de Guatemala**
*J. Tejada*
$156,612
New Purification and Immunological Techniques for Characterizing and Diagnosing Plant Viruses Infecting Beans. *To develop simple, effective methods that can be readily used by LDC institutions to identify and characterize viruses that infect food crops.*

**University of Houston with the International Institute for the Winged Bean (Sri Lanka)**
*S. Venketeswaran*
$95,702
Isolation of Strains, Clones, and Regeneration of Plants from Single Cells of the Winged Bean. *To develop cultures of the winged bean, Psophocarpus tetragnolobur.*

## BIOMASS RESOURCES AND CONVERSION TECHNOLOGY

**University of Hawaii with LDC Collaborators**
*J. Brewbaker*
$150,000
Acquisition, Characterization, and Dissemination of Germplasm of Potentially Useful Nitrogen-Fixing Trees. *To assemble and characterize seed stocks of less-well known nitrogen-fixing tree species with agro-forestry potential, with a network of institutions in Indonesia, Kenya, Thailand, Taiwan, Senegal and Costa Rica.*

**North Carolina State University with Collaborators in Guatemala, Honduras and Mexico**
*W. Dvorak*
$132,570
Range-Wide Exploration, Seed Collections, and Testing of Three Economically Valuable, but Endangered Pine Species. *To collect superior genetic material for three conifer species native to the Central American highlands and lower Mexico. These species have tremendous potential in plantation forestry.*

**University of Idaho with the Corporación Hondurena de Desarrollo Forestal (Honduras)**
*J. Ehrenreich*
$175,000
New Methods for Classifying Upland Pine Forests of Central Honduras for Site Quality and Productivity. *Develop a forest site classification system for the management of the pine forests of Central Honduras and similar sites.*

**Texas A&I University**
*P. Felker*
$152,918
Exploiting the Unique Germplasm Resources of Leguminous Trees: Prosopis, Leucaena, and Acacia. *To improve the usefulness of three species of fast growing trees which have major potential as firewood sources. Includes unique prosopis germplasm capable of rapid growth in full seawater.*

**Instituto de Investigación Nutricional (Peru) and Johns Hopkins University**
*A. Gastanaduy*
$149,853
The Safety and Efficacy of Sewage-Grown Duckweed *(Lemnaceae)* as Feed for Chicks, Broilers and Layers. *To show that duckweed grown in sewage as a by-product of wastewater treatment may be successfully and safely employed as a major ingredient in poultry feeds.*

**University of California at Davis with the International Rice Research Institute (Philippines)**
*J. Goss*
$108,950
Design and Development of a Small-Scale Producer Gas Generator Engine System Using Rice Husks. *To test the feasibility of producing producer gas from rice husks suitable for direct use in a low horsepower internal combustion engine for use by small farmers.*

**University of Peradeniya (Sri Lanka)**
*S. Ilangantileke*
$25,757
The Feasibility of Promoting *Jatropha Curcas* Oil as a Fuel Substitute for Diesel Engine Fuel in Sri Lanka. *To study the potential of this plant-extracted oil as a fuel substitute for diesel engines, and to assess the economic feasibility and environmental impact of its use.*

**Tribhuvan University (Nepal)**
*M. Karki*
$55,000
Improved Management of Fodder Trees in the Terai and Outer Himalayas. *To determine how fodder trees could be used more effectively to meet the feed deficit for livestock in areas such as Nepal.*

**U.S. Department of Agriculture with collaborators in Jamaica, Trinidad and Costa Rica**
*L. Liegel*
$150,000
Growth and Site Relationships of Caribbean Pine Plantations Located on Diverse Soils in the Caribbean Basin. *To determine soil, topographical and climatic variables which exert the greatest influence on the growth and yield of the Caribbean pine or which cause such unusual phenomena as "foxtailing" and low cone/seed yields.*

**Kasetsart University (Thailand)**
*N. Lotong*
$144,000
Utilization of Cassava and Waste Through Fermentation Technology. *To develop a mixed microbial culture system to convert raw cassava roots and solid wastes from the starch industry into alcohol, and to upgrade the nutritional value of cassava for animal feed.*

**Instituto de Nutrición De Centro America Y Panama (Guatemala)**
*M. Molina*
$149,080
Development of Solid Fermentation Technologies to Upgrade the Quality and Utilization of Coffee Pulp as an Animal Feed. *To upgrade coffee pulp, an abundant by-product from coffee processing, to a higher-valued, less toxic material suitable for use as animal feed.*

**International Centre of Insect Physiology and Ecology (Kenya)**
*H. Osore*
$150,000
Research on the Biology and Biochemistry of Microorganisms from African Termites for Improved Biomass Degradation. *To determine whether microorganisms in the African termite system may have industrial potential as a faster and cheaper way to release cellulose from lignin. The cellulose could then be converted to feed, chemicals or biogas.*

**Central American Research Institute for Industry (Guatemala)**
*C. Rolz*
$169,460
Conversion of Lignocellulosics to Ethanol and Microbial Biomass Products: An Intermediate Acid Approach. *To make lactic and acetic acids and ethanol from citronella, lemon grass and sugarcane wastes using various pre-treatments and acidogenic bacterial fermentation processes.*

**University of Hawaii**
*P. Rotar*
$105,000
Sesbania as an LDC Agro-Forestry Resource. *To assess the potential of this varied genus as economical multi-purpose, nitrogen-fixing trees and shrubs suitable for subsistance farming.*

**U.S. Department of Agriculture Western Regional Research Center**
*R. Saunders*
$160,000
Development of *Prosopis* Species Leguminous Trees as an Agricultural Crop. *To determine the food and feed values of the foliage, fruit, seed and pod sub-fractions of various species of prosopis, a potentially multipurpose crop for marginal lands (funded through AID/S&T).*

**University of Miami with the Escuela Superior Politecnia del Litoral (Ecuador)**
*S. Snedaker*
$82,214
Shrimp Pond Siting and Management Alternatives in Mangrove Ecosystems in Ecuador. *To determine the mechanism by which expanding shrimp development and the attendant destruction of mangrove forests affect offshore production of finfish and shellfish in order to specify guidelines for the location of shrimp ponds.*

**University of Idaho**
*M. Stoszek*
$180,000
Food from Wood: A New Enzymatic System for the Degradation of Lignocellulose. *To identify the mechanism by which the sewellel, a native American rodent, can digest lignin and to explore the potential usefulness of this process for food or energy production.*

**Dynatech with a Consortium of 10 Developing Country Institutions**
*D. Wise*
$158,666
Low Capital Cost Fuel Gas Production from Combined Organic Residues. *To investigate a low capital system for production of fuel gas from the combined organic residues in LDC watersheds, including municipal, industrial and agricultural wastes.*

**Universidade Nova de Lisboa (Portugal) with the University of Georgia at Athens**
*A. Xavier*
$123,000
Optimization of Bioconversion of Liquid and Solid Residues. *To improve the production of biogas from agro-industrial, crop and forestry wastes by using a two-phased anaerobic reactor system, with improved biochemical characterization of these systems.*

## CHEMISTRY FOR WORLD FOOD NEEDS

**University of Panama**
*G. Alvarez*
$150,000
Vicariant Fertilization for Tropical Soils. *To study how application of silicates to acid tropical soils can maximize the release of phosphorus and related nutrients fixed on aluminum or iron compounds in the soil, to facilitate their absorption by plants.*

**University of Peradeniya (Sri Lanka) with the University of Hawaii**
*J. Bandara*
$21,650
Improving Nitrogen Fixation in Grain Legumes Using Selected Strains of Rhizobia. *To study the effectiveness of selected Rhizobia bacteria on nitrogen fixation in grain legumes of Sri Lanka.*

**Purdue University**
*L. Butler*
$196,328
Development of Low-Tannin Sorghums Resistant to Birds and Microbial Seed Deterioration. *To minimize the antinutritional effects of tannins in sorghum grain, while maintaining or enhancing their beneficial agronomic effects.*

*An Apinaje Indian woman collects babassu palm kernels in primary forest near Goias, Brazil. The hard-shelled fruit is set on the tip of an ax and hit with a wooden stick. The traditional babassu fiber baskets hold the kernels, which contain high levels of protein and edible oil.*

**King Mongkut's Institute of Technology (Thailand) with Washington State University**
*B. Chattong*
$150,000
Soil Salinity Control for Growth of Plants Which Can Serve as Energy Sources. *To develop a soil salinity control system which would permit growing plants which can produce a fuel oil on coastal wasteland.*

**Central Agricultural Research Institute (Sri Lanka) with the Commonwealth Institute for Biological Control**
*H. De Alwis*
$45,000
Biological Control of Insect Pests of Vegetables in Sri Lanka. *To identify biological controls for five insect pests affecting tomatoes, cabbage, beans, eggplant and gourds.*

**Central American Industrial Research Institute (Guatemala)**
*M. De Arriola*
$118,100
Destruction of Aflatoxin in Corn, and Nucleic Acids in Yeast-Corn Mixtures. *To test how successfully the traditional cooking of corn with lime can destroy the high levels of aflatoxin found in village corn. To determine if this process also destroys excess nucleic acids in yeast, a potential food supplement.*

**Central American Industrial Research Institute (Guatemala)**
*R. Garcia*
$101,400
Industrialization of Coffee Pectins. *To determine the feasibility of exploiting the pectins found in coffee-producing wastes for food applications.*

**University of California at Davis with EMBRAPA (Brazil)**
*A. Lauchli*
$158,748
Phosphorus Deficiency in Tropical Bean Production: An Approach Through Foliar Fertilization. *To determine if spraying a phosphorus solution onto the leaves of bean plants is a more effective and less costly way to increasing bean production in tropical soils than by applying conventional fertilizers.*

**Ohio State University Research Foundation with the Instituto Superior de Agricultura (Dominican Republic)**
*M. McDonald*
$110,853
Seed Vigor Influence on Nitrogen Fixation of Field Beans *(Phaseolus Vulgaris). To determine the influence of seed vigor on nodule initiation, nodule numbers, nodule distribution, and nitrogen fixation of the red field bean.*

**Purdue University with the U.S. Department of Agriculture**
*J. McLaughlin*
$175,000
Elimination of Toxic Bitter Principles from *Chenopodium* Grain Crops (Quinoa). *To isolate and characterize the undesirable toxic/bitter ingredients of quinoa seed, a native Andean food grain, to identify and develop less bitter varieties using tissue culture.*

**University of the Philippines**
*E. Mendoza*
$90,846
Biochemical and Nutritional Studies of Philippine Indigenous Food and Forage Legumes. *To provide a comprehensive biochemical and nutritional assessment of indigenous food and forage legumes in the Philippines, with emphasis on relatively unknown and underutilized species.*

**Fruit Experiment Station (West Indies) with the U.S. Department of Agriculture**
*S. Michelini*
$70,000
New Techniques for Enhanced Citrus Production in Barbados and East Caribbean Using Mychorrhizal Fungae. *To isolate and identify species of the root fungus mycorrhizae which could increase the potential of citrus root stocks for growth, nutrient uptake, pathogen resistance and drought tolerance.*

**Ministry of Health (Burma)**
*C. Nwe*
$17,658
Development of Appropriate Indigenous Weaning Foods. *To develop a range of feeding options for infants and weaning children using acceptable, safe and nutritionally balanced weaning recipes from inexpensive locally available food items.*

**Louisiana State University with the Sukarami Research Institute for Food Crops (Indonesia)**
*W. Patrick, Jr.*
$149,828
Redox Chemistry and Fertility Problems in the Wetland Soils of the Transmigration Areas of Sumatra. *To investigate chemical processes that influence availability and toxicity of inorganic constituents in the podzolic and the peat soils of rice-producing areas.*

**Louisiana State University with Kasetsart University (Thailand)**
*W. Patrick, Jr.*
$179,784
Redox Chemistry of the Acid Sulfate Soils of Thailand. *To study the chemistry of oxidation/reduction reactions in Thai soils and the responses of plants under controlled conditions.*

**University of Minnesota with ORSTOM (Senegal)**
*E. Schmidt*
$42,833
Infection Process in the Formation of the Nitrogen-Fixing Stem Nodules of *Sesbania Rostrata. To study important new nitrogen fixation mechanisms in the recently discovered stem modules of S. rostrata, a Sahelian legume. Unlike those in common root nodules, the rhizobia bacteria in this system seem to be unaffected by external levels of nitrogen.*

**Department of Agriculture (Thailand)**
*Y. Vasuvat*
$160,000
Role of VA Mycorrhizae in the Phosphorus Nutrition of Economically Important Leguminous Crops (Soybeans and Mungbeans).. *To improve the phosphorus nutrition of soybeans and mungbeans in Thailand through symbiosis with vesicular arbuscular (VA) mycorrihizal fungi.*

## BIOLOGICAL VECTOR CONTROL

**Fundacao Oswaldo Cruz (Brazil)**
*F. Barbosa*
$60,400
Competitive Interactions Between Populations of Freshwater Snails. *To develop an environmentally safe way to control snail species susceptible to the parasite causing schistosomiasis, through competitive replacement by resistant species.*

**Texas A&M University with the International Atomic Energy Agency**
*J. Deloach*
$171,451
Development of Defined Diet for In Vitro Membrane Mass Rearing of the Tsetse Fly. *To develop a diet which will permit the mass rearing of tsetse flies for suppression programs which use sterile male tsetse flies. This proposal will also train African scientists for three years in these techniques.*

**Ben Gurion University (Israel)**
*J. Margalit*
$171,451
Development of *Bacillus Thuringiensis var. Israelensis* and Other Related Strains as Effective Biological Control Agents. *To isolate more effective strains of this bacterium which is native to Israel and produces a highly effective chemical toxic to mosquito larvae. Current strains produce toxins with comparatively short lifetimes in the field.*

**Uniformed Services University of the Health Sciences with the Tropical Disease Research Center (Zambia)**
*E. Michelson*
$158,491
Characterization of Zambian Host-Snail Populations with Reference to Their Role in the Transmission of Schistosomiasis. *To characterize the schistosome snail-hosts in Zambia and clarify their role in the epidemiology and transmission of schistosomiasis.*

**University of Chile**
*H. Niemeyer*
$130,000
Role of Secondary Metabolites in the Resistance of Cereals to Aphids. *To understand the chemical factors in cereal plants that could be manipulated to increase plant resistance to aphids.*

**Mahidol University (Thailand) with Arizona State University and Western Illinois University**
*S. Pantuwatana*
$149,930
Improvement of Bacterial Agents for Control of Mosquito Vectors. *To increase the toxicity of bacterial pathogens of malaria-carrying mosquitoes through genetic engineering.*

**Boyce Thompson Institute (USA) with the International Rice Research Institute (Philippines)**
*D. Roberts*
$165,450
Development of Microbial Control Agents Against the Brown Planthopper. *To find a pathogen which alone or as part of a pest management system will restrict brown planthopper populations in Asia below an economically significant threshold.*

**Institute of Agriculture and Animal Science (Nepal)**
*S. Shrestha*
$46,341
Studies on Late Blight of Potato and Tomato in Chitwan Valley of Nepal. *To find a way to manage late blight disease, which has discouraged the growing of tomatoes and potatoes in the Chitwan Valley.*

**Johns Hopkins University with the Liberian Institute for Biomedical Research (Liberia)**
*M. Trpis*
$240,000
Comparative Study of the Vector Competence of the *Simulium Damnosum* Complex in the Rain Forest of Liberia. *To determine which sub-populations of black flies transmit "river blindness" in West Africa — and to what extent — and to thus suggest more effective control measures.*

**Johns Hopkins University with the Liberian Institute for Biomedical Research (Liberia)**
*M. Trpis*
$150,618
The Development of Biological Control Strategies for *Anopheles* Mosquitoes Breeding in Rice Fields in Liberia. *To investigate the potential of Bacillus thuringiensis and three species of consumable fish to complement each other in integrated strategies for the biological control of mosquitoes.*

**Mahidol University (Thailand)**
*S. Upatham*
$150,000
Biological Control of Schistosomiasis-Transmitting Snails in Southeast Asia. *To test the ability of five species of insects and four species of competing, non-carrier snails to control snails susceptible to Schistosoma parasites. To study the genetic variability of snails which transmit schistosomiasis in relation to the degree of parasite susceptibility.*

**Michigan State University with the National Crop Protection Center (Philippines)**
*M. Whalon*
$150,000
Identifying and Monitoring Insecticide Resistance in the Brown Planthopper, a Pest of Cultivated and Wild Rice. *To develop a biochemical tool to monitor changing insecticide resistance in the brown planthopper, a major rice pest, which is also the vector of viral diseases of rice plants.*

**University of Florida**
*M. Young*
$193,278
Effects of Insect Pathogens on the Ability of Mosquitoes to Transmit Malaria. *To develop biological control methods for malaria-transmitting mosquitoes.*

## EARTH SCIENCES

**Florida State University with the Indian Institute of Technology at Kanpur**
*T. Krishnamurti*
$144,642
Cooperative Monsoon Research Program. *To develop a weather prediction capability, based on computer models, at the Indian Institute of Technology at Kanpur, with an emphasis on monsoon prediction.*

*The combination of frequent earthquakes and traditional building materials like sun-dried clay bricks (adobe) leads to recurrent disaster in many LDCs. PSTC investigators in Peru discovered several simple ways to strengthen the bond between adobe bricks and mortar, which are highly vulnerable to earthquake damage.*

**University of Dakar (Senegal) with the Senegal River Basin Development Authority**

***M. Sall***

$117,000

Study of Environmental Effects of Diama and Manantali Dams in the Senegal River Valley. *To develop remote sensing methods to study the impact of two new dams on acacia forests and farming along the Senegal River.*

**Instituto Nacional de Sismologia . . . y Hidrologia (Guatemala)**

***C. Urrutia***

$106,960

Volcanic Zonification and Risk in the Republic of Guatemala. *To obtain a zonification and seismic risk map of Guatemala and to optimize the use and benefits of the current seismic instrument network.*

## ENGINEERING AND COMPUTER SCIENCE

**University of San Andres (Bolivia) with the Massachusetts Institute of Technology**

***M. Arellano***

$150,000

Development of High Gradient Magnetic Separation Prototype Plant. *To design and construct a continuous flow plant that can separate tin oxide from calcium and iron borosilicate particles, using their differing magnetic properties.*

**U.S. Bureau of the Census**
*R. Bair*
$214,000
Feasibility of Using Microcomputers in LDCs. *To determine if microcomputers can meet LDC statistical processing needs and diminish widespread LDC data processing problems.*

**University of Sierra Leone with Kansas State University**
*O. Davidson*
$10,000
Design, Construction, and Field Testing of Rice Drying and Storage Facilities Appropriate for Sierra Leone Farmers. *To reduce post-harvest grain losses through the development of improved farm site drying and storage facilities.*

**University of California at San Francisco with the Ministries of Health of Egypt and Tunisia**
*C. Dawson*
$198,017
Primary Eye Care: Treatment Guide for Frontline Health Workers Utilizing a Hand-Held Computer. *To develop and field test a small battery-operated computer to provide expert medical advice on the treatment and disposition of eye disorders to LDC health workers under frontline rural conditions.*

**American Association of Engineering Societies**
*D. De Simone*
$145,000
Program for Engineering Technology in the Service of Development. *To stimulate invention through international competition in producing needed LDC technologies.*

**Corporacion Hondurena de Desarrollo Forestal (Honduras) with the University of Idaho**
*J. Garcia*
$174,940
Bonding of Portland Cement with Hondural Wood Biomass and Other Lignocellulosics for Structural Materials. *To identify Honduran tree species appropriate for producing new LDC wood/cement construction materials, and to study the problems of cement bond formation with wood particles.*

**University of Benin (Togo)**
*M. Gninivi*
$124,000
Salt Gradient Solar Ponds for West Africa Applications. *To design an efficient solar pond for rural areas in southern Togo, especially as a source of energy for drying and conserving corn.*

**Asian Institute of Technology (Thailand)**
*V. Jindal*
$150,000
Heat Sterilization and Accelerated Drying of High Moisture Rice for Safe Storage. *To reduce microorganism-induced spoilage of wet rice, harveted and awaiting drying during the rainy season.*

**Illinois Institute of Technology with the Indian Institute of Technology**
*Z. Lavan*
$51,200
Research and Development of a Solar-Powered Desiccant Refrigeration System for Cold Storage Applications. *To develop energy-conserving refrigeration systems for coldstorage applications.*

**University of Nebraska with the Nebraska Educational Television Network**
*J. McBride*
$159,400
Developing, Adapting and Testing Interactive Videodisc Instruction for LDCs. *To reformat U.S. college-level interactive science laboratory videodisc lessons (using both Indonesian and English) and to develop a low-cost computer/videodisc system for field tests in Indonesia.*

**Pontificia Universidad Catolica (Peru) with the University of California at Berkeley**
*J. Neumann*
$137,410
Earthen Buildings in Seismic Areas. *To study the seismic strength of adobe walls with particular attention to the degree of unity between bricks and mortar, a major problem in earthquake-prone areas.*

**University of Delaware**
*C. Pleass*
$166,528
Delbuoy Wavepowered Seawater Desalting Systems for Caribbean Countries. *To conduct the sea trial research needed to develop a wavepowered reverse osmosis desalination system for use in Caribbean countries. When fully developed, such a system could purify sea water, at a cost affordable for agriculture.*

**Economic Development Foundation (Philippines)**
*H. Shutler*
$54,000
Design and Development of Low Cost Grain Dryer. *To field test a prototype design for a low-cost grain dryer for small farmers.*

**Pan American Health Organization**
*M. Vasconcellos*
$146,697
Machine-Aided Translation from English to Spanish for LDC Health Applications. *To develop an operational, automated system for translating English health texts into Spanish. The converse system (Spanish to English) exists, but is conceptually simpler.*

**Instituto de Investigaciones Electricas (Mexico) with the Comisión Federal De Electricidad**
*J. Vilar-Pedroche*
$79,400
Electrical Energy Supply to Rural Communities Directly from Transmission Lines. *To develop and test special voltage divider circuits to provide electricity to rural communities of 500 or less inhabitants, for which conventional means of electrification are uneconomical.*

**Battelle Pacific Northwest Laboratories**
*J. Williford*
$90,450
Feasibility and Planning Studies for Low Cost TV Systems Adapted to LDC Use. *To determine the feasibility of low cost TV receivers ($5-15) requiring no more than 5-15 watts of power.*

## GENETIC RESOURCES

**Institute of Agriculture and Animal Science (Nepal)**
*R. Adhikari*
$70,070
Prospect of Vegetable Cultivation in Chitwan, Nepal. *To determine how best to exploit the vegetable growing potential of this part of Nepal and similar regions.*

**Somali National University (Somalia)**
*A. Ali*
$168,000
Improvement of Tomato Production in Somalia. *To transfer resistance to white fly from the indigenous cherry tomatoes to other tomato varieties introduced into Somalia.*

**Harvard University with the University of Massachusetts and University Peradeniya (Sri Lanka)**
*P. Ashton*
$153,684
Population Biology of Tropical Forest Plant Species in Relation to Conservation and Domestication. *To provide the scientific basis for the domestication of local tropical forest species which are threatened with extinction due to overexploitation.*

**New York Botanical Garden with the Centro Nacional de Recursos Geneticos (Brazil)**
*M. Balick*
$184,724
Domestication of the Babassu Palm. *To improve through germplasm collection, characterization and breeding this important multi-purpose tropical resource.*

**Organization of American States**
*D. Black*
$400,000
AID/OAS Program for Research Cooperation in Latin American and Caribbean Tropical Plant Resources. *To involve U.S. and Latin American scientists in setting research priorities dnd implementing small research grants in tropical agriculture, with an emphasis on the smaller institutions of the Caribbean basin.*

**Instituto Nacional de Pesquisas da Amazonia with the Centro Nacional de Recursos Geneticos (Brazil)**
*C. Clement*
$127,835
Peach Palm Germplasm Bank . *To collect and evaluate genetically diverse peach palm populations in the Amazon Basin, and to select the best germplasm for use in the breeding programs of Costa Rica, Ecuador, Peru, Bolivia, Brazil and Colombia.*

**Colegio de Postgraduados de Chapingo (Mexico)**
*J. Galindo-Alonso*
$140,427
Papita Guera *(Solanum Cardiophyllum and S. Ehrenbergii)*: Potential New Crop of Great Importance for Arid-Warm Regions. *To bring under cultivation underexploited wild potatoes. The study will include breeding varieties with high yield, early maturity and resistance to pathogenic fungi.*

**Missouri Botanical Garden with the Universidad Nacional de Amazonia Peruana (Peru)**
*A. Gentry*
$150,000
Potentially Useful Plant Resources of the Eastern Andes. *To identify, characterize and preserve unexploited plant species in this rapidly disappearing Peruvian ecosystem, which may have significant economic or environmental value.*

**University of Peradeniya (Sri Lanka) with the U.S. Department of Agriculture**
*H. Gunasena*
$20,000
Collection, Characterization, Evaluation, Multiplication and Distribution of Important Root and Tuber Crops in Sri Lanka. *To develop a carbohydrate alternative to rice by collecting germplasm of the most important locally-available dioscorea and avoid species, and characterizing and selecting the best for crop improvement programs.*

**Rodale Research Center (USA) with the NAS/BOSTID Amaranth Network**
*C. Kauffman*
$150,000
Utilization of the World Amaranth Germplasm Collection. *To initiate a breeding program for this important, neglected grain, native to the Andes. This complements the network of LDC research institutions in Latin America, Africa and Asia working on grain amaranth under an NAS/BOSTID grant.*

**University of Hawaii with PNPES, CIAT, ORSTOM and WARDA**
*T. Lumpkin*
$150,000
Program for Assessment of Azolla Use in Tropical LDCs. *To further develop azolla (an aquatic fern which contains nitrogen-fixing blue-green algae) as an indigenous source of nitrogen for rice paddy culture.*

**Makerere University (Uganda) with the Kenya and Tanzania Fisheries Research Institutes**
*J. Okedi*
$15,000
The Potential of Lake Fly Biomass in Lake Victoria for Animal Utilization: A Pilot Study. *To develop the fly biomass of African lakes as an inexpensive local feed resource for aquaculture and other projects near the lakes.*

**Agency for Agricultural Research and Development (Indonesia)**
*B. Siwi*
$107,500
Hybrid Rice Project for Indonesia. *To investigate the usefulness of hybrid rice seed in the LDC context and to develop methods for commercial production in quantities sufficient to optimize LDC rice production.*

**Universidad Peruana Cayetano Heredia (Peru) with the Universidad Catolica**
*A. Vaisberg*
$115,542
Investigation of Cicatrizant Properties of the Plant Extract Sangre de Grado and its Possible Therapeutic Utilization. *To assess the suitability of this traditional preparation, which promotes wound healing, as a commercial pharmaceutical.*

**University of Maryland with the University of Peradeniya (Sri Lanka)**
*R. Weil*
$73,475
The Winged Bean in Tropical Cropping Systems. *To conduct a series of experiments in the greenhouse and in the field for improving winged bean production as part of mixed cropping systems and crop rotations.*

## AQUATIC RESOURCES

**Island Research Foundation with the University of Rhode Island**
*M. Goodwin*
$155,320
Assessment of Indigenous Eastern Caribbean Brine Shrimp and Selected Salt Pond Habitats. *To provide a technical basis for evaluating the development potential for growing local brine shrimp in Eastern Caribbean salt ponds.*

**Ministry of Trade and Industry (Belize) with the University of Illinois**
*W. Miller*
$146,880
Genetic and Demographic Assessment of *Strombus Gigas* Fisheries and Development of an In-Shore Research Facility. *To determine which strains of conch are most amenable to hatchery production and which survive in economically significant numbers after release in off-shore sites.*

**Cottage Industries Department, Ministry of Cooperatives (Burma)**
*M. Nyo*
$20,000
Research on Floating Net Cage Fish Culture. *To test the feasibility of raising Burmese cat fish in floating cages positioned in rivers and lakes as an alternative to using excavated ponds.*

**Tribhuvan University (Nepal) with the U.S. Fish and Wildlife Service and the University of Arkansas**
*T. Shrestha*
$34,000
Propagation of Mahaseers in the Himalayan Waters of Nepal. *To develop means of preserving these useful, edible fish in the hydroelectric dam reservoirs now blocking their normal spawning runs.*

**Florida International University with the Univesity of the West Indies (Jamaica)**
*A. Thorhaug*
$159,000
Seagrass Restoration in Caribbean Nearshore Areas. *To test whether tropical Jamaica is capable of restoring its offshore fishery nurseries through rehabilitating its seagrasses. Both selection and underwater "reforestation" field research will be conducted.*

**University of California at Santa Barbara with the Palau Marine Reseach Institute (Palau)**
*R. Trench*
$198,000
Spawning and Developmental Physiology of *Tridacnid* Bivalves. *To acquire the biological knowledge necessary to permit the mariculture of tridacnid as a useful, fast-growing food source, especially for resource-poor Pacific islands.*

## OTHER RESEARCH GRANTS

**Department of Medical Research (Burma)**
*Daw Than Saw*
$150,000
Relationships Between Control of Ascaris Infection and Child Nutritional Status. *To define the relationship between infection by the Ascaris worm and poor nutritional status in Burmese children.*

**Instituto de Investigación Nutricional (Peru) with the Peruvian Institute of Agrarian Research**
*G. Lopez de Romana*
$133,368
Cassava: Consumption and Digestion by Small Children. *To compare the impact on child caloric levels of different preparations of this LDC staple. Digestibility varies with preparation, which may have considerable implications for small children.*

**Rutgers University**
*K. Maramorosch*
$155,675
Effect of Chemotherapeutic Agents on Malarial Sporozoites *In Vitro. To develop an in vitro assay to evaluate drugs with potential activity against the first invasive stage of malaria (sporozoite) and subsequent liver stages. Until recently, in vitro assays against human malaria were restricted to the blood stages.*

**Escuela Superior Politecnica del Litoral (Ecuador)**
*J. Marcos*
$144,400
Traditional Agricultural Technologies to Improve Present Agricultural Practices. *To examine the potential of ancient agricultural and maricultural methods, reconstructed by archeologists from the ruins of raised agricultural fields in the Guayas River Basin flood plains, for improving modern agriculture in Latin America.*

**Cornell University with the Instituto de Investigación Agropecuaria de Panama**
*M. Nesheim*
$145,032
Ascaris Infection and Food Intake. *To investigate the significance of the intestinal parasite Ascaris lumbricoides on the dietary practices and food intake of preschool children.*

**Uniformed Services University of the Health Sciences**
*A. O'Brien*
$150,611
Production of Shiga-Like Toxin by *Escherichia Coli. To obtain information on the pathogenicity and epidemiology of enteropathogenic E. Coli for use in future studies on development of effective measures against this diarrheal agent.*

**Uniformed Services University of Health Sciences with the Instituto Nacional de Pesquisas de Amazonia**
*L. Scheibel*
$153,824
New Approach in Design of Anti-Malarials Selectively Toxic to the Parasite. *To test chemical compounds (lipophilic chelators) which are selectively toxic to intracellular malaria parasites, which have become resistant to quinine and chloroquine, the usual drugs of choice.*

**Lovelace Foundation**
*G. Simpson*
$170,000
Study of Putative Chloroquine and Quinine Receptors in *Plasmodium Falciparum* Malaria. *To determine the biochemical mechanisms underlying the increasing resistance of human malaria parasites to chloroquine and quinine.*

**Center for Disease Control with the Instituto de Investigación Nutricional (Peru)**
*F. Trowbridge*
$135,033
Energy and Protein Stores in Stunted Children. *To study body fat stores and lean body mass in growth-stunted children in Peru, to define the ability of anthropometry to assess body composition and to better understand the roles of energy and protein deficiency in retarding growth.*

## CAPACITY STRENGTHENING

**Organization of American States with the Ministries of Education of Panama, Ecuador and Jamaica**
*D. Black*
$150,000
Encouragement of LDC Science Education, Careers and Indigenous Science Base Development. *To organize a system of local and national competitions ("Science Fairs") in Panama, Ecuador and Jamaica at which high school students exhibit their original research projects related to development.*

**Organization of American States with the Countries of the Caribbean Basin**

*D. Black*
$145,000

Regional Science Fair for the Caribbean Basin: Strengthening Capabilities in LDC Science. *To strengthen secondary school interest and capabilities in science by arranging local, national and regional competitions for original student science research projects, throughout the developing countries of the Caribbean Basin.*

**Tulane University with Collaborators in Botswana, Lesotho, Swaziland, Zimbabwe and Malawi**

*J. Carter*
$168,524

Mobile Certificate and Masters of Public Health Program for Southern Africa. *To study the feasibility of using summer staff from established U.S. institutions to conduct training in conjunction with local institutions, leading to a MPH degree.*

**U.S. National Academy of Sciences (NAS/BOSTID) with the International Foundation for Science**

*J. Hurley*
$450,000

Small Grants Support for the International Foundation for Science (Stockholm). *To permit U.S. participation in this innovative multi-donor program which sponsors the work of promising young LDC investigators.*

**NAS/BOSTID with the International Rice Research Institute (Philippines)**

*J. Hurley*
$250,000

Planning Conference for PSTC Module in Chemistry Applied to Food Needs. *To convene a 3-day workshop of distinguished U.S. and LDC scientists attending CHEMRAWN II (Manila) to advise AID on research priorities and opportunities in this area.*

**U.S. Food and Drug Administration with the Institut Nacional de Nutrition (Tunisia)**

*C. Jelinek*
$115,000

A Survey of Food Contamination Research and Control in Tunisia. *To develop local technical capacity to determine the frequency and levels of pesticide residues and heavy metal content in the local diet.*

**University of Michigan with Kasetsart University (Thailand)**

*K. F. Lagler*
$200,000

Strengthening of Southeast Asia Aquaculture Institutions. *To strengthen the research capabilities of Kasetsart University (Thailand) in inland fish culture.*

**American Chemical Society with CHEMRAWN II**

*F. Marin-Price*
$55,000

CHEMRAWN II: International Conference on Chemistry and World Food Supplies/The New Frontiers. *To involve the U.S. private sector in the support of this meeting to examine the factors affecting world food supplies and to recommend priorities for attention by agricultural chemists and chemical engineers. (Funds donated by U.S. private sector)*

**U.S. National Institutes of Health with the Ministries of Health of Jamaica and Barbados**

*H. Metz*
$300,000

Developing LDC Technical and Institutional Capacity to Repair and Maintain Scientific and Biomedical Equipment. *To set up self-sustaining programs to repair and maintain scientific equipment in Jamaica and the Eastern Caribbean. Lack of such facilities in LDCs is a major cause of the underuse of donated or purchased scientific equipment.*

*Many LDCs need a reliable source of biomass that can grow on marginal lands. The hardy Prosopis species include everything from weeds to trees more than 40 feet high. The repotted mesquite clones shown here survived exposure to a 3.3% salt solution, the equivalent of seawater.*

**American Association for the Advancement of Science**

*R. Scribner*
$75,000

Science, Engineering and Diplomacy Fellow Programs. *To expand the scientific awareness and capabilities of the Agency and the development awareness and capabilities of U.S. scientists through one-year fellowships for work in AID technical offices.*

**International Cell Research Organization (UNESCO) with the University of the Philippines**

*T. Thorpe*
$4,000

Training: Plant Tissue Culture Course "PTC Methods and Applications in Agriculture" (Philippines). *To permit training of twelve LDC scientists from Bangladesh, Fiji, India, Indonesia, Sri Lanka, Malaysia and Thailand in this important biotechnology.*

# APPENDIX B. BOSTID GRANTS PROGRAM GRANTEES

## GRAIN AMARANTH

**Institute of Nutrition of Central America and Panama (Guatemala)**
*R. Bressani*
$118,793
Development of Basic Information on Guatemalan Amaranth Germplasm

**Archivos Latinoamericanos de Nutrición (Guatemala)**
*R. Bressani*
$50,000
Grain and Vegetable Amaranth Newsletter

**Institute of Nutrition of Central America and Panama (Guatemala)**
*R. Bressani*
$136,700
Limiting Factors for Nutritional Quality of Raw and Processed Grain Amaranth

**Thailand Institute of Scientific and Technological Research (Thailand)**
*Soonthorn Duriyaprapan*
$87,900
Species Selection and Potential Uses of Grain Amaranth as an Introduced Crop

**Department of Crop Science, University of Nairobi (Kenya)**
*V. Gupta*
$94,000
Selection and Introduction of Grain Amaranth for Dryland and Semi-Arid Climates

**Centro de Investigación de Cultivos Andinos (Peru)**
*L. Sumar-Kalinowski*
$118,508
Grain Amaranth: Selection, Nutritional Analysis, and Agronomic Comparison of Andean Varieties

*Nitrogen fixation is common in legume systems, but not in grasses, where it would be extremely valuable. Here BOSTID grantee Dr. Kauser Malik of the Pakistan Nuclear Institute inspects a planting of nitrogen-fixing kallar grass growing in a saline environment.*

**Instituto Nacional de Investigaciones Agricolas (Mexico)**
*A. Sanchez-Marroquin*
$110,900
Agronomic and Industrial Studies of Amaranth Grain

**Nutrition Research Institute (Peru)**
*E. Morales*
$138,000
Human Digestibility and Utilization of Grain Amaranth Protein and Carbohydrates

**Department of Agronomy, Chiang Mai University (Thailand)**
*Chuckree Senthong*
$95,140
Yield Improvement, Agronomy, and Local Use of Amaranth

## BIOLOGICAL NITROGEN FIXATION

**National Research Centre (Egypt)**
*H. M. Abdel Al*
$81,000
Competitive Relationships Between Indigenous and Inoculant Rhizobia Nodulating Broadbeans and Lentils

**Empresa Brasileira de Pesquisa Agropecuaria (Brazil)**
*J. Dobereiner*
$114,430
Nitrogen Fixation by Plant-Bacteria Association in Tropical Grasses and Cereals

**Central American Research Institute for Industry (Guatemala)**
*R. de Leon*
$135,800
Production and Field Testing for Effective Strains of *Rhizobium phaseoli*

**State University of Haiti**
*J. Felix*
$50,000
Field Assessment of Need to Inoculate Pigeon Pea and other Legumes

**National Agricultural Research Centre and Institute of Agricultural Research (Senegal)**
*M. Gueye*
$64,000
Improving the Yield and Biological Nitrogen Fixation of Bambarra Groundnut

**Sukamandi Research Institute for Food Crops (Indonesia)**
*O. Hidayat*
$150,000
Improved Grain Legume Production by Enhanced Biological Nitrogen Fixation

**Department of Soil Science, University of Nairobi (Kenya)**
*S. Keya*
$118,715
Effects of Environmental Factors on Nitrogen Fixation

**Nuclear Institute for Agriculture and Biology (Pakistan)**
*K. Malik*
$106,155
Associative Biological Nitrogen Fixation in Grasses Growing in Saline Environments

**National University of Mexico**
*R. Palacios*
$147,900
Genetic Manipulation of *Rhizobium phaseoli* for Increased Bean Production

**Rubber Research Institute (Malaysia)**
*E. Pushparajah*
$109,800
Improved Soil Fertility by Inoculation of Cover Legumes with Rhizobia and Mycorrhiza

**Chiang Mai University (Thailand)**
*Benjavan Rerkasem*
$100,200
Interactions in Legume-Nonlegume Intercropping Systems

## TROPICAL TREES

**National Forestry Research Centre and Institute of Agricultural Research (Senegal)**
*C. Bailly*
$85,000
Selection of Root Endophytes to Increase Tree Productivity in Semi-Arid Regions

**Pontificia Universidad Catolica de Chile**
*O. Balboa*
$117,600
Vegetative Propagation and Improved Breeding Systems for *Prosopis* Species

**University of Gezira (Sudan)**
*M. Beshir*
$45,800
Collection and Nursery Trials of *Acacia* Species for Biomass in Non-Irrigated Drylands

**Centre Technique Forestier Tropical (People's Republic of the Congo)**
*D. Diangana*
$75,330
Selection of Fast-Growing, Nitrogen-Fixing Tree Species for Large-Scale Biomass Production in Savannah Zones

**Bunda College of Agriculture (Malawi)**
*O. Edje*
$90,440
Fast-Growing Nitrogen-Fixing Trees in Agroforestry: Effect on Crop Yields and Soil Properties

**Visayas State College of Agriculture (Philippines)**
*R. Escalada*
$116,170
Nitrogen Fixation and Multiple Uses of *Albizzia falcataria, Gliricidia sepium,* and *Sesbania grandiflora*

**University of Panama (Panama)**
*B. de Hernandez*
$98,685
Factors Limiting Biomass Production and Biological Nitrogen Fixation in *Leucaena leucocephala* in Acid Soils

**International Council for Research in Agroforestry (Kenya)**
*P. Huxley*
$57,024
Technical/Scientific Back-up

**University of Nairobi (Kenya)**
*F. Owino*
$163,770
Selection and Testing of Fast-Growing, Nitrogen-Fixing Trees for Use in Farm Woodlots and Agroforestry Combinations

**Instituto Nacional de Investigaciones Sobre Recursos Bioticos (Mexico)**
*E. Pardo-Tejeda*
$113,100
Native Fast-Growing, Nitrogen-Fixing Trees in Upland and Lowland Sites as a Source of Fodder, Fuelwood and Soil Management

*Unexpected flooding at Chan Thuek, Thailand yielded valuable information on the flood resistance of the fast-growing species under test. Here leucena are shown growing in deep water*

**Instituto de Investigaciones Technolgicas (Chile)**
***E. Elena-Torres***
$110,185
Evaluation and Testing of Fast-Growing, Nitrogen-Fixing Tree Species for Semi-Arid Regions

**Center for Water Resources Development and Management (India)**
***V. Vamadevan***
$63,000
Alley Cropping Systems in Coconut and Cassava Production Systems

**Thailand Institute of Scientific and Technological Research (Thailand)**
***K. Yantasath***
$102,630
Field Trials and Testing of Selected Species of Fast-Growing, Nitrogen-Fixing Trees

## MOSQUITO VECTOR FIELD STUDIES

**University of Panama (Panama)**
***A. Adames***
$116,100
Relationships of Mosquito Vectors and Waterbirds in the Potential for Transmission of Two Arboviruses

**National Institute of Health (Peru)**
***G. Calderon***
$102,500
Dynamics of Malaria Transmission in a New Settlement Zone

**University of Dakar (Senegal)**
***S. Diallo***
$101,700
Ecology of Malaria Vectors in a Zone Undergoing Desalinization and Agricultural Development

**Universidad del Valle (Guatemala)**
***M. Dix***
$140,600
Assessment of *Salvinia auriculata* as a Plant Larvacide for Malaria Control

**University of Sao Paulo (Brazil)**
***O. Paulo-Forattini***
$107,500
Relationships of Mosquito Feeding Patterns to Vectorial Capacity in Diverse Ecological Settings

**Malaria Research Center (Mexico)**
***J. Mendez-Galvan***
$88,600
Isolation and Identification of Potential Pathogens for Anopheline Mosquitoes

**Tropical Disease Research Center (Malaysia)**
*J. Hii*
$116,000
Genetic Variation of the *Anopheles balabacensis* Complex and its Relationship to Malaria Transmission

**University of Nairobi (Kenya)**
*T. Mukiama*
$106,000
The Ecology and Possible Control of Malaria Vectors with Extracts of *Melia volkensis*

**Uganda Virus Research Institute**
*L. Mukwaya*
$13,800
Taxonomy and Population Genetics of *Aedes simpsoni* Complex

**Mahidol University (Thailand)**
*Sakol Panyim*
$163,600
Development of DNA Probes to Differentiate Sibling Species of *Anopheles dirus* and *A. maculatus*

**University of Peradeniya (Sri Lanka)**
*J. Peiris*
$162,480
Vector Biology and Vector Competence of Man-Biting Mosquitoes in an Urbanized Environment and an Area Under Agricultural Development

**Sarawak Medical Department (Malaysia)**
*Chang Moh Seng*
$93,600
Bionomics of Two *Mansonia* Species and Their Response to Insecticides

**Malaria Eradication Service (Colombia)**
*M. Suarez*
$117,400
Genetic Variation among *Anopheles albimanus* Populations and Relationships to Vector Competence, Ecology and Geographic Distribution

*Adult mosquitoes can be captured with a hand-held aspirator tube. Their larvae can be collected from stagnant water by simple scoops or siphons. Both techniques are used in BOSTID-sponsored mosquito vector field studies.*

**Mahidol University (Thailand)**
*Suchart Upatham*
$127,600
Studies on the Bionomics of *Anopheles maculatus* and its Role in Malaria Transmission

## RAPID EPIDEMIOLOGICAL ASSESSMENT

**University of the Philippines**
*E. Domingo*
$104,400
Standardization of Simple Method for Identifying Infants at Risk of Becoming Hepatitis-B Carriers

**Center for Planning and Social Research (Ecuador)**
*W. Freire*
$104,700
Positive Predictive Value of Hemoglobin Measures for Program to Control Deficiency Anemia

**Nutrition Institute (Egypt)**
*O. Galal*
$146,500
Risk Assessment: Identification and Monitoring of Fetal Malnutrition

**Guatemala Social Security Institute**
*E. Kestler*
$114,500
Risk Assessment: Development of an Instrument to Detect Pregnant Women at High Risk of Delivery of Low Birthweight Infants

**Nutrition Research Institute (Peru)**
*C. Lananta*
$160,200
Development of Survey Methodology to Assess Childhood Health Status and Service Utilization

**Institute for Nutrition Research and Food Technology (Chile)**
*F. Mardones-Restat*
$44,570
A Malnutrition Risk Assessment Instrument for Infants

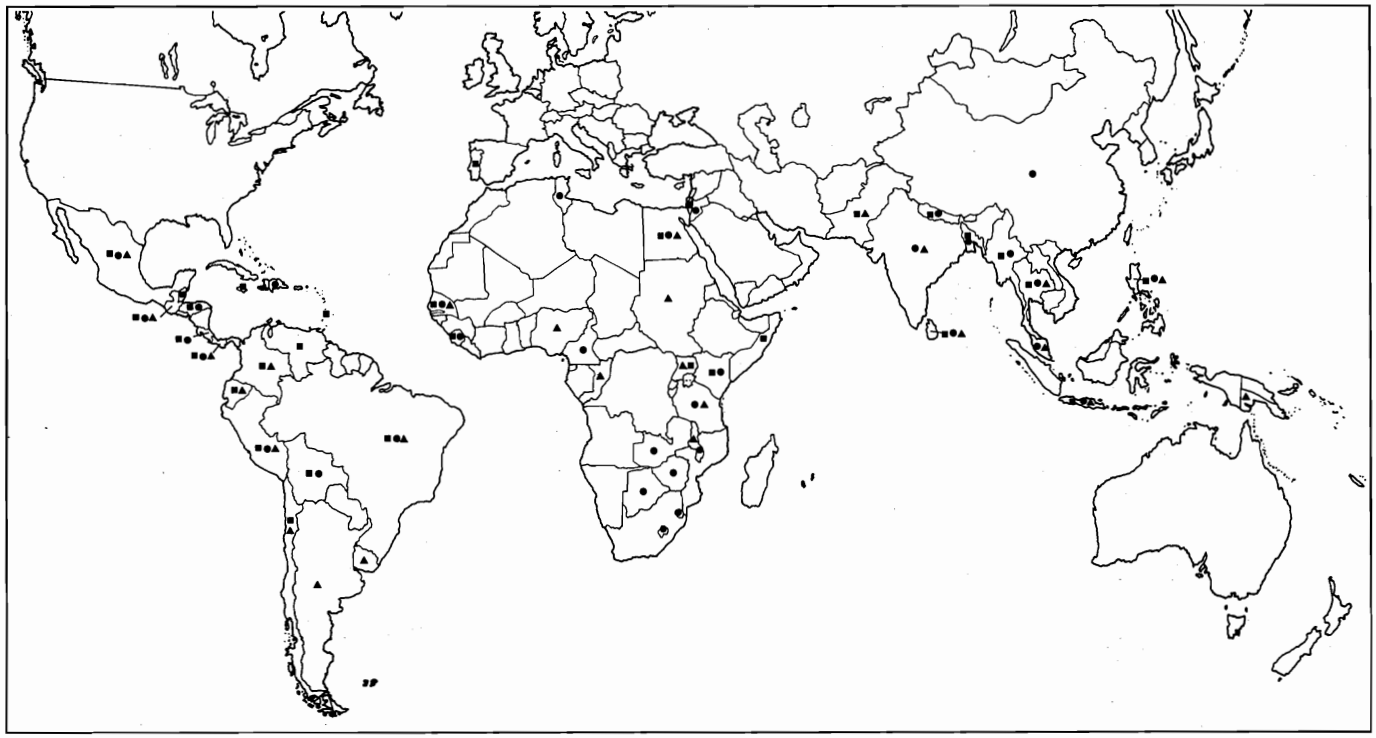
**Institute of Nutrition of Central America and Panama (Guatemala)**
*V. Valverde*
$90,300
Determination of the Value of School Children's Height Measurements as a Tool for Nutritional Surveillance

**Aravind Eye Hospital (India)**
*G. Venkataswamy*
$128,700
Assessment of Rapid Survey Technique for Ophthalmic Health Planning and Monitoring

## ACUTE RESPIRATORY INFECTION (ARI)

**Papua New Guinea Institute of Medical Research**
*M. Alpers*
$197,000
Viral and Bacterial Pathogens Responsible for ARI in Young Children

# A Worldwide Initiative . . .



*No one country has a monopoly on new ideas. PSTC grantees span the globe.* ■ *AID/SCI grantees,* ● *AID/SCI collaborators,* ▲ *NAS/BOSTID grantees.*

**Institute of Nutrition of Central America and Panama (Guatemala)**
***J. Cruz***
$167,500
Epidemiology and Etiology of ARI in a Low-Income Urban Population: Identification of Nutritional and Other Risk Factors

**Christian Medical College and Hospital (India)**
***T. John***
$216,600
Etiology, Risk Factors and Transmission of ARI in Rural Children

**University of Ibadan (Nigeria)**
***C. Oyejide***
$238,200
Etiology of ARI in Low-Income Urban Children: Hospital and Community Studies

**Central Public Health Laboratory, Ministry of Public Health (Uruguay)**
***M. Hortal de Peluffo***
$120,100
Identification of Etiology and Risk Factors of Childhood ARI in the Community

**Research Institute for Tropical Medicine (Philippines)**
***T. Tupasi***
$173,600
Etiology of Childhood Acute Respiratory Infections: Hospital and Community Based Studies

**University of Nairobi (Kenya)**
***E. Wafula***
$150,300
Clinical and Familial Study of ARI in a Rural Area

**National Research Council (Argentina)**
***M. Weissenbacher***
$114,300
Etiology of Lower ARI: Relation to Clinical Features and Environmental Variables

# APPENDIX C. INDEX OF PSTC PROJECTS BY COUNTRY