Fiscal Year 1981
Congressional Presentation

Institute for
Scientific and Technological Cooperation

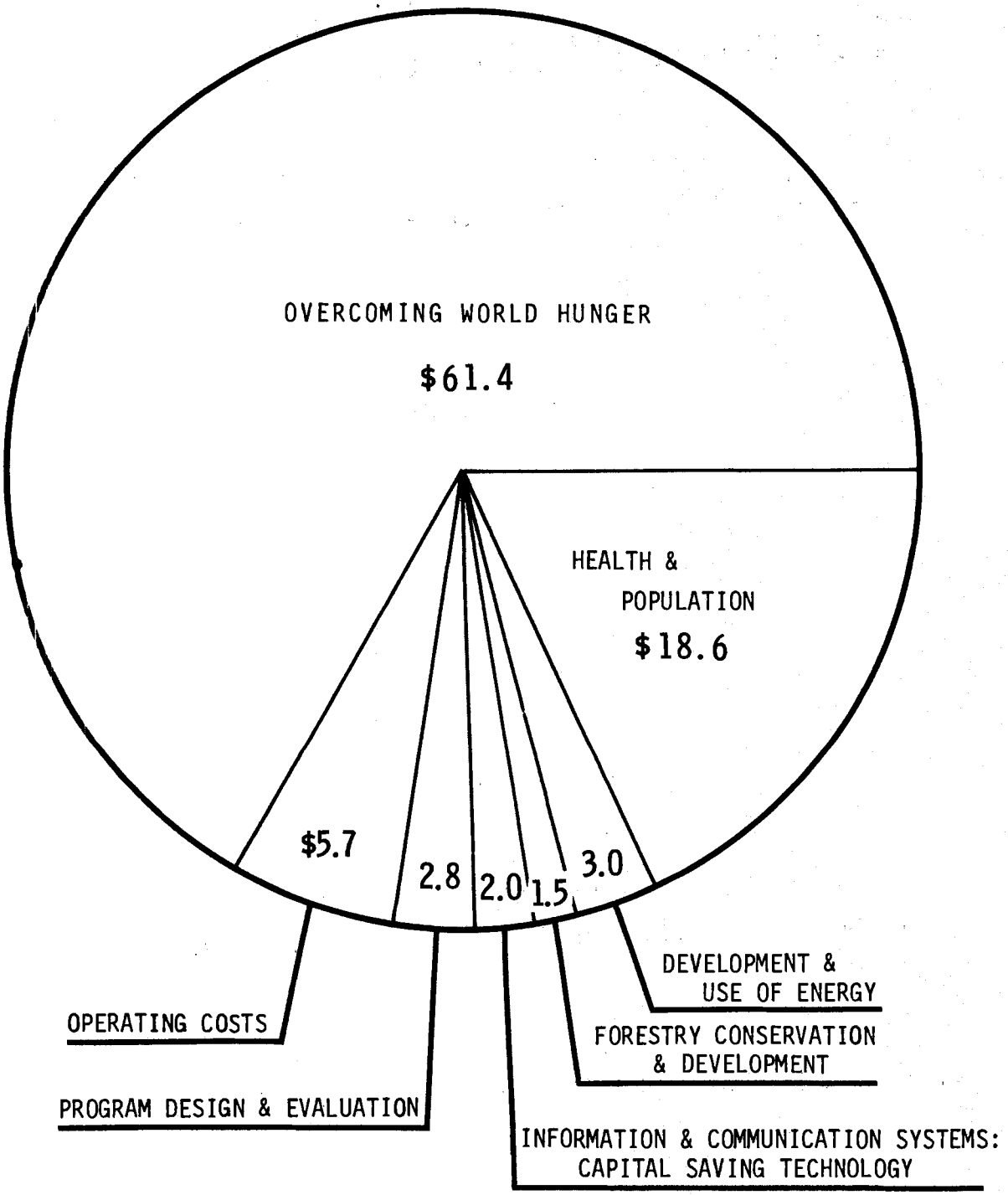
Submitted as
Annex IX
of the Congressional Presentation
of the AGENCY FOR INTERNATIONAL DEVELOPMENT

A Component of the
INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

Figure 1.

ALLOCATION OF ISTC FY 1981 PROGRAM — $95 MILLION

(in millions)



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UNITED STATES

INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

Washington, D.C. 20523

TO THE CONGRESS OF THE UNITED STATES:

I am pleased to transmit the authorization and appropriations request for the Institute for Scientific and Technological Cooperation for Fiscal Year 1981.

The President has stressed that the Institute, a key component of the new International Development Cooperation Agency, is an essential element in the foreign assistance program of the United States. It will provide a much-needed means to promote the effective application of science and technology to neglected problems of development.

The Institute will focus on critical needs, particularly in the areas of agriculture, energy, and health and population. It will, I am confident, yield substantial benefits.

Cordially,

Thomas Ehrlich

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1. Introduction and Summary

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Introduction and Summary

"It has never been more clear that the state of the union depends on the state of the world. . . ."

These words, introducing the President's 1980 State of the Union Message, reflect the increasing recognition by Americans that the well-being of the United States depends, to a large degree, on the world that lies beyond our borders. And many of the tensions in that world arise from conditions of poverty, disease, and hunger that affect the larger part of the world's population.

Hence, in our own interest, as well as for humanitarian reasons, we must be prepared to participate more actively in attacking development problems that affect the larger part of the world's population. Science and technology are essential to this process and must be used more effectively. It is for this purpose that the Institute for Scientific and Technological Cooperation (ISTC) is being established.

The ISTC

The ISTC was authorized by Congress in 1979 to serve as a mechanism for intensifying the application of science and technology to the most important problems of the developing countries. Its stated purpose is:

> To strengthen the capacity of the people of developing countries to solve their development problems through scientific and technological innovation, to foster research on problems of development, and to facilitate scientific and technolgical cooperation with developing countries.

Organization

The ISTC is uniquely designed to meet this contemporary challenge.

Its structure and style of operation will permit sustained scientific and technological attention to the major problems of poverty in the Third World.

The Institute will be organized by subject problem area, rather than by geographical region, so that its professional staff will be in continuing contact with the broad range of efforts extending from research through technology creation to adaptation and field experimentation. In this way, the ultimate purpose of the Institute's activities, to devise practical means for improving living conditions of the poor, will always be in sight. The organization of ISTC necessarily will differ from that required by AID in conducting country programs.

Style of Operations

In addition, ISTC's style of operations will be distinctive with regard to collaboration with the developing countries. Recognizing that those who live with development problems must lead in their eventual resolution, ISTC will function in close collaboration with scientists and institutions in developing countries and will participate with them in the development of their long-term problem-solving capacities. The uniquely international character of ISTC's Council on International Scientific and Technological Cooperation and of its staff strengthens this collaborative bond.

ISTC will seek to attract the best scientific talent in the United States and abroad to tasks often misper-

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ceived as mundane—the search for practical means to alleviate the worst aspects of poverty.

Special arrangements will be made to engage the technological experience of the private industrial sector in designing and implementing programs.

At all times, the program will retain the flexibility to respond to research needs and opportunities as they arise, recognizing that the nature of the key questions often change in the course of scientific inquiry. Hence, the program of the Institute will continually evolve in terms of strategy but remain persistent in terms of longer-range objectives.

Advantages of ISTC

In addition to the advantages of its collaborative and flexible mode of operation, the ISTC will be well placed to identify the results of research activities in United States institutions which, although primarily intended for domestic purposes, can be applied or adapted to development problems. It will also serve as a focal point for access by developing country scientists and institutions to United States scientific and technological resources.

Finally, the ISTC will enable United States institutions to collaborate more closely with their counterparts in middle-income countries on problems of mutual interest such as food, health, population, environment, and energy production. Many of these countries, no longer eligible for AID assistance and often less in contact with the U.S. scientific community, have developed invaluable capability and experience in dealing with development problems.

In establishing this new Institute, the United States breaks new ground in the conduct of its international scientific and technological activities for development purposes. In doing so, it emulates Canada, which first launched an International Development Research Centre (IDRC) in 1971. Sweden, West Germany, and The Netherlands have also organized similar institutions that are distinct from their foreign aid operations. All are characterized by high quality professional work and a collaborative style of operation. All are esteemed by cooperating institutions in developing countries. The ISTC plans to work closely with these and other industrial country counterparts within a framework of international cooperation on the resolution of development problems.

Needs for Improved Use of Science and Technology in Development

International cooperative research for development is a growing and promising phenomenon. The Consultative Group on International Agricultural Research (CGIAR), although widely known, is less than a decade old. In the health field, the successful World Health Organization (WHO) campaign against smallpox, which had an indispensable research component, has been followed by a Tropical Disease Research Program. Like the CGIAR and the smallpox campaign, this program also involves multinational funding, staffing, and collaborative research.

Despite these and other efforts, many problems remain and will be more difficult to deal with than in the past.

Food production, for example, doubled over the past 25 years, primarily through the expansion of acreage. Production must double again in the next 25 years if minimal nutritional targets are to be met. Opportunities for expanding acreage are limited, however, to less than one percent per year. Thus, the balance of the increased production must be found through the intensification of agriculture, a process heavily dependent on improved production technology. Much research will be required to improve the quality and yields of the major cereals as well as such staple foods of the poor as cassava, lentils, millets, and yams.

Energy requirements will also grow in the years ahead. For many developing countries, the burden of meeting their needs from petroleum sources could prove ruinous to their economies. They will need the capacity to exploit their natural sources of energy. Most of the affordable technology for doing this is yet to be devised.

In health matters, the world simply lacks the knowledge to deal with malaria, tuberculosis, leprosy, and many other scourges of the tropics. Research has led to the elimination or control of the most serious infectious diseases of the temperate zone. But for diseases of the tropics and semi-arid areas, the state of medical knowledge is much less advanced.

The industrial world could not undertake all the scientific research and technological adaptation needed to deal with development problems, even if it were disposed to do so. The task for the future is to find the means to attack persistent problems of

developing countries by enhancing their scientific and technological capabilities while, at the same time, bringing more of the competence of the industrial world, particularly the United States, to bear on these problems.

Developing nations attach increasing importance to building their own capacities to deal with their own special problems. In world conferences, such as the World Food Conference in Rome and the United Nations Conference on Science and Technology for Development in Vienna, they have emphasized their need for assistance in developing the capacity to select and adapt relevant technologies. They stressed at Vienna the desirability for each industrialized and developing country to have a focal point for scientific and technological cooperation through which developing countries and international agencies could gain access to specialized competencies.

The United States is rightfully proud of its success in bringing science and technology to the service of its people. In biomedical and agricultural research, the United States has long played a leading role. A greater share of the research and development capacity of U.S. public and private institutions could be applied to the needs of developing countries for research, training, and the enhancement of their own problem-solving capabilities if a better mechanism existed for doing so. The ISTC was authorized by the Congress to that end.

Startup and Staffing

The inauguration of the Institute's program awaits final action by Congress on the Foreign Assistance Appropriations Act of 1980. It is hoped that the Congress will act favorably on the appropriation for ISTC and that the Institute will launch its proposed FY 1980 program in March 1980.

The chief executive officer of the Institute will be the Director who, along with the Deputy Director, will be appointed by the President with the advice and consent of the Senate.

A Council on International Scientific and Technological Cooperation will be appointed by the President to advise the Director with respect to the policies, programs, planning, and procedures of the Institute. The Council will consist of up to 25 members, up to eight of whom will be experts from developing countries. Five will be officials of the United States Government.

The Institute's staff is expected to number not more than 100 professionals by the end of FY 1981. The staff will be organized mainly along the lines of development problems selected for the attention of the Institute. Through a fellowship program, the ISTC will obtain the services of individuals who have demonstrated exceptional competence and ability in the fields of scientific, technological, economic, or social endeavor. As many as 20 Fellows, half of whom will be from developing countries, will be selected annually for appointments of up to two years.

ISTC In Relation to Other Agencies

The ISTC will operate as a small, semi-autonomous agency within the framework of the basic policies and overall budget established by the International Development Cooperation Agency (IDCA) and in parallel with the Agency for International Development (AID).

AID and ISTC will have a complementary relationship. AID as well as other United States and international agencies will assist in the identification of problems requiring research and in the dissemination of results. AID will benefit directly from ISTC-sponsored research, as will developing countries and other national and international development agencies.

The Institute will, within the foreign policy guidelines of the Department of State, serve to facilitate and coordinate the scientific and technological activities of all government agencies that are related to development problems. It will be a principal contact point between international, regional, and national institutions engaged in development-related research and the U.S. science and technology community.

FY 1981 Program and Budget Summary

The requested ISTC program budget for FY 1981 is $95 million. A summary of programs and projects and the amount allocated to each are set forth in Table 1 and Figure 1.

Of the $95 million budget, approximately two-thirds will support research projects previously administered by AID. These are now integrated into a consolidated ISTC program. The projects selected for transfer to ISTC were those dealing with research and the development of new technology, especially those of major importance to the poor. All projects

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fall within program areas requiring long-term, sustained attention and the results of which, in whole or in part, will be applicable to problems in a number of countries or regions. Most of them incorporate cooperative research activities between United States public and private institutions and national and international institutions in other countries. As such, they serve to build the capacity of developing countries to undertake research on, and apply technology to problems most relevant to their own needs. The projects include support for international agricultural and medical research programs, the Collaborative Research Support Programs developed under Title XII of the Foreign Assistance Act, and other projects that have been reviewed by the AID Research Advisory Committee.

The remainder of the program budget is devoted to new or expanded initiatives formulated in consultation with scientists and relevant research institutions in the United States and other countries.

All programs and projects will be subjected to continuing close review and appraisal over the coming years. Over time, it is expected that the emphasis of the ISTC program and the design of its projects will progressively change and evolve as a result of the collaborative programming process.

It should be noted that the current financial allocations by program area do not necessarily reflect the relative importance of the problems addressed in each area. Rather, the allocations are designed to strengthen and complement efforts funded by others. For example, only $1 million is proposed for work in population. ISTC's effort is a relatively small but needed complement to major research programs of AID and other agencies. In the course of its continuing review, ISTC will consider the magnitude of resources allocated to this and other problems in the context of broader scientific and technological activities wherever conducted. In brief, program execution and the allocation of funds are intended to be dynamic processes.

Programs and proposed projects will be subject to peer review through procedures similar to those of the National Science Foundation and the National Institutes of Health. The major proportion of program funds, our estimate is 75 percent, will be expended for work in developing countries.

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Table 1 — ISTC Consolidated Budget Summary
($000)

	1980[1] (Estimate)	1981 (Proposed)
Overcoming World Hunger	**52,600**	**61,400**
Commodity Productivity	34,350	36,810
Production Inputs Efficiency	8,200	9,545
Farm Production Systems	7,500	10,300
Applications and Use of Knowledge	800	3,100
Improving Nutritional Status	1,750	1,645
Health and Population	**14,576**	**18,600**
Major Tropical Diseases	10,976	12,200
Control of Diarrheal Diseases	2,400	2,900
Prevention of Diseases through Immunization	500	2,500
Population Research	700	1,000
Development and Use of Energy	**500**	**3,000**
Forestry Conservation and Development	**500**	**1,500**
Information Systems and Capital Saving Technology	**400**	**2,000**
Program Design and Evaluation	**2,185**	**2,810**
Administrative Expenses	**1,115**	**5,690**
TOTAL PROGRAM	**71,876**	**95,000**
Budget authority	**23,750[2]**	**95,000**

[1]This presentation consolidates certain activities currently administered by AID with activities to be financed from funds appropriated directly to the Institute. It is anticipated that administrative responsibility for the transferred activities will be assumed by the Institute toward the end of fiscal year 1980. In most instances, FY 1980 obligations will have been made by AID prior to transfer and consolidation with the ISTC program. The FY 1980 column includes $56.9 million of transfers.

[2]At the time this document was prepared, congressional action on funding for the Institute for FY 1980 had been delayed for four months and the level of funding ultimately to be provided was uncertain. During this period, planning for the Institute's program was suspended. Because of these delays, it will not be possible for the Institute to fully program in 1980 the amount contained in the House Appropriations bill. The presentation to the Congress for FY 1981 is based on the assumption that $15 million will be programmed in FY 1980.

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2. Background and Policy Discussion

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Background and Policy Discussion

The Institute for Scientific and Technological Cooperation(ISTC) was proposed by the President and authorized by the Congress in the International Development Cooperation Act of 1979 for the following purposes:

to strengthen the capacity of the people of developing countries to solve their development problems through scientific and technological innovation, to foster research on development problems, and to facilitate scientific and technological cooperation with developing countries. To carry out these tasks, the ISTC will:

- Help research institutions in developing countries increase their capacity to deal with selected problems through grants for training, equipment, and collaborative research with United States institutions;
- Support problem-oriented research and studies of technological application to the problems of the poor consonant with its role as the research arm of the foreign assistance program;
- Serve as a principal contact point for institutions in developing countries seeking access to United States scientific and technological resources for cooperation on development problems;
- Facilitate the training of scientific and technical personnel for developing countries.

Science and technology encompass the spectrum of man's activities to discover new knowledge and to put it to practical use. In an increasingly interdependent world, it has become ever more apparent that closer international cooperation in the development of science and technology is mutually beneficial. In his message to Congress (March 27, 1979) on science and technology, the President specifically called attention to the growing need for international cooperation. He identified four principal themes that have guided Administration policy:

- the pursuit of new international initiatives that advance our own research and development objectives;
- the development and strengthening of scientific exchanges that bridge political, ideological, and cultural divisions between countries;
- the formulation of programs and institutions that help developing countries use science and technology; and
- cooperation with other nations to manage technologies with global impact.

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The ISTC eventually will serve, in part, all four objectives. But it is specifically oriented to the third of these — helping developing countries use science and technology. To accomplish this requires improved and more appropriately applied technology. It is also clear that new technology and new knowledge will be needed. The ISTC is specifically structured to help countries develop their own capacities to understand and deal with problems in science and technology, and to enlist highly qualified United States public and private participation in addressing these problems.

The Need for Research on Development Problems

Research and innovation are so integral a part of the culture of every industrialized country that few pause to reflect on the implications of their neglect in the developing world. The proportion of the world's non-military research and development effort conducted in Third World institutions is at most 4 percent. The fact that virtually all developed countries are in the temperate zone has led to a serious neglect of many problems of vital importance to the tropical developing countries.

In the United States, as in most countries, government is a major sponsor of research. The agencies that administer the bulk of the research funds are focused by law and tradition on problems of direct concern to the American people. Although their research missions have increasingly led these agencies into international activities, such activities in most cases have to be justified to the Congress in terms of domestic benefits. It is therefore not surprising that problems of the tropical and semi-arid countries have received relatively little attention in the United States. This tendency is illustrated by the fact that research sponsored by the foreign assistance program represents only 1.5 percent of the research budget of U.S. universities.

The ISTC will continually monitor ongoing research in the United States to identify potential development applications. It will selectively supplement existing research to increase its usefulness to development and will generate new research programs targeted to development problems. The new funds involved will necessarily be modest, but the catalytic, facilitating, and coordinating efforts of the ISTC should result in a substantially greater contribution to development by the United States scientific community. Many, if not most, development problems will need to be addressed in the developing countries themselves, although some aspects of these problems can only be dealt with in the modern research establishments of the United States.

The need for more research on development problems has frequently been cited by world leaders and scientific bodies. The Tokyo Summit of leaders from the United States, Japan, Canada, and Western Europe in June 1979 called for more emphasis on cooperation with developing countries in overcoming hunger and malnutrition, in developing human resources, and in tapping their energy potential. It considered increased bilateral and multi-lateral aid for agricultural research to be particularly important.

The need for research on the world's food problems in the 1980's and beyond has been more thoroughly analyzed and documented than the research needs in other problem areas. Both the Preliminary Report of the Presidential Commission on World Hunger issued in December 1979 and the National Academy of Sciences' *World Food and Nutrition Study* of June 1977 establish the priority of the problem for the United States and the international research agenda for dealing with it.

The Presidential Commission cited the long-term need to "direct a far larger share of America's research capabilities and research budget to the task of overcoming hunger and poverty in developing countries." It found serious underfunding for research in the physical, biological, and social sciences related to development.

The Academy study is an exhaustive examination of the potential contributions of research in meeting the urgent problems of food and nutrition needs. The study took two years to complete, involved 14 highly qualified study teams, and the contributions of approximately 1,500 people. The study identifies more than 100 important research topics and designates 22 high-priority areas. It stresses the United States role

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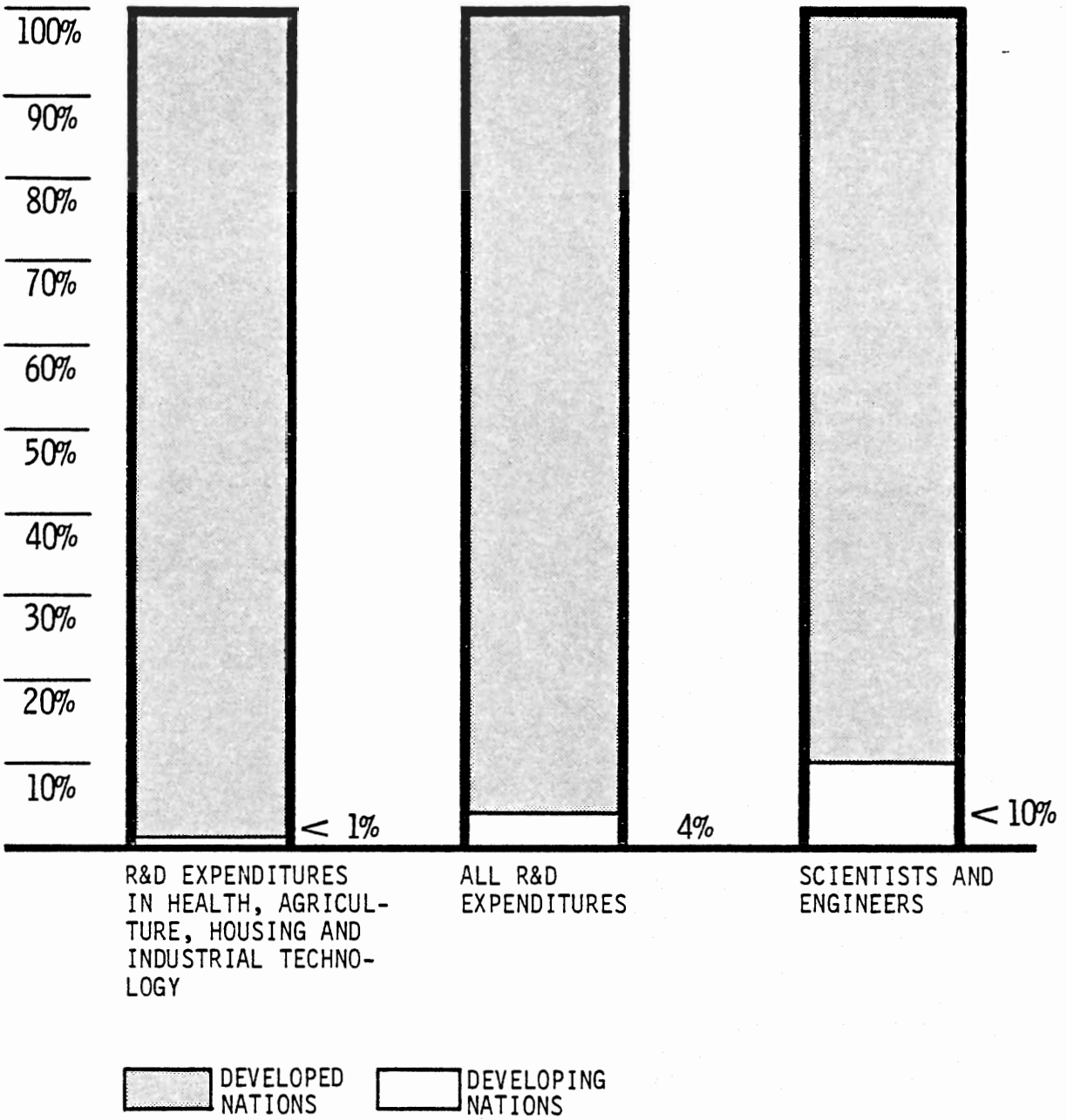
Figure 2

RESEARCH RESOURCE DISTRIBUTION



SOURCE: Jairam Ramesh & Charles Weiss, Jr., eds. Mobilizing Technology for World Development. Praeger, N.Y., 1979. p.28.

in (1) building research capacities in developing countries, (2) providing increased support for the international agricultural research centers, and (3) greatly increasing research efforts within the United States.

The recommendations call for substantial increases in the amounts devoted to research on the food and nutrition problems of developing countries by the United States Department of Agriculture, the National Science Foundation, the National Institutes of Health, and other government agencies, as well as the foreign assistance program. The enormity of the tasks proposed transcends the scope of any single agency. The ISTC will assume the pivotal role in facilitating and coordinating efforts undertaken by a variety of agencies.

The priority research needs relating to health problems of developing countries are no less important. The National Academy in 1979 defined seven areas in which the scientific and technological research expertise of the United States could make a major contribution to development efforts:

- Infectious diseases of the tropics;
- Water systems;
- Contraceptive technology;
- Nutrition;
- Infrastructure for primary health care services;
- Operational planning and management of health, nutrition, and family planning programs; and
- Policy planning and basic data systems.

Similar lists of priority research needs related to development problems are available in fields such as energy, natural resources, environment, urbanization, industrialization, and communications. The needs are many and the resources few. The problem for the ISTC will be sorting through the many priorities to determine the optimal allocation of the Institute's limited funds.

Capacity Building

The emphasis on strengthening the problem-solving capacity of developing countries is especially welcome to countries seeking self-reliance. Beyond considerations of national dignity lie solid technical reasons for building indigenous capacities. Technology adapted to local conditions will be required to deal with such problems as food production, health, and energy in the future. The industrial world, including the United States, could not undertake all the scientific research and technological adaptation needed in these areas, even if it was disposed to try to do so.

ISTC will help build the needed capacity through involvement of developing country institutions in worldwide research programs. Through collaborative involvement of the developing countries in the research process, potential benefits that may be derived from science and technology will be greatly enhanced.

Scientific breakthroughs and technological leaps, such as the discovery of DDT, the dwarfing of wheat and rice plants, and the gasoline engine, may occur in the future to the benefit of millions of people. But, as illustrated below, they must not be relied upon to the extent of not exploring alternative and/or complementary solutions to problems.

The DDT-based eradication campaign aimed to rid the world of malaria. It succeeded in some areas, but in most tropical countries the disease has had a resurgence to levels rivaling the worst experiences of the past. As a result of overreliance on "miracle" pesticides, investigation of alternative methodologies was neglected and two decades of research experience was lost. Now it is recognized that malaria will need to be controlled through a variety of measures in which malariologists once were skilled, such as environmental manipulation, larvicides, and drug treatment and prevention. All of these could be greatly improved by research and development involving experts from both the developed and developing countries. The discovery of an effective vaccine would play an important role in controlling the disease, but this will require many years of research. Even when a vaccine is available, there will still be a need for improved measures for disease surveillance, prevention, and treatment.

Similarly, as the price of petroleum rises, increasing ingenuity will be required to harness energy from a variety of sources that will differ from one geographical area to another. Research and experimentation on energy production from renewable sources was neglected during the era of low-cost petroleum. Although major gains may be made by advances in nuclear and solar technologies and the development of synthetic fuels, few believe that any of these can provide inexpensive energy for developing countries within the foreseeable future. Every country will need the capacity to exploit its natural opportunities for energy creation.

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In food production, many crops that form the staple of the diets of the poor in developing countries have not been addressed by the more sophisticated research techniques that have proved so successful in improving temperate zone crops. Local research capacity is required to increase yields and improve the food quality of such plants as cassava, lentils, millets, winged-beans, and yams.

Scientific advances made elsewhere almost always require adaptive research in the developing countries before they can be applied. The capacities of most developing countries for conducting research on crops of largely local importance, and for adapting and applying research results on the crops studied elsewhere, is, with few exceptions, currently very limited.

Food production, energy creation, and disease control all involve societal as well as technical processes. Understanding those processes and bringing about changes in them require a sound understanding of the society concerned, and research on these matters to a large extent must be done locally. The applied social sciences are thus an integral part of a country's problem-solving capacity.

Scientific and Technological Collaboration

International cooperation in recent years has produced significant advances in knowledge useful to developing countries. The international agricultural research centers, the first four of which were pioneered by private foundations, provide outstanding examples of successful collaboration between scientists from industrialized and developing countries. In the medical field, collaboration between the Center for Disease Control in Atlanta, the National Institutes of Health, and the Cholera Research Institute in Bangladesh (now the International Center for Diarrheal Research) was similarly successful. The ISTC will assume responsibility for U.S. contributions to these important international efforts, and for contributions to other multi-lateral programs such as the WHO Program in Tropical Disease Research and Training (TDR).

Increased cognizance must be taken of current and planned programs in other developed countries. It is noted that from 1960 to 1977, the United States share of development assistance provided by the western industrial nations and Japan declined from 58 percent to 28 percent, although rising slightly in nominal terms. With increased numbers of multi-lateral and bilateral organizations providing assistance, the need has grown for better coordination between United States scientific and technological activities in development and the work of others. ISTC will provide a focal point of coordination for United States foreign assistance programs.

The ISTC will also serve to stimulate the formation of collaborative links between United States institutions and regional and national research systems in developing countries. Cooperative regional efforts, exemplified by The Association of South East Asian Nations and the Andean Pact, are increasing in importance as a means of pooling scarce scientific resources for common purposes. This represents a trend that deserves United States support and encouragement. Bilateral linkages between research institutions will also be valuable, particularly if they are focused on carefully defined development problems.

The ISTC will also seek to improve United States mechanisms for interaction with universities, research stations, and individual scholars from developing countries. United States institutions will continue to be a major training resource for scientists and technologists from developing countries. In this context, renewed attention to placement procedures, the relevance of courses to developing countries, and methods of recruiting United States scholars for service abroad are required.

Little appreciated is the fact that research on problems of importance to the developing countries often produces results of direct benefit to this nation. Varieties of food crops developed abroad but now grown by American producers include lentils from Turkey that have winter production potential, soybeans from China, potatoes incorporating Andean genes, Nigeria beans of high nutritional quality, and virus-resistant pangola grass from South America. The United States is also using food fortification techniques developed abroad and is benefiting from studies that link diet to cancer, coronary heart disease, and other illnesses that afflict Americans.

Techniques devised for the detection and containment of smallpox outbreaks in developing countries are now being successfully applied in the United States to control measles. The stimulus for development of a heat-stable measles vaccine, now recognized to be of great value in this country, derived from the need for such a vaccine in tropical areas. Efforts made in and for developing countries to simplify and reduce the costs of immunization pro-

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grams and of therapy for tuberculosis have been translated into practice in America. Recommended childhood vaccination schedules here have been changed because of the discovery in developing countries that several vaccines could be successfully and safely administered at one time. Finally, contemporary methods for the ambulatory treatment of tuberculosis were developed and perfected in Asia.

Interest of Developing Countries in Scientific and Technological Cooperation

The developing countries differ substantially from one another. Some countries, particularly in the Far East and Latin America, have industralized to a substantial degree, and the oil-producing countries have in some cases become wealthy, but most countries remain quite poor.

As change has taken place in the developing countries, United States foreign assistance has adapted and modified its programs. Paradoxically, this has resulted in the reduced involvement of United States scientific and technological skills and institutions in development efforts in these countries, as well as diminished access by these countries to United States scientific resources. Many U.S.-trained scientists and many institutions created with U.S. assistance have less contact with the United States now than was common only a few years ago. This is due in part to the concentration of concessional aid in poorer countries in a direct effort to alleviate poverty and a withdrawal of resources from "middle-income" countries. It results also from the concentration of research resources for development in special centers with western scientific leadership. These trends have had the unintended effect of preventing developing countries from playing a more dynamic role in solving technological problems in their own advancement.

At the same time, the developing countries have expressed increasing interest in deriving greater benefits from science and technology. National authorities, however, appreciate that they lack the knowledge and the institutional strength to deal by themselves with the formidable problems of increasing food production, curtailing population growth, and preventing or curing disease. Trained researchers in the developing world express concern about their intellectual isolation and the shortcomings of available research facilities. Compounding the problem is an increasing recognition of the problems implicit in direct technological transfer. Common to all countries of the Third World is a keen desire for greater "self-reliance."

President Carter, in announcing his intention to create the ISTC, told the Congress of Venezuela on March 28, 1978, that the new institution would help developing countries become more self-reliant by strengthening their technological capabilities. This can be achieved only through an increased measure of genuine cooperation, based on peer relationships, mutual interest and respect, and shared costs.

The Third World objectives were reflected in the agenda for the United Nations Conference on Science and Technology for Development held in Vienna in August 1979. The Conference dealt with the choice of technologies and their transfer, the elimination of obstacles to a better understanding or a better use of science and technology, methods for integrating science and technology into economic and social development, and the development of new science and technology to overcome obstacles to social and economic growth.

The Conference affirmed international support for building the capacity of developing countries to undertake more of their own research and development, particularly in areas that most directly affect the lives of their own people, such as food production, health, energy, and the production of goods for domestic consumption. The creation of a special voluntary fund for this purpose was approved in principle by the General Assembly. Activities made possible by such a fund would be highly complementary to those of ISTC.

Third World interest in science and technology and, in particular, the eagerness to cooperate with the United States through the ISTC was affirmed during visits by the President's Science Advisor, Dr. Frank Press, to the Caribbean and South America in October 1979. These sentiments were also shared at scientific and technical levels during meetings of ISTC planning staff with regional groups of scientists in Singapore, Nairobi, and Bogota during the past year. These meetings, arranged by the Kettering Foundation, permitted prospective collaborators with ISTC to offer advice on its purposes, procedures, and priorities before the Institute became established.

The 60 participants in these meetings warmly welcomed cooperation on pressing research problems, particularly those related to food production, health, and energy. They pointed out that their

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objectives were to build their own capacities for research on problems in the environmental and social context where they exist. They noted the inadequancy of information flow and collaborative mechanisms between advanced and developing countries and among developing countries. They anticipated that ISTC's problem-oriented program would foster international networks dealing with selected problems and that such networks would enhance their own efforts.

Specific benefits seen as flowing from ISTC activities included improved research planning and management, access to specialized equipment and rare skills, project support, staff development, and increased motivation for research on immediate problems. The participants urged ISTC to become involved in research on the social processes relating to the assimilation of technological change into sometimes resistant cultures.

The scientists participating in these meetings were most appreciative of the opportunity to make their views known before the Institute began operations, and they urged that there be continuing consultations with developing countries in setting ISTC priorities and designing programs. They found objectionable the practice of setting program goals in the donor country and expecting developing institutions to respond to an external agenda.

ISTC Programming and Planning

In order to establish its priorities and to carry out its functions competently and collaboratively, the ISTC requires a program planning and development process that is sensitive and responsive to the views of the scientific communities in developing countries and in the United States.

U.S. participation in international scientific and technological activities has three interwoven sets of objectives: developmental, scientific, and foreign policy. ISTC will primarily serve the development and scientific objectives, but its activities have a positive bearing on foreign policy as well.

Developmental Objectives: As a principal part of its role in improving the use of science and technology for development, ISTC will serve as the long-term research component of the development assistance program. It will have a problem orientation and be empowered to pursue its activities from the laboratory through the stages of technology creation and adaptation to pilot testing on the ground in developing countries. This will serve to prevent research activities from becoming isolated from the realities of the field and will serve to realize its ultimate mission, i.e., to discover and apply practical resources to improve the human condition. The problem focus will also permit a comprehensive attack on the cross-cutting problems without the geographical constraints of country programming.

Research has a different time horizon from operations, and the United States is not unique in separating research from the ongoing operational milieu of its development assistance agency. In 1971, the Canadian Government established an International Development Research Centre (IDRC) separate from its regular aid program. It has proved to be an effective institution, popular in the developing countries and emulated by several countries in Western Europe. Similar efforts in Sweden and the Netherlands are modeled on the IDRC, and the impetus to create ISTC itself owes credit to the IDRC.

Organizationally, the ISTC is a parallel agency to AID under the umbrella of the International Development Cooperation Agency (IDCA). This sister relationship should prove mutually beneficial, as AID helps in identifying problems requiring research and puts into practice technologies developed by ISTC.

Also benefiting from ISTC efforts will be developing countries, including those in the middle-income range, as well as multi-lateral international agencies and others.

Finally, special attention will need to be paid to the effect of science and technology on particular groups within society. The American Association for the Advancement of Sciences (AAAS), in a study of the special effects on women of technological change in the Third World, showed that some of the effects were particularly harmful. In other instances, the potential for benefits to women was not realized because their circumstances were not taken fully into account. The ISTC will seek to ensure, through its own staffing, its selection of recipient researchers, its choice of programs, and the analysis of problem-solving technologies in each sector, that the role of women in development is enhanced by the uses of science and technology.

Scientific Objectives: Beyond the development objectives, U.S. national interests embrace numerous science-related issues of interest to ISTC, such as aggregate world food production, population growth

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rates, environmental quality, natural resource exploitation, and disease control.

The problems of management, oversight, and coordination of the diverse range of United States research activities are formidable. Both the Executive Branch and Congress have addressed those problems. For example, the Federal Coordinating Council for Science, Engineering, and Technology, chaired by the President's Science Advisor, has been designated as the principal inter-agency mechanism for coordinating the science and technology-related activities of the Executive Branch. One of the Council's standing committees, the Committee on International Science, Engineering, and Technology (CISET), is chaired by the Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs and carries out this responsibility with regard to international activities. The creation of a subcommittee of CISET (to be chaired by ISTC) for the purpose of coordinating international science and technology activities with development implications is currently under consideration.

In 1978, the United States Congress passed Title V (Science, Technology, and American Diplomacy) of the Foreign Relations Authorization Act and created a statutory framework that emphasizes the need to use science and technology more effectively in United States foreign policy and to take international considerations into account in formulating domestic science and technology policies.

Two unique features of the ISTC will link these communities to the programing process. A Council on International Scientific and Technological Cooperation will advise the ISTC Director on policies, program planning, and procedures. As many as one-third of its members will be from developing countries. It is intended that the Council play an active and formative role in the major decisions of the Institute, and the legislation specifies that the Council shall advise the Director with respect to selection, termination, or significant change in program areas.

The Institute will also have a Fellows program for the purpose of bringing highly qualified scientific and technical experts into the work of the Institute for 2-to-4 year periods. Up to 20 appointments may be made each year, half from developing countries.

In formulating programs, the Institute staff will actively consult with the relevant research institutions in the United States and the developing countries, and will take cognizance of other international efforts in the field. Care will be taken to involve the private sector in program development and implementation. Once formulated, programs will be subject to peer review, using procedures similar to those of the National Science Foundation and the National Institutes of Health.

When the Institute undertakes a particular line of program activity, it is anticipated that from 5-to-15 years of sustained effort may be required before the program can be responsibly terminated. The history of the Green Revolution illustrates the need for this type of sustained commitment. This characteristic of problem-solving research will require the ISTC thoroughly to examine a problem and the prospects for its resolution before embarking on major efforts, and to continue monitoring it by professional evaluation throughout its course.

Foreign Policy Objectives: In international affairs, the quality of U.S. relationships with developing countries is more important than ever before. The science and technology content of United States relationships with Third World countries forms one of the primary strands of mutual interest and, being largely devoid of idealogical and religious overtones, is one of special importance.

Of particular interest are the influential Third World countries in the middle-income group, which are no longer, or never were, AID beneficiaries. Scientific and technological relationships with these countries continue to exist, primarily in the area of military, industrial, and commercial activities. These activities are important but do not relate directly to the well-being of the poor. Although it would be inappropriate for the United States to resume concessional assistance to middle-income countries, some mechanism is needed to facilitate a broader American interaction with these countries. The ISTC, able to undertake shared-cost programs on the basis of mutual interests and peer relationships, will take at least a small step in the direction of more balanced relationships.

The ISTC should not, therefore, be viewed only in the context of foreign assistance. Its functions and style should continue to serve United States interests in international relations long after concessional programs have ceased to be required.

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3. Program

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Overcoming World Hunger — $61.4 million

Nature and Importance of the Problem

The report of the President's Commission on World Hunger emphatically underscores the concern of the United States in helping to eliminate world hunger. The extent of world hunger has been variously estimated. It affects a significant proportion, perhaps as much as a quarter, of the total world population.

"Undernutrition" is, in many ways, the worst form of hunger. It is more widespread and less obvious and dramatic than the famines caused by natural disasters and war. Undernutrition is also more devastating because of the enormous number of people it robs of the vitality to lead fully productive and satisfying lives. Reliable estimates show that in the period 1972–74 some 446 million people (excluding those in China) had a food intake below that required to provide the energy needed by a person at rest and far below that required by an active person. This persistent undernutrition seriously retards the economic growth of developing countries and prevents the improvement of the well-being of hundreds of millions of people.

Alleviating world hunger is partly a matter of increasing the total supply of food, and partly a matter of its distribution among the people of the world. The needs of the poorer people of the world have received relatively less attention from science and technology. The resources they control are generally less responsive to technological input. According to a 1979 study by the International Food Policy Research Institute (IFPRI), total food imports by developing countries with food deficits in the year 1990 are expected to be three times what they were in 1975. For those in the group that had less than $300

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average income per person in 1973 (representing more than 60 percent of the population of the non-communist Third World), it is estimated that their food deficits will be six times greater in 1990 than they were in 1975.

Although there may be occasional temporary improvements in the world food situation, a number of trends indicate that the general outlook is not good.

1) Population pressures. Although the growth of total world food production since the 1970's has been greater than the growth in population, there is evidence that the gap is now closing. Moreover, the picture is not the same for all countries. The annual percentage growth in cereal production between the periods 1961–65 and 1972–74, for instance, fell behind the rate of population growth in 52 of 110 countries studied by the International Agricultural Development Service (IADS).

2) Limitations on land use. Past increases in world food output have been achieved largely by expanding acreage. For the next 25 years, as reported in the 1977 World Food and Nutrition Study carried out by the National Academy of Sciences, crop area is unlikely to grow by as much as one percent annually. Thus, most of the increased food production will have to come from intensification of agricultural production, that is, from increasing crop yields per cultivated acre. Much of the technology to achieve this increase is restricted not only by rising energy prices but also by lack of adaptability and by lack of institutional mechanisms for achieving more widespread use of appropriate technologies.

3) Energy cost pressures. The rising cost of fertilizers, pesticides, and fuel for machinery has made the prevailing production technology in advanced countries much less usable in the poor countries. A further problem is the higher cost of food imports from these more advanced food surplus countries.

4) Income pressures. As incomes have risen, food consumption has increased, especially in the middle-income countries. While this is beneficial to those whose incomes are rising, the result is an increased demand for grain staples to feed livestock. The poor, however, depend upon these grain staples. There is also a change in world demand. Even in developing nations with relatively higher food production, the increased output has not satisfied the increased demand for food. For example, in 16 countries that increased their staple food crop production by an average of 58 percent between the periods 1961–65 and 1974–76, net imports of food increased 133 percent during the same period. These imports represent a growing demand for food supplies and work to the further disadvantage of the poor countries.

The Role of Research in Combatting World Hunger

In calling for increased levels of United States development assistance, the President's Commission on World Hunger said that there is a "long-term need to direct a far larger share of America's research capabilities and research budget to the task of overcoming hunger and poverty in developing nations." Although research alone cannot solve the problems of hunger and undernutrition, progress in alleviating these problems will be possible when readily adaptable and appropriate technologies are developed. Developing these technologies requires both the systematic generation of new knowledge and the equally systematic application and dissemination of that knowledge.

At present, most farmers in developing countries rely on guesswork and past practices. And, as noted by the President's Commission, they are the ones who must achieve the unprecedented increases in food production required.

The Benefits of Research

What promise is there that research can contribute significantly to the alleviation of world hunger? Although the scientific evidence is limited, that which exists suggests that the payoffs are large.

In September 1979, for instance, *Science* magazine published an article showing calculations from six recent studies of rice research in Asia. It reported rates of return, in the sense of total economic benefit attributable to expenditures on research, ranging from 27 to 102 percent and higher. (The typical rate of return on commercial investments is in the 10–15 percent range.) Case studies also exist that trace the adoption of new practices to purposeful efforts at adaptation and application of new technology.

Research on soybeans is a specific example of benefits to both the United States and other countries. Although soybeans have been relatively neglected until recently, research on this crop has

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increased yields, greatly expanded the potential growing areas, and provided more uses for it as a nutritious food both here and abroad. The crop has become important to American farmers and increasingly valuable in meeting the protein needs of the developing countries. Some of the crops under study in the developing countries in the ISTC program are at the stage of research where soybeans were 60 years ago. Many of these — winged bean, *leucaena*, and others — appear to have a similar potential.

The ISTC Strategy

ISTC's research approach to the problems of world hunger is twofold: to increase agricultural productivity and to promote the equitable participation and involvement of poor people in production and better nutrition. Greater productivity of the principal food crops will be a major goal of this research, which will build on the work in rice and wheat that made possible the Green Revolution. Biological innovations, farming systems, and risk-reducing technologies that will most benefit the poorest farmers and farm laborers constitute a more recent and growing emphasis. ISTC will sponsor and encourage a mix of policy- and technology-oriented research particularly relevant to the needs of these people. The ISTC program will also help build Third World capacity for addressing development problems by supporting more involvement of developing country institutions in this research program. The NAS study emphasized the need to build research capacity in the developing countries themselves, as well as to direct United States research activities more to global requirements for more food and better nutrition. Since an estimated one-third of the world's agricultural research is currently carried out in the United States, its contribution to the massive effort that the NAS believes to be required is still central. These are some of the basic concerns of the Institute's program.

Organization of the ISTC Program

The ISTC's program is organized around five major issues: commodity productivity; production inputs efficiency; farm production systems; application and use of knowledge; and improving nutritional status. (See Figure 3 for budgetary allocations.)

Commodity productivity. The technology of the Green Revolution, involving high-yield seeds, fertilizers, irrigation, and other technologies still is the best method for producing enough food to feed the world, at least through the rest of this century. Attention will be focused on applying these techniques to the cereal grains and to the less studied grain legumes, roots, tubers, and vegetables that make up a significant part of the diet in the Third World. A separate program covers crop and food protection, including the pre-harvest and post-harvest phases. Animal sources of food are represented by programs on livestock health and productivity and on fisheries and aquaculture.

Production inputs efficiency. Promising leads will be followed that will study the potential, for instance, of biological nitrogen fixation, of plant breeding to enhance photosynthesis, and of plant utilization of both natural and applied production inputs.

Farm production systems. The Institute's program recognizes that all agricultural and food-related activities (on-farm and off-farm) take place within so-called "systems" of physical, biological, institutional, and behavioral elements and interactions. The ISTC will be structured to promote a systems approach to multiple and sequential crops, farm organization, and introduction of new crop methods for small farms. Also included will be the study of the institutions and patterns of social behavior that are directly and indirectly relevant to agricultural production and distribution.

Application and use of knowledge. The objectives are to promote the use and application of research results and to help provide poor people with greater control over the means for improving their situation in the light of research findings. Among the areas targeted for the Institute's attention are: increasing farmer participation in the development of research priorities; improving methods of communicating results to farmers; and identifying government policies that increase the rural poor's control and use of the techniques and resources for agricultural production.

Improving nutritional status. Despite greater attention to the problem of undernutrition in developing countries, very little is known about some of the specific factors that contribute to the problem. Studies are needed on the effects of sustained nutritional

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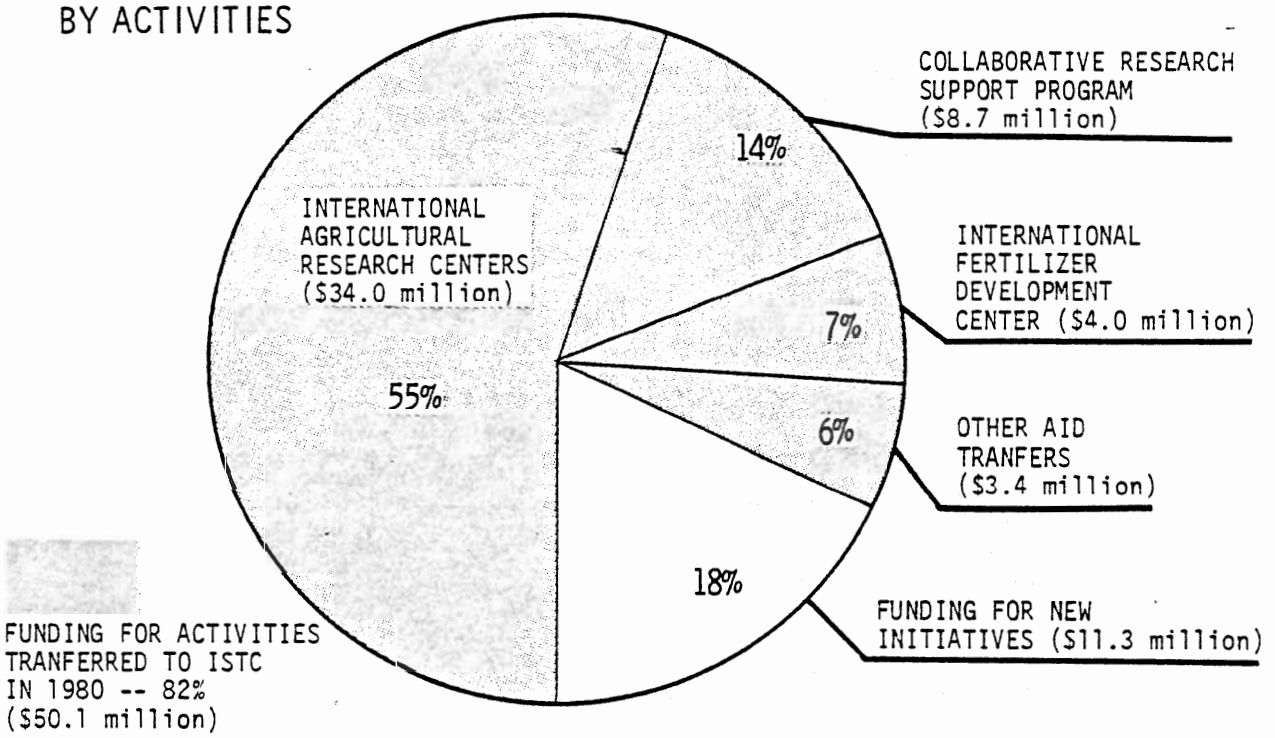
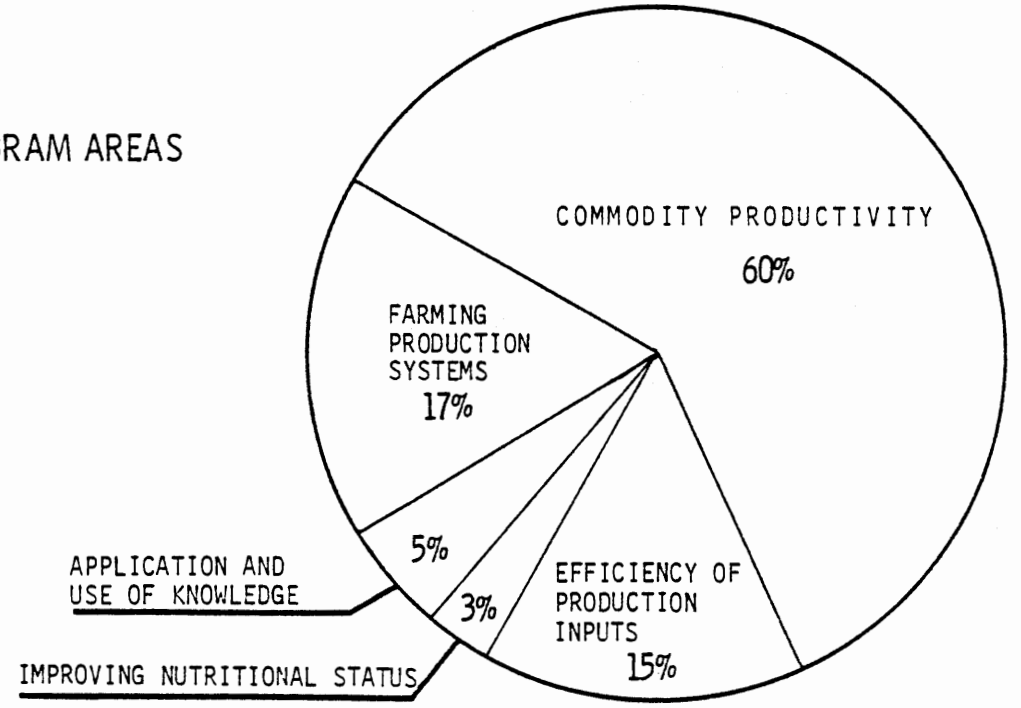
Figure 3

ALLOCATION OF THE ISTC WORLD HUNGER PROGRAM, FY 1981 ($ 61.4 MILLION)

A. COMPOSITION OF PROGRAM BY ACTIVITIES



B. MAJOR PROGRAM AREAS



deficiences on basic human functions, adaptive potential in people in areas of food deficit, and the effects of various incentives on dietary habits.

Transfer Funds and Their Relationship to Ongoing Research

Within these various program areas, ISTC will assume management of several important activities in agricultural research previously managed by AID. These areas include: the United States contributions to the international agricultural centers supported by the Consultative Group on International Agricultural Research (CGIAR)(See Appendix 2 for details); the Collaborative Research Programs (CRSPs) developed under the Board for International Food and Agricultural Development (Title XII of the Foreign Assistance Act)(See Appendix 3); several special research projects begun in earlier years, and support to the International Fertilizer Development Center (IFDC) in Alabama, and the Asian Vegetable Research and Development Center AVRDC) in Taiwan. (These centers receive contributions from other countries as well. Their activities are discussed elsewhere in this presentation.)

These ongoing activities to be subsumed by ISTC represent $50 million or 82 percent of ISTC's FY 1981 agricultural program. (See Figure 3 for detail on budgetary allocations of transfers.)

ISTC will manage these ongoing projects within an integrated overall program strategy for addressing the research problems of world hunger. The strategy follows that developed by the CGIAR, as well as priorities urged by the National Academy of Sciences and the President's Commission on World Hunger.

As ISTC implements its program, the overall effort will evolve in response to the increasing involvement of developing countries in the worldwide research networks. There is also a growing degree of coordination between the international agricultural research centers and the United States agricultural research community which will allow a more complete and efficient integration of United States research strength into the worldwide attack on world hunger problems.

In this regard, it is important to note that the Consultative Group has decided to plan continued program growth, though at a reduced overall rate compared with past years, projecting a doubling of total contributions over the period 1980–84. Further, it was decided to conduct a detailed review of its program, objectives, and future course during 1982. Participation in this review will give ISTC the opportunity to help shape the fugure plans of the widely-acclaimed CGIAR system. It will also serve to ensure that ISTC's related programs with developing country and United States scientific and technological institutions are fully attuned, both as to priorities and practice, to the work of the international agricultural research centers.

Program Elements:

Commodity Productivity — $36.8 million

Nature and Importance of the Problem. Food deficits are growing in developing countries and imports are increasing. Since there is little scope for opening new land areas to cultivation, most of the prospective increases in food availability will have to come from increasing crop and animal yields per cultivated acre or animal unit — that is, through the *intensification* of agricultural production.

Considerable potential appears to exist for increasing crop output per area unit. The International Agricultural Development Service, using FAO data, reports that there are currently wide differences in yield in the major crops which provide the bulk of the world's food. For instance, there is great country-to-country variation in yields of dry land cereal grains such as sorghum and millet. Of the 72 countries reporting sorghum production to the FAO, about half produce an average of one ton per hectare, while 20 percent produce more than two tons per hectare. Over 60 percent of the countries producing various forms of millet average less than one ton per hectare, while the remainder obtain between one and two tons per hectare.

With respect to grain legumes, the IADS reports that of the 82 countries producing common dried beans, 21 produced less than half a ton per hectare, but 22 others produced more than one ton per hectare. Similarly, for peanuts, half of the 83 countries reporting significant areas under cultivation harvested less than one ton per hectare, but almost 10 percent obtained over two tons per hectare.

Ruminants like sheep, goats, and cattle are adapted to grass and other sources of forage which otherwise would make little contribution to human food supplies. Many different approaches could serve to improve their productivity, including improved management techniques for rangeland accompanied

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by nutrient supplementation and animal health care. Although 10 percent of the world's land area is made up of permanent pasture in developing countries, access to large tracts in Africa is barred by a disease transmitted to cattle by the tsetse fly. Upgrading the genetic quality of livestock adapted to widely different local conditions is possible through artifical insemination. The controlled management and cultivation of fish is still in its early stages of development, and involves only relatively few species.

Although much attention is given to the relatively well-understood principles of crop and animal production, the cross-cutting issues of reducing preventable losses due to pests and diseases are less well-understood. The use of biological controls, as contrasted with chemical controls, raises issues of relative costs, farmer safety, and environmental conservation.

Program Objectives. To increase production of crops and animal food products among leading commodities to provide significant marketable surpluses.

Major Research Strategy. Selectively remove the constraints on yield per area unit or yield per animal unit of major food commodities. This strategy includes modifications of the plant or animal, or the environmental and socio-economic conditions relating to them, such as breeding and genetic improvement, modification of structure or form, nutrient and water management, pest and disease control, density of spacing, logistics of input availability, input-product price relationships, resource competition from other enterprises, labor costs and management, public regulation policies, public research and extension policies, and popular tastes and habits.

The ISTC Program. The ISTC will concentrate on the development of methods to increase production of major food commodities: the major cereal grains and the less-studied grain legumes, roots, tubers, and vegetables. A program area is devoted to the so-called "new crops" consisting of poorly known plants which appear to have a significant unrealized potential and which have received little, if any, research attention. A separate program area is directed to strategies and techniques of crop and food protection, including pre-harvest and post-harvest phases. Programs to develop animal sources of food include those dealing with livestock health and productivity and fisheries and aguaculture.

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Title: Cereal Grains

Purpose: To develop varieties and cultural practices that increase the productive capacity of the basic cereal grains, including rice, sorghum, wheat, millet, maize, and barley.

Importance: About 80 percent of the current output of the major staple foods in the developing countries are cereal grains. Cereals are grown in every country and are important in the diets of most people, especially the poorest. They are the major sources of calories for energy but often lack the adequate protein-calorie balance necessary for proper human nutritional health. Low-income countries in the tropics face particularly difficult problems in developing farming systems that produce high, stable yields of cereal grains with a minimum dependence on energy and capital. Continued research is needed on these crops to increase and stabilize production and to improve crop quality. Even the Green Revolution cereals, wheat and rice, need improved productivity, adaptability, disease and insect resistance, and characteristics to make them more palatable and nutritious. At present, increased yields of cereal crops require nitrogen and other nutrients from fertilizer or alternative sources, along with protection from pests and proper crop management. Research is needed by national institutions to enable them to develop varieties adapted to local environments and farming systems. Crop management studies will determine ways to optimize production for the benefit of the farmer.

Location of Activity: Given the extent of interest in research on cereal grains, collaborative activities will be widespread. Because of the importance of cereal grains as food, the International Agriculture Research Centers (IARCs) have allocated almost two-fifths of their budgets for activities pertaining to cereal grains. These projects include work on the following: (a) rice — the International Rice Research Institute or IRRI (Philippines); The International Institute of Tropical Agriculture or IITA (Nigeria), and The West African Rice Development Association or WARDA (Libera), together with cooperative activities at The International Center for Tropical Agriculture or CIAT (Colombia), and in several other developing countries; (b) wheat, triticale, and barley — The International Maize and Wheat Improvement Center or CIMMYT (Mexico) and The International Center for Research in the Dry Areas or ICARDA (Egypt), with cooperative activities in several other countries supported by research to develop new wheat varieties through crosses of spring and winter wheat being conducted at Oregon State University; (c) maize — CIMMYT and IITA with cooperative activities in several countries; (d) sorghum and millet — The International Research Institute for the Semi-Arid Tropics or ICRISAT (India), with major adaptive breeding and agronomic programs in West Africa and other countries. These are coordinated with the Title XII CRSP on sorghum and millet to be implemented in several countries in Africa, Asia, and Latin America in conjunction with the Universities of Nebraska, Texas A&M, Kansas State, Kentucky, Purdue, Mississippi State, Arizona, and Florida A&M.

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Title: Grain Legumes

Purpose: To develop varieties and agricultural practices that increase the productive capacity of the basic grain legumes, including common beans, lentils, broadbeans, cowpeas, groundnuts, soybeans, chickpeas, mung beans, and pigeon peas.

Importance: Some 500 million people live in the semi-arid tropics, where the grain legumes are a vital component of diet. Elsewhere in the humid tropics, where populations are denser than in the semi-arid areas, legumes are also important dietary components, providing the most significant proportions of available protein to the poor.

Compared to cereals, the grain legumes are low in yield. The wide variability in legume yields throughout the world suggests great potential for increased production and subsequent improvements in the diets of the poor. In addition to providing essential protein, the legumes also provide calories and, in some cases, high-quality cooking oil. A major advantage of grain legumes is their ability to obtain nitrogen from the air through a unique symbiotic relationship between the plant root and specific root nodule bacteria. Pre- and post-harvest food losses due to pod shattering in the field, diseases, insect pests, weeds, and predation are serious. Factors in the harvested seed which hamper digestion often make processing mandatory.

At least half of the increase in soybean productivity in the United States in recent years is due to improved varieties, and half is due to improved agricultural practices. Methods of increased grain legume production in the developing countries are not available today but could be developed if existing problems were given adequate attention. Approaches to this problem include improvement in breeding for disease resistance, biological nitrogen availability, fertilizer response, seed quality and uniform seeding stands, water control, and pest and disease resistance, as well as in the associated techniques of farm management.

Location of Activity: Research activities in the past have emphasized the problems of the United States and Europe. Most developing countries have made some progress in research on indigenous grain legumes but lack adequate support. The International Agricultural Research Centers (IARCs) initially concentrated on the cereal grains but in recent years have increasingly taken up research on the relatively neglected grain legumes. ISTC will continue the support for, and expansion of the IARC programs, including those on common beans — CIAT (Colombia); lentils, chickpeas, and broadbeans — ICARDA (Eygpt), cowpeas and soybeans — IITA (Nigeria); peanuts, chickpeas, and pigeon peas — ICRISAT (India); and soybeans and mungbeans — the Asian Vegetable Research and Development Center or AVRDC (Taiwan). ISTC will continue support for the International Soybean Program — INTSOY (Universities of Illinois and Puerto Rico) and several projects in the biological nitrogen fixation program. ISTC will also, under the Title XII Collaborative Research Support Program (CRSP), further strengthen research efforts on common beans, cowpeas, and peanuts.

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Title: Roots and Tubers

Purpose: To develop more productive and pest-resistant varieties of roots and tubers, more effective agricultural practices and improved storage, handling, processing, and marketing techniques and materials.

Importance: Roots and tubers, such as cassava, potatoes, sweet potatoes, taro, yams, and cocoa yams, provide the basic diet for 400 to 500 million people in developing countries. These people are usually the poorest who cannot afford the relatively more costly cereal grains and grain legumes as the primary staple food in their diet. In 1976, about 177 million metric tons of roots and tubers were produced in developing countries, compared to 433 million tons of cereal. Although they provide 41 percent as much tonnage as cereals, roots and tubers provide only about 12–15 percent of the total caloric value of the cereals because of high moisture content. In many developing countries roots and tubers are the primary source of calories. In Zaire, Ghana, Mozambique, Tanzania, Angola, and Uganda they provide more calories than do the cereals, while they provide more than one-third as many calories as cereals in Kenya, Nigeria, and most South American and Carribbean countries. In Brazil, cassava is a primary staple. In 1962–63, Brazilian consumption was reported to be 124 kg of roots per person per year compared to 39 kg of rice, 27 kg of beans, and 17 kg of corn. In urban areas the per capita intake was 42 kg, whereas in rural areas it was 200 kg.

Although cassava, sweet potatoes, taro, and cocoa yams are grown in the humid tropics, potatoes are most often grown in the tropical highlands and in the temperate zones. Cassava is more drought tolerant than many basic food crops and is often grown in the drier areas. Roots and tubers, therefore, are adaptable to wide geographical and climatic zones. They can also yield much more carbohydrate per unit of land area per year than cereal grains. Yet, compared to the cereals, only very modest efforts have been made so far to develop new or improved root and tuber varieties, better production practices, and more effective storage, processing, and marketing methods. The result is that yields generally are low compared to their practical potentials, while storage processing and marketing are inefficient. The National Academy of Sciences estimates post-harvest losses of 25–35 percent of the harvested root and tuber crop to be the norm. Fresh cassava, for example, deteriorates markedly in three to five days after harvest and thus methods to increase its storage life are needed. Processing, which is common in cassava, is also rudimentary. Low-cost village-level processing technologies should be developed.

Location of Activity: The ISTC will provide partial core support funding to continue research on roots and tubers at three of the CGIAR International Agriculture Research Centers, which are: (1), the International Institute of Tropical Agriculture (IITA-Nigeria), which is working on cassava, sweet potatoes, yams, and cocoa yam breeding and agricultural practices; (2), the International Center for Tropical Agriculture (ICTA-Colombia) which is also working on breeding, variety trials, and production research on cassava; and (3), the International Potato Center (IPC-Peru) which is conducting a broad range of research and experimentation with potatoes. The ISTC will also support work on the sweet potato and white potato at the Asian Vegetable Research and Development Center (AVRDC-Taiwan).

The ISTC will also carry forward with planning for a CRSP on roots and tubers, which will eventually involve cooperative activities between appropriate United States universities and various research institutions in developing countries.

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Title: New Crops

Purpose: To evaluate and improve the economic potential of selected known, but underutilized, plants and crops. Plants selected for initial investigation are *leucaena*, the winged bean, plantains, and jojoba, although others, such as arid forages and legumes, may receive attention as the program develops.

Importance: The increased availability of economic plants for cultivation in densely populated areas and in sparsely populated marginal agricultural lands expands the opportunity for increasing incomes of relatively poor rural populations. Their availability also reduces pressures for food and fuel imports, conserves natural resources, and reduces pressures for migration to populated urban localities. An increased and more systematic effort is required to identify promising plants and associated research needs.

For instance, rapidly growing giant woody species of *leucaena*, a legume, have been identified and experimental stands established. Bushy varieties are being tested as potential fodder crops for livestock. Research is needed to reduce the toxicity of leucaena fodder, to increase its nitrogen fixation capacity (a phenomenon common to the legumes), to extend the range of elevation and latitudes under which giant species may be grown as a wood fuel (as discussed further in the energy and forest conservation program descriptions), and to develop crop management systems for various ecological zones and in agroforestry.

Winged bean is an almost totally edible nitrogen-fixing legume. It has potential as a commercial livestock feed. Dried seeds have 30–38 percent crude protein. Winged bean is widely grown as a backyard crop in mainland and insular Southeast Asia, South India, Sri Lanka, and Papua New Guinea. It has been little studied, with the result that the state of knowledge is comparable to that of soybeans 40 to 50 years ago.

The **plantain**, or cooking banana, is a familiar food crop in the humid lowland tropics throughout the world. It is especially important around Lake Victoria in East Africa, in humid parts of West Africa, in Southeast Asia, and in the lowlands of the Caribbean, Central America, the Amazon basin, and coastal South America. In these parts of the world, millions of people derive their major energy needs from plantains. Its advantages are high yields, minimal management requirements, ease of cooking and preparation, and relatively good nutritional qualities. It can also be fermented for ease in preservation. Research efforts should be directed to resistance to disease and environmental stress, yield stabilization, and more effective management methods.

Jojoba is a woody shrub from which Indians of the southwestern United States and Mexico harvest a bean that yields an oil virtually identical to sperm whale oil. It provides a source of income to poor people in dry areas who have few alternative employment opportunities in agriculture or in other economic activities. Jojoba oil has important industrial manufacturing and lubricating applications and is increasingly being used in cosmetics and pharmaceuticals. Research is needed on varietal selection, plant propagation, and plantation management for arid zones to achieve higher productivity on marginal dry lands (its natural habitat) and, through decreased costs, to extend jojoba oil into broader markets.

Location of Activity: Investigation of *leucaena* will be conducted by the Universities of the Philippines and Hawaii. The Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), located in the Philippines, has been the focal point of a modest network of specialists and institutions interested in the winged bean. This interest has been supported by AID. Discussions with the IITA in Nigeria, with the University of the Philippines, with the Tropical Agricultural Research and Training Center (CATIE), and with the private fruit companies interested in bananas in Central America will help establish research needs on plantains in which ISTC could play a role. Needs for research on jojoba will be identified in conjunction with scientists at the Mexican National Council on Science and Technology (CONACYT), with the University of Arizona, the Research and Development Authority of Ben Gurion University of the Negev (Israel), and the United States Departments of Commerce, Agriculture, Interior, and State.

A0080:870 OMB ISTC , Page 0032 is composer page 000041 DATE 02/15/80 roman. :10.0: 10.0: 38.0 W65:63 Reel 2840

Title: Livestock Health and Productivity

Purpose: To increase the productivity of livestock, particularly small ruminants, through improved breeds, control of major livestock diseases, and better use of range and crop residues for animal feed.

Importance: Animal products provide an important part of the nutritional requirements of the people in many developing countries. Meat and milk products are often the only source for some key nutrients. Demands for these products in the poorer countries are rising sharply. Livestock such as sheep, goats, swine, poultry, cattle, and water buffalo increase the available food supply by consuming and effectively processing plant materials which cannot be used for human consumption. Such materials include post-harvest crop residues and grasses and the leaves of trees and shrubs on lands not suitable for crop production. Commonly, almost half of the total digestible energy from crops is left in the fields after harvest while two-thirds of the world's agricultural lands are in the form of permanent pasture and range, most of which is unsuited for cropping. Livestock also provides a means to conserve and store food when other food sources become scarce. They are also a major source of fertilizer and a source for farm power and energy requirements. Small farmers can also supplement their incomes through local sale of animal products.

Animal diseases, such as foot-and-mouth disease and diseases borne by insect pests such as tsetse flies and ticks, have a devastating effect on livestock productivity. The FAO estimates that in 1970 the developing countries lost 30 million tons of milk and 15 million tons of meat and eggs from animal diseases. In addition, because of disease, large areas of the world with a significant potential for livestock production are unused or significantly underused. For example, lands in Africa with the potential of supporting 125 million cattle now support only 8 million because of tsetse fly-borne trypanosomiasis. A sterile male fly technique for control of the tsetse fly has been developed, but its success requires the development of an efficient fly propagation technique and program management methods. The shortage of adequate and/or balanced animal feeds also severely restricts livestock productivity. Improved forage plant varieties and better selection of existing varieties, especially tropical legumes, are needed to increase the capacity of rangelands and pasture. Inexpensive, locally produced mineral supplements are required to improve animal growth and reproductive rates and to strengthen overall animal health.

Location of Activity: The ISTC will continue support for the recently initiated Collaborative Research Support Program on small ruminants (sheep and goats) involving cooperative research efforts among five developing countries: Peru, Brazil, Indonesia, Kenya, and Morocco, and thirteen United States institutions. The CRSP program includes work on small ruminant nutrition and feeding, reproductive physiology, genetics and breeding, health, management, sociology, economics, and systems analysis. The ISTC will also provide continuing core support for research on livestock productivity at two international agriculture centers under the CGIAR. Work at the International Laboratory for Research on Animal Diseases (ILRAD in Kenya) will focus on the development of effective control measures for fly-borne trypanosomiasis and tick-borne thieleriasis in cattle. The International Livestock Center for Africa (ILCA in Ethopia) works on livestock production for arid, humid, and highland zones in Africa using a "systems" approach involving biological, social, and economic factors. Through the International Center for Insect Physiology and Ecology (ICIPE), the ISTC will support researchers in Kenya and Israel in studies directed toward more effective and lower-cost livestock tick control programs.

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Title: Fisheries and Aquaculture

Purpose: To develop effective methods of aquaculture, including breeding for high yield under enclosed conditions, improved supply of juvenile stock, nutrition, disease prevention and treatment, and the mixing of cultivated species in enclosures; to develop improved methods of stock assessment for off-shore fisheries; and to develop low-cost storage and processing techniques that will reduce waste and widen the market area.

Importance: An estimated 750 million people in developing countries derive 50 to 85 percent of their animal protein from fish. Aquaculture, or fish farming, is a relatively undeveloped technology that holds promise for increasing significantly fish supplies for people in and near coastal zones. Approximately 7 percent of the world's fish harvest is now derived from aquaculture. In Southeast Asia alone, it is estimated that a five-fold increase in pond aquaculture productivity could be obtained by improving fish feeds and cultivating more than one species in the same enclosure ("polyculture"). For instance, techniques of artificially induced spawning have already dramatically cut costs and supply constraints in the cultivation of the popular milkfish. Fish geneticists estimate that work in their area of specialization could provide annual increases in pond production on the order of 2 to 5 percent. In Brazil, for example, two varieties of the hardy and popular talapia have been crossbred to produce a high-yielding hybrid with a worldwide potential for cultivation.

Lacking accurate knowledge of offshore fish popuations, fishermen have sometimes overfished, cutting into the breeding stock for subsequent years, with harmful effects on subsequent employment and food supplies.

Waste is a serious problem in the use of fish for food. Fish deteriorate rapidly in the tropics when they are removed from the water. It is estimated that as much as one-third to one-half of the edible fish harvest is lost due to spoilage in transportation, processing, and marketing.

Location of Activity: The ISTC will provide partial support to the International Center for Living Aquatic Resource Management (ICLARM), located in the Philippines. Based on CRSP planning efforts conducted during the past 2 years, ISTC will proceed with research plans for pond aquaculture, beginning in Asia. Explorations are being conducted with institutions in Thailand, the Philippines, Indonesia, Malaysia, and possibly China by a group of three United States universities — Oregon, California (Davis), and Auburn. In future years, this work will be extended to other regions. Topics suitable for research are being explored in the post-harvest handling of fish, as well as in stock assessments within the 200-mile offshore limits of each nation's jurisdiction.

A0080:870 OMB ISTC , Page 0034 is composer page 000043 DATE 02/15/80 roman ;10.0; 10.0; 38.0 W65;63 Reel 2840

Title: Crop and Food Protection

Purpose: To devise cost-effective methods for reducing losses to crops (due to the action of pests and diseases and due to spoilage and other wastage in processing, storage, and distribution) while they are growing and after they are harvested.

Importance: Significant proportions of potential crop yields are lost because of weed competition; disease organisms; and attacks by insects, rodents, birds, nematodes, slugs, and snails. Animal pests and micro-organisms also cause significant losses to harvested crops during storage, processing, and transportation to market. Tropical environments and inadequate handling technology contribute to post-harvest losses.

In previously described programs dealing with specific commodities, techniques to combat insects, animals, weeds, and diseases will be part of the investigation. However, integrated programs to control crop pests and conserve perishable food commodities require specialist studies to analyze problems of loss in a wide range of crops and food products and to devise solutions.

To the extent that low cost, easy-to-conduct methods for pest control and post-harvest handling can be applied, important segments of potential food supplies now being lost can be economically conserved for use. For example, the Rodent Research Center in the Philippines and the Denver Wildlife Research Center developed a sustained rodent-baiting technique which reduced rice crop losses in areas of heavy rodent damage from 50 percent to 5 percent of the standing crop.

Another example is the root knot nematode, one of the five leading plant pathogens in the world. It causes damage to a wide variety of crops, including cereal grains, legumes, fruits, and vegetables in all parts of the world. In the United States alone, annual losses have been estimated at $1.6 billion. In developing countries, existing control technologies (about $35 per acre) are not economically feasible. Alternative approaches under study include the development of new cultivation practices which reduce nematode populations and the breeding of crop varieties resistant to nematode attack.

In addition to chemical controls, development of crop management practices which make the environment less hospitable to pests, and the breeding of resistant varieties, it is also possible to develop other organisms which act as biological controls of pests.

After a crop is harvested, losses may be reduced by the development of inexpensive methods of food processing, preservation, and storage which are adapted to local climatic, economic, and social conditions.

Location of Activity: In research, the ISTC will follow the recommendations emerging from two CRSP planning efforts dealing with integrated pest management and post-harvest food losses. The University of California, Purdue University, and the USDA's Animal and Plant Health Inspection Service are among those organizations having experience in these areas.

The ISTC will continue to support the collaborative work of North Carolina State University on root knot nematodes in conjunction with 91 cooperating institutions in 55 developing countries. The ISTC will continue to support Montana State University's work on diseases of barley, a staple crop of poor people in the drier areas of North Africa and West Asia, in cooperation with ICARDA and CIMMYT. Other ongoing work dealing with crop and food protection is included in CRSPs dealing with sorghum and millet, beans and cowpeas, and peanuts. The ISTC core support to the CGIAR system's units sustains pest management and post-harvest food handling work at these centers. Future program development will include contacts with the International Center for Insect Physiology and Ecology (ICIPE), which is already involved in livestock-related work supported by the United States.

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Title: Agricultural Production Policy

Purpose: To promote the formulation of public policies in developing countries which foster increases in the production of agricultural commodities for the benefit of people as producers and consumers.

Importance: The ability of farmers to use existing and emerging knowledge about improved commodity production is often constrained by factors that are beyond their control. For example, governments must make adequate investments in research to sustain potential and necessary increases in productivity. Recent analyses, however, show that research in agriculture is a consistently undervalued investment. This is a matter of public policy. Among the agricultural research needs, it is necesary to make allocations according to the importance of different commodities in diet, export earnings, numbers of cultivators, acreage planted, and similar criteria.

The terms and conditions of the availability of major agricultural production inputs, such as water and fertilizer, are also sensitive to public policies. For instance, public works construction and the availability of associated materials and equipment, especially if imported or fabricated domestically under license, govern water availability and these, too, are determined by public policy.

Emerging public policy issues also include such questions as the relative proportions of agricultural production that should be devoted to energy products versus food.

Policies for trade and food aid affect the domestic prices of harvested commodities and have an indirect impact on the prices and availability of purchased inputs for the production of a wide range of commodities. Policies for food supply security and stabilization also help stablize agricultural markets to the benefit of farmers seeking to predict returns at harvest time as they make planting decisions.

Governments must also appreciate that if they wish to make inexpensive food available to consumers while still encouraging production, low-cost purchased inputs must be made available to farmers.

Policy matters such as these are determined not by individual farmers but by government authorities, but all are influential factors affecting the life and well-being of the farmers.

Location of Activity: Through support to the CGIAR system, ISTC will continue to sustain the growing interest of the commodity-oriented International Agricultural Research Centers in dealing with public policies that affect the utilization of technical knowledge emanating from their programs. In 1979, the International Food Policy Research Institute (IFPRI) joined the CGIAR. One of the four principal areas of IFPRI's mandate is production policy, covering such areas as problems of growth and stability, growth and equity, agricultural prices, research resource allocations, investment requirements and efficiency, and irrigation and fertilizer policy. IFPRI currently is a focal point for the development of policy research. ISTC will keep in close touch with the evolution of IFPRI's program and explore the potential of an expanded research role for the ISTC on specific problems.

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Production Inputs Efficiency ($9.5 million)

Nature and Importance of the Problem. Plants take nutrient materials from the soil, water, and air and convert them into usable form for humans and animals, with the sun as the energy source. The nature and quality of these "production inputs" are thus of great importance.

The nature and quality of soils vary widely and require markedly different management by farmers. Although much progress has been made in the identification and understanding of soil differences, much remains to be done. Techniques that work in one location under one set of geographic and economic conditions are often not transferable to another. For example, forest soils deteriorate rapidly in quality for farming once they are cleared and cultivated with conventional farming practices. Under normal farming condtions, vast quantities of soil are lost to water and wind erosion.

The plant production breakthroughs that have marked the Green Revolution depend on matching high-yielding seed with fertilizer applications under favorable farming conditions. Fertilizers are thus a vital input to the production process. However, they are becoming more costly as the costs of energy and petroleum feedstocks go up.

Certain plants, most notably the legumes, such as beans, are able to use nitrogen that is drawn from the air by micro-organisms living in their root zones. This process reduces the requirements for fertilizer applications. However, because of the sensitive relationship between the host plant and the micro-organisms it shelters and supports and from which it benefits, the potential for this symbiotic relationship has not been fully realized as a practical farming technique. Many farmers who have the potential to take advantage of this process of biological nitrogen fixation are not yet able to do so. Little is known about the extent to which other kinds of plants, such as rice, wheat, and corn, may also be able to obtain nutrients from association with micro-organisms.

The process of photosynthesis, which uses solar energy to convert available nutrients to food, has been enhanced by plant breeding that has modified the exposed leaf area or shifted the timing of major growth periods to take greater advantage of available sunlight. There are, in addition, major differences among plants in this effectiveness in conserving and storing the products of photosynthesis. Some, like corn (maize) are relatively effective, while others are less so.

Genetically determined traits of different plants govern their ability to make maximum use of the water and nutrients coming to them. However, the genetic and physiological processes involved are not well understood.

Future developments in this area have the potential for improving the net performance of photosynthesis in other economically valuable plants. The ability to manipulate genes of economically valuable species would reinforce this line of work.

Program Objectives. To understand better the nature and improvement of plants, the natural resource environment, and applied production inputs with respect to the efficient uptake and utilization of productive factors by plants.

Major Research Strategies. To understand, conserve, modify, or condition crop environments so as to promote the most efficient, least costly production of food. Approaches to this strategy will encompass soil and water conservation; irrigation, drainage, soil conditioning, detoxification, soil analysis and classification; fertilizer production, formulation, marketing, and application; improvement of plant associations with other beneficial organisms; plant and animal shading; and the like.

To modify plant types so that they are more tolerant of environmental stress and make the most effective and efficient use of environmental factors and applied inputs in producing food.

This approach includes breeding, tissue culture, morphological and physiological modification, and the like.

The ISTC Program. The ISTC will continue and expand the deliberate exploration of the fundamental economic, physical, chemical, and biological processes affecting plants and their environments. They will be subject to testing and adaptation in specific conditions of developing countries. Emphasis will be on irrigation, drainage, and water conservation; soils and their management; the plant-microbe associations important in biological nitrogen fixation; the design, manufacture, and distribution of fertilizers; and the mechanisms by which plants adjust to the stresses of heat, drought, salinity, and chemical toxicity. The following sections discuss the program.

A0080:870 OMB ISTC , Page 0037 is composer page 000046 DATE 02/15/80 roman ;10.0; 10.0; 38.0 W65;63 Reel 2840

Title: Soils and Soil Management

Purpose: To find economic ways to increase the productivity of tropical soils while protecting them from short-term and long-term damage.

Importance: Food crop production is fundamentally based on the resources in soils. Most farmers in the developing countries work on relatively poor soils and the poorest farmers are usually on the poorest soils. In their efforts to make a living, they often degrade the soil and may further reduce its productivity. There is an urgent need to develop soil management techniques for use by farmers with little land and limited money to invest. Soil problems that are critical in food production include: nitrogen supply and efficient use; control of toxic quantities of aluminum and manganese and acidity; availability of phosphorus, potassium, sulfur, calcium, magnesium, and the eight essential nutrient elements required in smaller amounts; control of soil erosion; and the role of micro-organisms and organic matter in maintaining favorable soil fertility and structure. Research is needed to determine how soils can be economically sustained and improved by appropriate tillage, irrigation, drainage, and the use of fertilizers, lime, manures, and soil-conserving plants.

Development of the potentially arable land in the tropics of South America and Africa will be difficult and slow. Seventy percent of this land has acidic, high aluminum soils called oxisols. Growing conditions are far from ideal, and much research will be required before cultivated crops can be grown economically without adversely affecting the environment. For instance, under research conditions at one location in the Amazon jungle, 20 successive crops have been grown with improving yields in areas where fields are usually abandoned after three crops.

Because of widespread differences in soils, soil management research must be carried out in the country or ecological zone where the problems have been identified. The potential for transferring soil management practices to other soils classified in the same family of soils but located in different geographic areas is being tested through "benchmark" studies. Five major agro-ecological zones have been identified as target areas with the following priority: (1) Humid Tropics (2) Wet/Dry Tropics with Non-acid Soils, (3) Wet/Dry Tropics with Acid Soils, (4) Steep Lands, (5) Dry Cycle Paddy Soils.

Location of Activity: The ISTC is carrying forward the FY 1980 planning work on soils and soil management under a Title XII Collaborative Research Support Program (CRSP) with North Carolina State University as the planning entity. The program will include studies on ways to provide adequate soil nutrients, to overcome toxic factors (such as toxic aluminum), to minimize erosion, and to use appropriate tillage techniques on crops of local interest. Collaborating teams between countries such as Peru, Indonesia, Upper Volta, and Bangladesh, and United States universities will participate in this work. Support is also provided through the International Agricultural Research Centers under the CGIAR. These activities supplement and complement those of FAO and other international institutions. In future years additional work on benchmark soil studies may be warranted.

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Title: Water Management

Purpose: To develop methods for the analysis and management of water problems associated with irrigation, rainfall, and drainage.

Importance: Water is a major agricultural resource and a necessary condition for all forms of cultivation. Even though flooding and waterlogging are significant periodic or persistent problems of agriculture in various regions in the Third World, the major problem is its short supply and lack of dependable availability.

According to the NAS World and Nutrition Study, about 14 percent of the world's farmland is irrigated. This figure could perhaps be doubled in coming years. The remaining farmland will continue to depend on rainfall.

Virtually all of the International Agricultural Centers associated with the CGIAR devote research resources to water management. IRRI emphasizes irrigated rice cultivation but is also concerned with upland rice. ICRISAT has been a leader in watershed management under sparse rainfall conditions. Others could be cited.

The problems of irrigated agriculture include the important managerial requirement of organizing farmers and winning their cooperation in the use, upkeep, and financial support of shared facilities. In addition, there are serious problems with water quality and soil conditions including the recharge of the sub-surface water table. In certain dry areas, long-term irrigation has led to soil salinity, which has to be corrected and controlled through careful analysis and management. In still other areas, explorations of crop tolerance to saline water in varying degrees of concentration are taking place.

Location of Activity: In cooperation with selected CGIAR units and their networks of associated-country collaborators, the ISTC will develop supportive research and development studies. The NAS World Food and Nutrition Study lists on-farm water management, physical improvements, and new planning techniques to guide farmers as recommended priorities.

The Agricultural Development Council has developed and sustained an Asian Regional Irrigation Communication Network and its participants would be valuable contributors of ideas to the emerging ISTC program. In addition, there are a number of other organizations, such as the World Bank and the International Irrigation Information Center (Israel), which could also help in reaching program decisions on irrigated agriculture.

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Title: Plant Nutrients

Purpose: To develop low cost, effective means of providing nutrients to economically valuable crops through biological nitrogen fixation,the recycling of biological residues and wastes, and the application of commercial fertilizers.

Importance: Although agricultural soils provide significant nutrients to plants through the breakdown of parent materials, the decay of organic matter, and the in-flow of compounds dissolved in groundwater, economically valuable crops usually demand much higher levels of nutrients than are commonly available. The principal supplemental nutrient elements required by most plants are nitrogen, phosphorus, and potassium although there are some 14 other essential elements needed for adequate plant growth. Because of the variability in soils around the world and because of the variation in nutrient demands among different crops in different situations, it is possible only to derive general principles of plant nutrient analysis and the derivation of effective management practices to meet those needs. The rest must be left to adaptive research under specific conditions.

The single most important element for plant life and growth is nitrogen. The lack of adequate nitrogen supplies for agricultural crops is generally regarded as the single most important constraint to the rapid expansion of global food production. The United Nations Industrial Development Organization (UNIDO) has estimated that farmers in developing countries will need about 50 million metric tons of nitrogen fertilizer (worth about $50 billion) per year by the year 2000.

Certain types of plants, particularly the legumes (the bean and related group), are able to draw upon nitrogen from the air by a natural process involving a symbiotic relationship with specific bacteria contained in nodules in the plant's root zone. Biological nitrogen fixation provides an alternative to the application of commercial nitrogen fertilizer. Under conditions where the soil was innoculated with a few ounces per acre of material containing a proper microbe strain, legume yields have been increased by as much as 100 percent. Much work has yet to be done on identifying the particular bacterial strains that relate to particular crop species and developing effective measures for soil innoculation with these microbes.

Other natural nitrogen-fixing systems have been discovered that involve other kinds of plant-microbe relationships in crops such as rice, wheat, and maize. However, these are not yet well-understood or developed technologically and will require extended studies to determine their fundamental mechanisms.

In addition, it has been known for some time that mycorrhizal fungi growing in the roots of tropical plants help the roots pick up needed nutrients, especially phosphorous, without harming the plant. Because phosphorous is such a vital nutrient to many plants, research is needed to develop practical, economic methods of using mycorrhiza to a greater extent.

Commercially manufactured and formulated fertilizers have been, and continue to be, the mainstay of crop production increases. The Green Revolution was built around cereal crop varieties that could efficiently convert applied fertilizers to grain under otherwise favorable farming conditions. The most pressing problems in fertilizer research include lowering the costs of raw materials; production and distribution in a time of rapidly rising costs for energy, petroleum, and other feedstock; and the development of more efficient slow-release techniques for applying fertilizer in the field.

Location of Activity: ISTC will continue and expand research on biological nitrogen fixation in the tropics for both the legumes and the grasses (such as rice, wheat, maize) in a series of programs involving the United States Department of Agriculture, Brazil, and the Universities of Hawaii, Puerto Rico, Cornell, North Carolina State, and Florida. The International Agricultural Centers which have significant programs in legumes and farming systems (CIAT, ICRISAT, IITA, ICARDA, and IRRI) include research on biological nitrogen fixation. Egypt, Mexico, the Sudan, Panama, and 10 other countries are also actively cooperating with the United States in biological nitrogen fixation in legumes.

Through support to the International Fertilizer Development Center (IFDC), ISTC will be continuing to support crucial work on the manufacture, distribution, and application of fertilizers to meet tropical crop needs for nitrogen, phosphorous, sulphur, and other elements.

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Title: Plant Stress

Purpose: To develop crop plants that can produce in hostile environments.

Importance: The productivity of a plant in a changing, often hostile, environment is determined by its ability to tolerate and overcome stresses such as heat, cold, wetness, dryness, toxicity, acidity, and the like. A stress is placed on a plant when any environmental factor deviates from the optimum range. The effect of the stress on yield depends on the severity of the stress and the ability of the plant to tolerate it. Plant stresses are greater as agriculture moves into marginal areas where farmers are usually the poorest. About 40 percent of the world's soils that could be cultivated are sufficiently acidic that aluminum restricts crop growth. Drought occurs periodically in nearly all cultivated areas. For instance, in semi-arid areas, one of the worst problems facing farmers is the instability of yields from one crop year to the next due to the impact of year-to-year variations in rainfall. Salinity is a hazard in more than half of the soils under irrigation. These hazards can be ameliorated by using costly inputs to change the environment, but plants that could produce well with a minimum of inputs would be especially valuable to poor farmers in developing countries.

New methodologies and new approaches promise to provide cost-effective ways to obtain stress-tolerant plants. These approaches include tissue culture, physiological studies of stress tolerance, the analysis of photosynthetic efficiency, and methods of genetic manipulation. One example of the usefulness of tissue culture is illustrated in work at Colorado State University. Using a tissue culture of a non-food crop (tobacco), researchers selected plant cells that tolerated much higher levels of salt than the original cells. These cells were regenerated into whole plants that retained tolerance to higher salt levels from one generation to another. Research is needed to determine how this technique can be used to develop food crops tolerant of soil conditions that are too costly to correct.

Location of Activity: The program of research development on plant stress will require considerable scientific refinement, but it offers great promise of achieving significant cost-effective plant development. Tissue culture studies to improve food crop varieties will continue at Colorado State University. Efforts will be made to develop wheat lines tolerant of salt, aluminum, high temperature, and drought and to develop similar tolerances in rice and millet. The role of ISTC in promoting and supporting research on physiology and on photosynthetic efficiency will be explored to identify other possible developments.

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Farm Production Systems ($10.3 million)

Nature and Importance of the Problem. When research attention focuses on particular crops, it tend to divert attention from the variety of farm enterprises in which cultivators are engaged and the possibility of using farm resources more intensively and effectively than at present. Systems of farming may be as different as migratory sheep herding in the Middle East, settled small-holder agriculture in Southeast Asia, or slash-and-burn cultivation in the forests in central Africa.

The elements of farming systems research and design cover a wide range of factors. This research approach differs from crop-oriented research, as commonly practiced, where only a few factors are dealt with at any one time. Because of its complexity, farming systems research is more difficult. Only within the past decade has it received scientific attention in international agricultural development. Four of the International Agricultural Centers under CGIAR have formal programs in farming systems research, and others include relevant approaches in their crop and livestock research.

The approaches and concepts used by these organizations differ to a significant degree. Some focus on crop-to-crop relationships (either simultaneously or in sequence) on known soils under controlled climates; others take a broad approach to crop ecology in different agro-climatic zones and may or may not include livestock enterprises. In principle, most scientists acknowledge the importance of economic and social factors to which farmers must accommodate, but few include them in their research.

Although the major staple food crops, such as wheat, rice, maize, sorghum, and millet, are included in farming systems research, most farming systems work has studied small-farm operations in which a diversity of crops is grown. Efforts are directed toward reducing the diversity and making them more manageable, productive, and efficient through systems analysis, design, and management that can be adapted and made operational in specific localities. This research provides important ways in which small farmers can be directly involved in a developmental process contributing to their own well-being.

Many crops now grown by small farmers have not been well-studied. Scientific attention has been and continues to be concentrated on those staples which give the greatest promise of meeting basic caloric energy requirements. As knowledge of farmer and consumer preferences has increased, growing attention has been given to other crops that are significant components of local diets, especially in those areas where farm resources are of a poorer quality than those where grains are commonly grown. The selection, improvement, adaptation, and introduction of little-known but promising plants into customary farming systems have the potential for raising the productivity of small-farmer operations in specific situations.

Program Objectives. To develop unifying concepts of farming systems that contribute to small-farm development; to develop methods of farming systems design and testing that are useful in implementing improvements in farm organizations; and to identify and analyze plant-to-plant relationships under various types of soil and other environmental conditions.

Major Research Strategies. To develop a coherent conceptual basis for the study and design of farming systems. Approaches under this strategy include the collation and interpretation of how terms such as "cropping systems," "multiple cropping," and "farming systems" relate to each other in order to understand small-farm agriculture as a whole, and provide guidance in the improvement of small-farm effectiveness in meeting food needs.

To devise guidelines for analyzing and designing the improvement of farm organization and operation. This strategy focuses on determination of the level of generalization at which farming systems methodologies can be developed that are further adaptable under specific conditions. By such means the participation of small farmers can be used actively in purposeful measures for agricultural development.

To determine what occurs in the micro-environment of plants grown in association with other plants. This includes the determination of what the physical, biological, and other conditions are in the zone immediately surrounding plants grown in sequence with other plants, or grown at the same time under various agro-climatic conditions.

The ISTC program consists of a series of background studies dealing with concepts and methodologies for the study and improvement of farming systems and the study of the micro-environments in farmers' fields. These are discussed in the section which follows.

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Title: Background Studies in Farming Systems

Purpose: To develop concepts and methodologies for farming systems research and design and for the study of root zone ecology where more than one crop species is cultivated.

Importance: Carefully designed farming systems have the potential of significantly improving output on small farms operated by poor people and of improving the diets of people who subsist largely on their own output. Many poor farmers themselves have developed resource-conservative farming systems that optimize total output under conditions of scarce land or other constraints. Because many organizations are now undertaking farming systems research in one form or another and because experiential wisdom has evolved in many traditional systems of farming, significantly different concepts of the nature of such systems have developed. The various working definitions deriving from different kinds of farming systems study and practice need to be compiled and reviewed.

At least four of the CGIAR units are pursuing farming systems research, and a number of other organizations in both developing and in developed countries are actively involved. In 1978 an analysis was conducted of known ongoing work. This study served to encourage additional work and to stimulate interest in bringing greater harmony in approaches to farming systems study and design.

Attention has also been drawn to the need for a greater understanding of what occurs in the root zones of different crops being grown in association with each other on various types of soils and in various ecological settings. This area of study is distinctive to research in farming systems and would not be expected to emerge from research concentrating on specific commodities.

Location of Activity: Cooperating institutions will include IRRI, ICRISAT, IITA, ICARDA, and (possibly) CIAT and ILCA which have been leaders in contemporary farming systems research. These CGIAR units have well-established networks of developing country cooperating institutions. This is equally true of the Tropical Agricultural Research and Training Center (CATIE) in Central America which has also been active in farming systems research. These institutions will be invited to participate in an effort to codify concepts and definitions to further expand studies into the areas of economic, social, and institutional constraints. In possible cooperation with the Commonwealth Agricultural Bureau and the U.S. Department of Agriculture, as well as the CGIAR units listed above, the ISTC will support physical and chemical studies on-site and in laboratories and greenhouses, of root zone changes related to crop associations.

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Application and Use of Knowledge ($3.1 million)

Knowledge relevant to overcoming world hunger is valuable only to the extent that it is used. However, it is widely recognized that a significant proportion of knowledge generated in past years has never been applied and that much of the knowledge being generated today will similarly be wasted if specific measures are not taken to put it to use.

In some instances, the technologies themselves are not in a form that users need. In some cases, the farmers or other users have neither access to the knowledge nor control over other factors needed to translate it into practice. Part of the problem relates to public policy.

Although scientists and policymakers may be committed to solving problems of world hunger, few fully understand the problems of the poor whom they are trying to help. The farmers, traders, and consumers, in turn, are often expected to use information that is hard to obtain, understand, believe, or act upon.

The problems of sharing knowledge between scientists or between farmers, are horizontal and principally involve the mechanics and logistics of information flow between persons with a similar background. The problems of exchanging information between farmers and scientists have the inevitable problems associated with communication across social, cultural, and experiential boundaries. This impedes several important kinds of communication including feedback to scientists from the implementation by farmers and other users of research results.

A professional field of information management has recently developed to help scientists and policymakers to be currently informed about the findings and recommendations of their peers. The problem, however, is more serious for small farmers, to whom little attention has been paid in regard to information exchange.

Few scientists study more than two factors at a time, but a farmer has to cope with a multitude of variables, including those of selection of plant varieties, soil conditions, climate and weather variations, fertilizer dose, pest control, probable commodity prices at harvest time, storage, and taste and cooking qualities.

When a scientist or policymaker is not confident about certain variables, he can state an assumption in proceeding to his conclusion. In regard to the needs and problems of small farmers, these assumptions are often mistaken. For example, it is often assumed that a farmer has control over necessary productive resources such as land, fertilizer, and credit; that he can competently use available knowledge in analyzing situations and in making decisions; and that he has adequate incentives to implement agricultural innovations. In developing countries, however, most farmers are poor and uneducated; most do not own or have secure rights to the use of the land they cultivate; and many have had bad experiences with government representatives and with the markets for primary agricultural commodities.

Program Objectives. To promote the use and application of research results in overcoming world hunger and to help provide poor people with greater discretion and control over the means for improving their own situations in the light of research findings.

Major Research Strategies. To identify and analyze the most effective mechanisms for information flow in rural areas as well as in scientific and technical organizations in developing countries. This approach requires an understanding of (1) methods to decentralize agricultural research and make it sensitive to farmers' problems and needs, and (2) the range of methods used to communicate research results and policy recommendations. A supporting approach is to assess the extent and means by which farmers may participate in the development of research studies.

To identify and analyze the most effective government policies for providing equitable access for small farmers to land and other inputs necessary for improved agricultural production. This approach requires developing an understanding of the experiences with formal programs of land tenure reform, as well as analyses of other related policies in basic education, public health, access to mass communications and rural transportation, land use planning, differential taxation, and rural zoning that have served to reduce inequities among rural people in their control and use of agricultural production.

The ISTC Program. The ISTC will conduct policy and technical studies on research information utilization, and on policies which promote increased equity. These are described in the sections that follow.

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Title: Improving Research Information Utilization

Purpose: To study and develop the most effective procedures for putting information about farmers and farming into the hands of scientists and policymakers in developing countries, and to build a more sensitive, dynamic, and effective relationship between research workers and research information users.

Importance: The CGIAR centers have long been concerned about the slow pace at which developing countries were picking up research findings and testing, adapting, and applying them. This has led to the development of more active outreach programs and the training of increasing numbers of developing country personnel. This also stimulated the establishment of the International Service for National Agricultural Research (ISNAR) in the CGIAR in 1979. Even today, however, the emphasis within the CGIAR system is primarily on building research capacity in developing countries, with significantly less attention given to innovation in support of the necessary two-way flow of information between farmers and scientists.

Location of Activity: Cooperative relationships will be explored with the Southeast Asian Regional Center for Graduate Study and Research in Agriculture located on the same site as the Philippine Council on Agriculture and Resources Research and the International Rice Research Institute. All three are active in developing national research capacities in Asia and elsewhere. Explorations will also be conducted with the Interamerican Institute of Agricultural Sciences (Costa Rica), the Agricultural Research Corporation (Sudan), with the Jordan Valley Development Authority (in conjunction with the University of Jordan), the International Institute of Tropical Agriculture in Nigeria, and the Indian Council on Agricultural Research. U.S. institutions which may be expected to participate include the Kellogg Foundation (Michigan), the University of Wisconsin, The East-West Center (Hawaii), Harvard University, the Midwest Universities Consortium on International Activities, and Cornell University.

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Title: Policies for Increased Equity

Purpose: To evaluate the impact on stablized controlled access of small farmers to the principal production inputs (such as cultivated land, credit, water, information) resulting from public policies for land reform, public education, mass media, public health and rural transportation, regional land use planning, rural zoning, taxation, resource conservation, and the subsidization of farming inputs.

Importance: Attention was drawn to this problem in a 1979 FAO "World Conference on Agrarian Reform and Rural Development" (WCARRD), at which 140 national delegations participated. AID has long been interested in this problem and, as long ago as 1970, produced a major topical review on land reform. AID's recently developed Agricultural Development Policy emphasizes the problems of uneven distribution of productive assets, particularly land, among cultivators in developing countries. A major achievement of the immediate post-WWII period in Japan and Taiwan was the success of their land reform programs, which provided optimism that such reforms could be implemented elsewhere. However, direct efforts to deal with the problem which incorporated the transfer of ownership from non-cultivators to cultivators, or the formalization of rental agreements, have met resistance from groups with vested interests. Progress has been slow, and there have been frustration and tension between disadvantaged and advantaged segments of the population in many countries.

It has been evident that policies for land reform, by themselves, are insufficient to meet the needs of small farmers. They require access to a broader range of production inputs. The report of the 1979 WCARRD clearly points out that the problem of access to farm production inputs is deeply imbedded in broader issues of rural economic equality. The ISTC emphasis will be supplemental and supportive of research and development plans of other organizations which proceed from the recommendations of the WCARRD.

Location of Activity: Overseas organizations with which the ISTC will explore collaborative arrangements include the Pan-African Institute for Development (Cameroon), the Indian Institute of Management (Ahmedabad), the Bangladesh Academy for Rural Development, the Interamerican Institute of Agricultural Sciences (Cost Rica), the National Community Development Service (Bolivia), the Institute of Development Studies (Kenya), the Faculty of Agriculture of the University of Sri Lanka, the Intermediate Technology Group (UK), and the African Training and Research Center in Administration for Development (Tunisia). Explorations with U.S. institutions will include the Atlanta University Center, Southern University, the University of Wisconsin, the University of Minnesota, the Maxwell School (Syracuse University), the Overseas Liaison Committee of the American Council on Education, the Departments of Land and Natural Resources (in Hawaii and Maryland), North Carolina State University, and the Southeast Consortium on International Development. The International Food Policy Research Institute has embarked on studies of the conflicts of growth and equity in agriculture development. The results of this work would be expected to help guide the evolution of ISTC's program.

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Improving Nutritional Status ($1.6 million)

Nature and Importance of the Problem. The one-half to one billion people suffering from significant deficiencies in their protein-calorie intake are among the world's poorest. Their hunger is associated with stunting of mental and physical growth. The single most important way to help improve the daily lives of the poorest is to find ways to increase their consumption of nutritious foods. The means of accomplishing this vary but in the main do not require high-priced animal proteins or the exotic processed formulas of modern food technology. Instead, most people need different quantities and combinations of the same food staples that already constitute the bulk of their diet — rice, wheat, and pulses at the higher end of the spectrum; maize, sorghum, and millets in the middle; and the various root crops at the lowest end of the scale.

Most developing countries now face a complex set of issues that they must try to resolve without a confident understanding of the social, economic, or medical-biological relationships involved. For instance, greater investment in agriculture and higher and more stable food prices are needed to provide an incentive to farmers to meet the production challenge. This poses a dilemma, however, since the higher prices could lead to nutritional difficulties for poor consumers in urban areas and for the landless and near landless in the rural areas who do not produce their own food. Government actions are therefore needed to protect those people who are threatened by the very steps being taken to increase food production. The information — solid data and analysis — on which to base the necessary understanding of the relationships and issues in human nutritional improvement can only be obtained through careful, well-designed research.

More needs to be known about the impacts cultural practices and beliefs of people can and do have in frustrating nutrition programs. Certain food taboos for pregnant women and the custom of feeding adults before children are examples of the problem.

Hunger is so apparent that the temptation is to take action on what seems to be an obvious problem. However, very little is known about the many specific factors that contribute to the cause of undernutrition. Without such knowledge, well-intentioned interventions could lead to harmful effects or to waste and further delay of adequate responses to the problem. In the early 1960's there were cases in which the incidence of nutritional blindness in children was increased through feeding high protein foods without Vitamin A fortification. Other cases showed that attempts to provide supplementary feeding for nursing infants were frustrated because the children could not consume and digest the quantities of rice or blended foods required to achieve the desired nutritional effect.

As such problems were recognized, new solutions have had to be formulated. At present the answers are still inadequate to enable developing countries to shape policies and programs with the needed assurance of their probable impact.

Program Objectives. To identify the important unanswered questions concerning human nutrition, and to conduct research to provide information on which policy makers can base their decisions. To develop a better understanding of the effects of marginal dietary deficiency and, thereby, of minimum nutritional needs.

The ISTC Program. The program supports research designed to estimate the impact of marginal dietary deficiency on such functions as resistance to disease, reproductive capacity, cognition, and productivity. These are expected to be different at different ages and to vary depending on the duration of time over which the deficiencies are extended. Determining what constitutes an adequate minimum diet under developing country conditions and crop availabilities would be a logical outcome of this research. These studies were planned during the previous two years under the Title XII Collaborative Research Support Program.

In addition, ISTC will, as a matter of very high priority, work with the CGIAR's International Food Policy Research Institute, the World Bank, WHO, AID, and other organizations to identify other key issues requiring interdisciplinary research. In particular, ISTC will address the assumptions concerning human nutrition on which present approaches to nutrition policy are based. In future years, ISTC will provide long-term funding for the necessary research and collaboration among interested institutions and agencies.

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Title: Impact of Marginal Nutritional Deficiencies

Purpose: This program is intended to produce quantitative information on the relationship between various substandard levels of food-energy intake and human functional response in the areas of disease, reproduction, activity, cognition, and social behavior.

Importance: Although it is known that severe caloric-protein deficiency in a child will produce debilitation and death, the functional significance of marginal nutrient deficiencies in calories, proteins, vitamins, and/or minerals is not well known. Even less understood are the requirements of people living under conditions of acute stress, such as infection or pregnancy. Although authorities have set standards for daily nutrient requirements, the applicability of those standards in the developing countries is questioned. Research is needed to ascertain the effect of diminished levels of essential nutrients over varying periods of time on such factors as child development and response to infection. Also to be determined is the individual capacity to adapt to altered nutritional conditions.

Location of Activity: The lead institution for planning the nutrition program is the University of California at Berkeley. Cooperative programs have been prepared for the following international university research teams: Connecticut/Mexico; California/Kenya; Hawaii/Thailand; Purdue/Egypt; and Tulane/Colombia. In pursuing this program, the ISTC builds on two years of intensive planning under the Title XII Collaborative Research Support Program.

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Health and Population — $18.6 million

Devastating health problems of great magnitude beset many developing countries. They are caused by and contribute to their economic, social, and environmental problems. Improvement of health is thus basic to development.

Infectious diseases, large and poorly spaced families, and malnutrition are the three problems of greatest immediate concern. Improved economic conditions and better housing and sanitation will help to alleviate these in the longer term. However, through problem-oriented research and practical application of new and improved preventive and therapeutic measures, health could be more rapidly improved to facilitate this development process.

In the infectious disease field, initial ISTC efforts will be concentrated in three major areas. First, it will participate in the development of better methods for prevention, treatment, and control of those major infectious diseases of the tropics incorporated in the World Health Organization's (WHO) Special Program for Research and Training in Tropical Diseases. Priorities for this program are being developed by WHO in concert with U.S. and foreign scientists. Second, support will be given to research and technology application to facilitate immunization programs to prevent those diseases for which effective vaccines are currently available and to develop vaccines for other diseases of major concern. This will be done in close collaboration with WHO and others participating in the WHO Expanded Program on Immunization. Similar support will be provided to a third priority program identified by WHO — the Diarrheal Diseases Control Program.

In the field of population, initial ISTC efforts will be directed toward the support and development of national capacities for research and evaluation of

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contraceptive measures. These efforts will complement an extensive program of population research and application activities now conducted by AID and other public and private agencies.

In the field of malnutrition, the ISTC's initiatives in nutrition strategy are described under the section on World Hunger.

Cross-cutting all of these problems are the needs of all countries for improved health planning, the development of elementary data systems to identify and monitor health problems, and the development of appropriate health services infrastructures to reach the extensive populations that currently are underserved or not served at all by existing systems. These problems will each be addressed, in part, in the context of the programs proposed. Broader consultation will be undertaken with administrators and experts in developing countries and relevant national and international agencies, to identify the appropriate ISTC mission to address these problems directly.

Although the three problems of infectious diseases, malnutrition, and population are separately identified, the three are inseparably related. For example, severe or prolonged illness may itself precipitate symptoms of malnutrition. Conversely, malnutrition causes an increased susceptibility to disease. Death rates in children under 5 years of age, in some countries as high as 40 to 50 precent, generate high birth rates, and high birth rates contribute to malnutrition and disease.

The Tropical Disease Research Program embraces six major diseases of the tropical developing countries. These are malaria, leprosy, schistosomiasis (snail fever), filariasis (the cause of river blindness and elephantiasis), trypanosomiasis (the cause of African sleeping sickness and, in the Americas, a form of killing heart disease), and leishmaniasis (kalaazar and other forms of debilitating illness). Because these diseases occur only or predominantly in the tropics, they have received little attention by biomedical research investigators who, with few exceptions, are located in temperate zones. Present methods for prevention and treatment are little changed from those of several decades past.

For a number of diseases, effective vaccines have been developed and are widely used in industrialized countries. However, the diseases remain major problems in the developing countries where, on the whole, less than 10 percent of the population has ever received these vaccines. Each year, approximately 5 million children die from measles, tuberculosis, whooping cough, tetanus, poliomyelitis, and diphtheria in the developing world, and millions of others are permanently disabled. There are vaccines currently available for these six immunizable childhood diseases, but most require improvement. Recent investigations also suggest that a vaccine against hepatitis could become a practical reality within the near future. Doubtless there will be other vaccines to counter major disease problems. Needed for all immunization programs are better devices for shipping and storing vaccines under tropical conditions, improved devices for administering vaccines, and program managment systems, as well as assessment and disease surveillance techniques applicable to programs using primarily health assistants and village volunteers.

Diarrheal diseases pose a special problem. It is estimated that at least one-half billion cases of diarrhea occur annually in children under 5 years old in the developing countries, about 5 to 10 million of which are fatal. Many who recover remain severely malnourished and physically retarded. A recently developed simple method for oral rehydration therapy offers promise for preventing death from diarrhea, but further studies are required to determine how best to apply it in the field. Recent research findings offer hope that a vaccine against a newly discovered virus (rotavirus) might prevent upwards of 50 percent of diarrhea cases. Prevention through provision of adequate safe water supplies is a UN target for the next decade, but it is now clear that more must be done than simply to drill a well and affix a pump. Much could be done to improve the design of pumps, to elaborate practicable systems for maintenance, and to devise simple methods and appropriate containers for water transport and storage which would minimize subsequent contamination of the water.

Population pressures represent perhaps the most fundamental of the constraints facing the developing world. Currently, some 70 million people (equivalent to the population of Mexico) are added to the world's population each year. Because of population increases, food supplies, jobs, and social services will need to be doubled in most poorer countries within the next two to three decades simply to sustain existing levels of subsistence. AID, private foundations, and a number of public and private agencies have supported and are now supporting a substantial and concerted effort to discover new methods for fertility regulation and to develop and apply these in

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the field. However, available birth control methods are still far from optimum in terms of safety and of acceptibility and continuity of use in many cultures. Existing programs could be greatly enhanced if there were a greater capacity in the developing countries themselves for study of the problems of fertility and of the applicability of new or existing methods for contraception.

Overall activities. In the fields of health and population, ISTC will maintain close contact with national and international agencies and scientists working in the priority problem areas; it will serve to identify developments, activities, and expertise in the U.S. science and technology community that can best address the major problems within a broader international complex of activity; it will support particularly promising activities, especially those that contribute to capacity building in the developing countries; and it will undertake to identify an appropriate ISTC role in the more intricate area of health policy, planning, and the development of a health infrastructure in the developing countries. Specific initiatives so far identified for FY 1981 are described in subsequent sections.

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Title: Major Tropical Diseases ($12.2 million)

Purpose: Modification and adaptation of currently available methods for disease control. Development of effective vaccines, drugs, and methods of biologic control of insect vectors for suppression of the major endemic tropical diseases.

Importance: Of the six tropical diseases determined by the World Health Organization to be of priority concern, malaria is the world's most serious and widespread. Annually, an estimated 150 million clinical cases occur, and in Africa alone more than 1 million children die each year from malaria. The other diseases, however, are not inconsequential. There are today an estimated 11 million persons with leprosy. Approximately 180 to 200 million persons suffer from the debilitating effects of schistosomiasis, the spread of which is abetted by agricultural and hydroelectric projects. There are thought to be some 250 million cases of Bancroftian filariasis (the cause of elephantiasis), and 30 million cases of river blindness. Some 10 million persons risk African sleeping sickness, and 10,000 new cases of that disease are known to occur annually. Over 10 million inhabitants of Central and South America suffer from Chagas disease, the most common cause of sudden death in young Brazilians. Nearly 80,000 new cases of kalaazar (leishmaniasis) occur annually in India alone, and unknown millions suffer from other forms of leishmaniasis.

Methods to control and to treat these widely prevalent tropical diseases are inadequate or ineffective. For example, available insecticides and drugs for malaria are unable to control disease throughout large areas of Africa, Asia, and South America. In the last two countries, the parasites and/or vectors of malaria have become increasingly resistant to existing drugs and insecticides. Presently available drugs for the other major tropical diseases are not practicable for large-scale control, and in fact no drugs are effective in treating victims of American trypanosomiasis (Chagas disease).

Different strategies are required for each of these diseases, depending on the biological characteristics of the organism, anticipated productive directions for research, and the availability of existing technologies for prevention or cure that might be better adapted to immediate use.

For malaria, a major research effort that has been supported by AID and will be supported by ISTC is directed toward the development of an effective vaccine and to a better understanding of malaria immunity. A dramatic breakthrough in the development of a practical method for culturing malaria parasites represents a major first step in this direction. Ten major projects in eight research centers, two of them in developing countries, are directed toward various aspects of this activity. These include the development of models of malaria infections in monkeys for subsequent testing of vaccine, the preparation of vaccines of different types, and a variety of studies that would give a better understanding of the mechanisms of malaria immunity so that the vaccines can be more directly assessed. The development of a malaria vaccine could prove to be the major weapon in malaria control, but vaccine development is inevitably complex and time consuming. In the meantime, other methods depending on vector control and disease therapy must be explored, better adapted for practical use, and applied in the field. The development of expertise in institutions in the malaria-infested countries is of special importance because of the range of biological, social, economic, and other conditions in different areas that directly influence the success or failure of control measures.

Leprosy has long defied control effects because of the long duration necessary for treatment and the frequency of drug reactions. Recently, research scientists have succeeded in growing sufficient numbers of the leprosy bacillus to be able to consider development of a prototype leprosy vaccine. This development is encouraging, but even if it is successful, a decade may be required to perfect the vaccine and to produce it in sufficient quantity for field use.

Epidemiological studies and competence urgently need to be augmented to define more precisely the locale, extent, and severity of each of the problem diseases, so as to assure that preventive and therapeutic measures can be directed most effectively to the afflicted. Epidemiological-clinical studies are particularly needed in both schistosomiasis and Chagas disease to determine the burden of disability, as contrasted to infection, imposed by the deseases.

For leprosy and for each of the other diseases, research will be along four separate but complementary lines: longer-term biological studies directed toward organism cultivation and, ultimately, the production of a vaccine; studies of chemotherapy methods to improve existing drugs and to find better ones; research directed toward easier and more rapid identification of cases in the field; and studies di-

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rected toward control of the disease vector. Definitive answers will not come quickly but, rather, incrementally. In the meantime, the development of expertise and of institutions in the infected areas is critical to facilitate studies of the disease and possible interventions under the variety of epidemiologic, climatologic, social, and economic conditions that prevail. A closely integrated network of effort and expertise between developing-country centers and those in the developed countries will be essential for success.

Major Program Elements. Continuing support will be provided to the Special Program for Research and Training in Tropical Diseases, sponsored by the World Health Organization and the United Nations Development Program. More than 30 governments and agencies support this $25 million (annually) program which, in turn, provides assistance for research, training, and institutional development to a network of programs throughout the world. Complementary to this are research and operational activities conducted by the National Institutes of Health's (Tropical Medicine Program, or National Institute the Public Health Services Center for Disease Control, (CDC), the Army, Navy, and the Rockefeller Foundation. ISTC programs in this area will facilitate coordination of these efforts and permit the extension of this network of activity, with particular emphasis on the strengthening of institutions for research and application in the developing countries.

Continuing support will also be provided to the network of six U.S. and two developing country laboratories where efforts are directed toward the development of a malaria vaccine.

For research of more immediate potential application, assistance will be given to the WHO-Indonesia Center for the field testing of new, environmentally acceptable insecticides. In addition, a cooperative program will be developed in two centers in developing countries to explore the utility of a model for a regional program for education and field research. These could serve to integrate the efforts of CDC and U.S. university expertise with a national university or the ministry of health and WHO. An academic-field research program will be developed to focus on the epidemiology, entomology, and parasitology of prevalent local diseases, particularly malaria. This program will also be directed explicitly toward training professionals in the problems and control of the major vector-borne disease problems and the development of research methodologies appropriate to the geographic areas concerned.

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Title: Control of Diarrheal Diseases ($2.9 million)

Purpose: Adaptation of available technology for prevention and control of diarrheal diseases. Development of vaccines and drugs for control of diarrheal diseases; further development of oral rehydration therapy.

Importance: Acute diarrheal diseases are among the three leading causes of mortality in most developing countries, accounting for 30 percent or more of admissions to children's hospitals or wards. These diseases are responsible for more than one of every four deaths from all causes in children under 5 years of age in the developing countries.

Diarrhea contributes to malnutrition and, in turn, is more common and severe in malnourished persons. Similarly, diarrheal diseases are related to household overcrowding, inadequate water supplies and/or storage, and sanitation. The serious effects of clinical illness and the difficulty in changing problem-causing environmental conditions points to an urgent need for vaccines and drugs to prevent and control diarrheal diseases. Two recent advances indicate that such methods are feasible. Oral rehydration solutions that can be produced locally have been shown to be effective in mitigating the effects of dehydrating diarrhea and preventing death. Further studies to adapt these to different local conditions are important. Identification of the rotaviruses as frequent causes of diarrhea and advances in techniques to propagate rotaviruses in the laboratory give reason to hope that with intensified research, a vaccine could be available for field testing within the next 2 to 3 years.

A further aproach to diarrhea control is through provision of safe water. Although diarrheal diseases are caused by a number of different agents, the modes of spread and, hence, approaches to prevention and control are common to many. Household water is a principal common source of diarrheal infections. Although much is being done by a number of national and international agencies to construct safe sources of water for household use, little has been done to investigate methods to prevent the all-too-frequent contamination of water after it is obtained from a safe source.

Major program Elements. Continuing U.S. support will be provided to the International Center for Diarrheal Disease Research in Bangladesh (ICDDR/B). This Center was established in 1979 as an independent international institution and is supported by AID and a consortium of donor countries and agencies. It is the successor to the Cholera Research Laboratory, which had operated in Bangladesh for 18 years. The Center has a budget of approximately $4 million for 1980. In addition to conducting research in diarrheal diseases and directly related problems in nutrition and fertility, the Center trains Bangladesh and other nationals in diarrheal disease control in collaboration with other national and international institutions.

Research support will also be provided through other selected regional and national research institutions in the developing world, such as the Institute of Nutrition for Central America and Panama (INCAP) in Guatemala, the Endemic Disease Center in Lahore, Pakistan, and the WHO Program for Control of Diarrheal Diseases. Collaboration of established U.S. institutions such as NIAID/NIH, CDC, and selected academic centers that are working with developing country institutions will be promoted to strengthen national capacities and to ensure technically sound research programs.

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Title: Prevention of Diseases Through Immunization ($2.5 million)

Purpose: Improvement of vaccines for control of important diseases and the development of technologies and systems to facilitate their administration; development of new vaccines for control of other important diseases.

Importance: An estimated 5 million children die annually in developing countries from six diseases (measles, polio, tetanus, diphtheria, whooping cough, and tuberculosis) that are wholly or largely preventible through immunization with currently available vaccines. Many other children are permanently crippled, blinded, or retarded by these diseases. Only 10 percent of children in the developing countries are being immunized with the vaccines at present. Although use of current vaccines and technology could prevent perhaps 40 percent of these deaths, technical factors limit realization of the full potential of the vaccines.

For example, whooping caugh (pertussis) is a serious problem in developing countries. Vaccine has been available and used for several decades. However, it is less effective than it could be and requires several doses and several visits to achieve its effect. Moreover, there are many undesirable side effects associated with its use. In addition, many questions remain about the optimal dose, schedule, and type (killed or live) vaccine for use in the tropics. Recent studies question the efficacy of contemporary BCG (tuberculosis) vaccine. Essentially all of the vaccines commonly in use share problems in being less heat stable and effective than they should be. Several require multiple injections to induce satisfactory immunity. The need for needles and syringes for administration complicates vaccination programs. And, finally, suitable, sturdy refrigerators using a readily available energy source and inexpensive efficient, insulated boxes for transporting vaccine are required for vaccine storage and transport.

Recently, there have been several encouraging advances. A measles vaccine which is much more heat stable than many other vaccines has been developed and is now being tested under tropical conditions. It offers great advantages in not requiring constant refrigeration. Under study is solar-powered refrigeration, and efforts are being made to produce insulated boxes using locally available materials. The results are encouraging, but much work remains to be done.

The incorporation of other vaccines into the program can be foreseen. A vaccine against hepatitis is now ready for field testing, but further developments will be required before a sufficiently inexpensive vaccine will be available. Vaccines that protect against deadly, epidemic meningococcal infections have proven effective, but as yet they do not confer sufficiently long-lasting immunity to be useful in developing countries. Other vaccines can be foreseen in the more distant future.

Major Program Elements. Most of the research capacity required for developing new vaccines and improving existing vaccines (potency, stability, etc.) is located in developed, temperate countries, especially in U.S. institutions. In collaboration with NIH/NIAID, the pharmaceutical industry, and WHO, investigators, projects, and institutions will be identified and support will be provided for collaborative development efforts. Assistance will also be provided through WHO's Expanded Program on Immunization to institutions in developing countries for the development of expertise in field testing of vaccines. WHO is presently serving a role in providing overall direction in the delineation of research priorities and in identifying institutions, investigators, and suitable research projects for support in developing countries. In the United States, the Center for Disease Control is serving as a principal collaborator. ISTC's role would be to serve as an interface and coordinator between U.S. science and technology resources and WHO's global effort.

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Title: Population ($1 million)

Purpose: To strengthen capacity in the developing countries in basic and applied research for the further development of contraceptive methods and the adaptation of contraceptive technology.

Importance The pressure of rapid population growth is acknowledged to be the most fundamental constraint facing the developing world in the next decades. Existing rates of population growth impose a tremendous strain on already poor countries and on the world as a whole. At the same time that demands for expenditures on education, health, housing, and transportation are increasing for this expanding population, a substantial investment in productive capacity is needed.

Assistance to the developing world in reducing population growth is thus a high priority. Required are better means of controlling fertility for couples who are motivated to limit family size, as well as the identification of such factors as governmental policies, educational efforts, and health conditions that may directly or indirectly serve to enhance such motivations.

Birth control methods now available require further development in terms of their acceptability, safety, and continuity of use. Their inadequacies constitute severe constraints on the rapid spread and continuing effectiveness of family planning. The most effective methods may pose special risks to health under conditions of malnutrition and disease that are endemic in the Third World. Methods are needed that are acceptable to people of widely differing cultural backgrounds and do not require well-staffed health delivery systems for safe and effective use. Meanwhile, both fundamental and applied research in reproduction and its control must continue if new birth control methods are to be found.

The oral contraceptive and modern versions of the intrauterine device are the two most significant advances in contraceptive technology of the last two decades. Successive modifications of these methods have significantly improved their effectiveness and safety. Potentially superior methods of administering new contraceptive compounds through long-acting subdermal implants and vaginal contraceptive rings are in advanced stages of clinical trials. Major improvements in surgical technology for sterilization have been achieved. However, methods that could radically improve fertility control, such as a reversible pregnancy vaccine, a post-coital contraceptive, or suitable methods for men have not yet been developed.

Improvement of contraceptive technology must take place on a number of fronts: fundamental research to discover new leads to fertility regulation; pursuit of these leads to develop new contraceptive products; modification of existing methods to improve acceptability and safety; and collection, analysis, and dissemination of data on risks and benefits of contraception under the particular nutritional status and disease conditions of women in specific countries and regions.

Worldwide funding for reproductive science and contraceptive development reached a plateau in the mid-1970's and has since declined. The National Institutes of Health and private foundations have helped university investigators develop fundamental knowledge in reproduction. AID has supported a wide range of investigations on methods expected to be ready for clinical testing within the short term, and it devotes substantial operational funds for dissemination of knowledge on existing methods. There is, however, a major gap in longer-term commitments to the contraceptive development and adaptation process.

During the past 15 years, a substantial number of biomedical scientists from the developing world have received advanced training in reproductive science and contraceptive technology in U.S. and European institutions and have returned to their own countries, where they represent a generally underutilized pool of scientific competence available for applied and fundamental research.

Major Program Elements. ISTC can collaborate effectively with scientists in developing countries across the spectrum of research needed to improve contraceptive technology. With the limited funds immediately available for operations, ISTC will make modest initial investments in four key areas, with the hope and expectation that these investments may be considerably expanded in future years:

- *Contraceptive Safety in Developing Countries.* Contraceptive methods have been introduced into national family planning programs in developing countries without benefit of ongoing evaluation of the health effects of contraceptive use in these countries. There is need for data both on the positive and negative efforts of

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contraception on maternal and child health under the special conditions of the developing world.

ISTC will help develop capacity for contraceptive safety studies within national family planning programs, indigenous drug-regulating agencies, and/or ministries of health. Safety studies will be conducted on currently used contraceptive methods as well as technologies as they are introduced. Further training of clinicians and scientists in epidemiological techniques will be important. This will be done by CDC and university facilities in areas with strong family planning programs. These countries include Colombia, Thailand, Indonesia, the Philippines, Malaysia, India, Peru, Bangladesh, and Mexico. A 5-to-10 year commitment will be required to put in place an adequate research capacity for safety studies.

- *Strengthening of Capacity in Basic and Applied Research in Human Reproduction and Contraception.* Hundreds of scientists from the developing world have received advanced training in reproductive science in the United States and other industrialized countries. Many who returned to their countries lack research funds and must turn to clinical practice or full-time teaching. Research funds are required if these scientists are to contribute to the development of contraceptive technology. An effective mechanism to provide such needed research support, PLAMIRH (Latin American Program for Investigations in Human Reproduction), has been in existence for the past 6 years with funding from the Ford Foundation and the International Development Research Center (IDRC-Canada). PLAMIRH provides small research grants averaging $7,000 to young investigators for supplies and equipment. Awards are made by a review committee consisting of Latin American scientists. A recent evaluation of PLAMIRH attests to its success in strengthening research capacity in Latin America. PLAMIRH is developing a network of research institutions to carry out collaborative clinical studies in human reproduction and contraceptive development, but PLAMIRH's program could effectively use additional funding.

  Scientists who have received advanced research training have established reproduction research groups in Southeast Asia, which are not now adequately supported. A program similar to PLAMIRH could be readily established in this region.

  Unlike Latin America and Southeast Asia, a critical mass of reproductive scientists is lacking in sub-Saharan Africa. ISTC may wish to help build competence by assisting in financing a regional research training institute to promote work on problems of special importance to Africa. A core of African scientists and a few foreign experts might be encouraged to design such an institute.

- *Advancing Contraceptive Technology.* The International Committee for Contraception Research (ICCR) is an international network of clinical investigators engaged in development of appropriate contraceptive methods for the developing world. ICCR is hampered by a budget inadequate to carry out its projects expediently, particularly in the areas of materials technology and manufacturing. Additional support for ICCR is likely to accelerate development of a number of improved contraceptive methods within the next few years. ICCR is also a potential resource for facilitating technology transfer for program management skills and materials and dosage forms to developing country organizations and scientists. ICCR has already established links with the All-Indian Institute of Medical Sciences, the Central Drug Research Institute in Lucknow, and research institutes in China.

- *Adaptation of Contraceptive Technology.* The successful integration of existing contraceptive methods into international family planning programs depends on the adaptation of the dosage form or device to the cultural, religious, ethnic, and socio-economic characteristics of the population that will be using it. During the past 3 years, PIACT (Program for the Introduction and Adaptation of Contraceptive Technology) has established a network of programs in Colombia, India, Indonesia, Egypt, Mexico, the Philippines, and Bangladesh that are engaged in adapting current contraceptive technology to specific conditions in an effort to improve its acceptability. One of the most significant projects to date has been the development of informational materials for illiterates on the use of methods such as the pill and

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intrauterine device. Technical services are provided through a Seattle, Washington-based unit that disseminates information, procures appropriate supplies for the country's programs, and provides technical expertise on request. PIACT is currently funded by multilateral agencies and foundations. The success of the program demands increased staff both in the Technical Services Unit (Seattle) and in national programs abroad.

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Development and Use of Energy—$3.0 Million

Importance of the Problem. Obtaining adequate energy is becoming critical for developing countries. Except for the oil-exportees, these countries have been seriously affected by the rising cost of petroleum and consequent foreign exchange problems. Some, in fact, have required emergency assistance from the International Monetary Fund and other organizations.

There is another dimension to the problem. Costs of energy are rising rapidly at a time when these countries have only begun to build an infrastructure in both rural and urban areas. The vast majority of their peoples still have no electricity, clean water, transportation, or communication. Unless solutions to the energy crisis can be found, these countries will be stopped or greatly slowed in their development efforts.

Finally, the developing countries face yet another energy crisis. Their traditional sources of fuel for cooking and warmth — wood in most cases — are disappearing. Population and economic pressures and the lack of conservation practices are leading to rapid deforestation. This in turn increases soil erosion and flooding, with consequent effects on food production. People needing fuel turn from wood to crop and animal wastes, diverting these from fertilizer, and this practice has further impact on agricultural production. The energy crisis in the rural areas, especially among the poor, is thus a central factor in the poverty problem.

The traditional sources of fuel in the rural areas cannot all be replaced by oil-based sources of electricity and power because petroleum prices have skyrocketed. To the extent countries do extend the use of petroleum-based energy in development, their foreign exchange problems deepen. Achieving rural

development may therefore depend on greater efficiency and conservation in use of existing energy sources and on finding alternative sources of energy.

The United States has a direct interest in helping to solve these problems. First, solutions are critical to any hope for helping the poor in the developing countries. Second, we share a common concern over dwindling world energy supplies at a time when demand is increasing. It is forecast that over the next decade, the developing countries' use of world oil will rise from one-sixth to one-fourth of the total. Third, we share an interest in finding efficient uses of more abundant (especially renewable) energy, such as gasohol.

The energy problems of the developing countries are so complex and vast that no one agency or program can address them. The international community is thus moving rapidly to develop a coordinated program for research with special emphasis on building developing-country capacity. Particular emphasis is being placed on renewable sources.

At the request of the Tokyo Summit countries, the World Bank is currently studying renewable energy research requirements in relation to the Third World. This project follows up on an earlier study by the Organization for Economic Cooperation and Development (OECD) of technologies potentially suitable to developing-country use and of developed-country research capabilities to support needed research. The World Bank effort will add to the OECD study by identifying more specifically national research capabilities and the needs for increased capacities. ISTC will develop its program in close collaboration with other donors and the developing countries in the context of the World Bank report's recommendations.

Program Objectives. ISTC's initial program will concentrate on creating with the developing countries and with other donors, research and testing programs that deal directly with the energy problems of the developing countries. These projects will be located primarily in developing countries so that a process of technology development, adaptation, and problem solving is rooted directly in their experiences and geographical conditions.

At $3 million, ISTC's program for FY 1981 is small compared to the scope and seriousness of the problems. At the outset, careful planning and assessment of strategies in conjunction with other donors and developing countries will be required, ISTC initiatives can begin to address high-priority objectives, however. And as energy becomes an increasing program focus over the coming years, as is expected, ISTC will expand its effort and coordinate program concerns for renewable energy sources with related programs in forestry and agriculture.

In carrying out its program, ISTC will be guided by several principles:

- Technologies will be chosen for research if they have a reasonable probability of reaching the point of successful operation in the relatively short term, perhaps in 3 or 4 years. Programs would not be undertaken in which basic scientific work was required or new physical principles needed to be established. Such basic research would be appropriate for the U.S. Department of Energy, the National Science Foundation, or other entities, and they would be encouraged to undertake such research.
- Programs will be chosen that apply to a number of developing-country locations and situations. AID is expanding energy programs in individual developing countries to help them assess their energy problems and to begin application of alternatives to petroleum. ISTC's programs are intended to support the development in national or regional centers, of interdisciplinary experience that can help solve problems in the design, maintenance, and economy of various technologies.

Major Research Questions. The oil crisis has spurred much new research in alternative energy technologies such as: solar, wind, and biomass. This research is presently directed to the needs of developed countries and emphasizes a scale and complexity of technology that have limited relevance to the needs of developing countries, particularly the rural areas. Research and experimentation on small-scale technologies—small windmills, cookstoves, biogas, etc.—have been undertaken mostly by small-scale entrepreneurs, developing country researchers, farmers, and others. Some of these technologies appear to hold promise for the developing countries but the work has been scattered, and as yet there is no means for coordination in solving problems through shared experience. ISTC will support research centers that provide for a pooling of this experience and for problem solving in the context of developing-country needs.

Discussed below are some examples of technologies that hold considerable promise but require more work to overcome some major problems.

Anaerobic digestion. In recent years, much research has been done on anaerobic (airless) sewage and waste disposal systems that generate a gas consisting mostly of methane (CH^4), carbon dioxide (CO^2), hydrogen sulfide (H^2S), and other incidental gases. In a satisfactory system, the gas produced has a BTU content of approximately 60 percent of that of natural gas. The fuel is excellent for cooking, heating, and even for running small internal combustion engines. Indeed, some large cities have sewage plants that for some years have generated part of the energy they use for sewage processing in this way.

There are other benefits of anaerobic digesters. If the process is correctly carried out, the residue or sludge that remains after anaerobic digestion is essentially free of bacterial pathogens. Work in the People's Republic of China has shown that dysentery bacteria can be eliminated in a day or two, and typhoid bacteria as well, if the material remains in the digester for 1½ or 2 months, a reasonable period for a properly designed anaerobic digester. Parastic worm eggs such as hookworm and schistosomes are 99 percent destroyed. In brief, anaerobic digestion can essentially destroy all pathogens except viruses, and even modern sewage disposal systems have not solved this problem.

If properly managed, anaerobic digesters are essentially odor free. What remains is an excellent nitrogen-rich fertilizer. The liquid effluent which runs off is extremely rich in nutrients. When it is run into ponds and allowed to stand in sunlight, algae and/or duckweed can be produced. These in turn provide high-protein animal feed for poultry, hogs, and certain types of edible fish.

Indeed, as energy becomes increasingly more expensive in the United States, there is reason to believe that we will be operating our own anaerobic digester sewage disposal facilities to produce fuel, nitrogen fertilizer, and nutrient effluent as a base stock for protein-rich animal food.

As with any technology, however, there are problems in operating anaerobic digesters. Their most extensive and successful application has been in the People's Republic of China. Many systems have been built in other developing countries primarily for biogas fuel, but the majority have proved to be disappointing failures. Although the plants are mechanically simple, the biology is complex and semi-sophisticated management is required. The degree of acidity/alkalinity in the digester is fairly critical. If input material does not have the right proportion of water, or if it is put in too fast and the unit becomes acidic, or if it is not properly agitated, the digestion process stops. Another problem with the present technology is scale, which raises problems of use by larger, wealthier groups rather than the poor.

What is needed is a program of research and experimentation to solve problems in design, maintenance, and costs to produce a total system suitable to different countries in different parts of the world. The design would necessarily include not only the processing system but would deal also with the materials to be put in the digester; use of the output fuel gas; the methodology for distributing the fertilizer; the subsystem design for producing algae and/or duckweed and subsequent use of the animal food produced; and the education of the local populace in its planning and operation. The research needed will require continuous interaction between the research community and practitioners in various locations, along with continuing adaptation and improvement.

Alcohol production. Liquid fuels will continue to be needed in all countries, as there are few possible substitutes for liquid vehicular fuel at present. True, in the United States we can derive kerosene from shales and liquid fuels from the liquification of coal; and we are also beginning to produce gasohol (a mixture of gasoline and alcohol) from surplus grain. But for many developing countries, the options for the local production of liquid vehicular fuels are extremely limited. A major option to be developed could be the fermentation of sugars, carbohydrates, and starches from local crops and the subsequent distillation of that alcohol to fuel. A drawback to this process is that the energy required to distill alcohol from the fermented liquid is a significant fraction of the energy obtained from the alcohol itself. Fortunately, the distillation temperatures required are relatively low, and almost any source of low-grade heat, such as flat solar panels and fires fueled by refuse, can suffice.

Another problem is that the biomass usuable for producing alcohol almost always consists of items that also can serve as animal or human food, such as potatoes, corn, wheat, barley, rice, sugar cane, sugar beets, and breadfruit. The importance of studying energy resources in relation to food needs is apparent, and will be an ISTC concern. Conceivably,

enzymatic or chemical hydrolysis of cellulose could in the future greatly increase the range of feedstocks for alcohol production to include such materials as straw, grasses, cotton hulls, and wood chips. However, hydrolysis technology is not sufficiently developed at this time to be ready for widespread use.

Alcohol production could have great potential if certain of these problems were solved. Brazil has already done extensive research on alcohol production and now uses gasohol to satisfy a significant portion of its fuel needs. Other current or potential sugar producers, such as the Philippines, are seeking to learn from the Brazilian experience. Sugar production, however, is usually a large-scale, plantation activity. Cassava, yams, taro, breadfruit, and other starchy plants are, by contrast, grown by very poor farmers as food staples. If problems of scale, distillation, engine adaptation, and marketing could be solved, alcohol could be a source of energy and income for these farmers, who are on marginal land and are the most difficult to reach with conventional energy supplies. But these questions remain to be answered:

- What input materials could be used most efficiently? To what extent could the production of taro, yams, breadfruit, or cassava be increased with the existing agricultural system, and what would be the yield of alcohol?
- How could the alcohol be used and what problems would be encountered in converting various engines to use alcohol?
- Where would necessary distillation energy come from? Is there sufficient waste cellulose and lignin residue from plant stalks, grass, coconut shells, etc., to provide that energy, or should flat-plate solar collectors be integrated into the process?
- How can the silage be disposed of? Can it be used in further processes (e.g., aqueous pyrolysis) to provide more fuel? Does the liquid effluent contain nutrients that can be used as fertilizer or animal feed or for some other purpose?
- For this and other technologies, how can equipment be designed so that local manufacturing is possible? Reliance on imported machinery raises the costs and inhibits widespread use in the rural areas.

Generation of Small Amounts of Electricity from Direct Solar Radiation. There are many villages and rural areas in the developing world that have essentially no biomass reserve for alcohol production and inadequate reserves of water for anaerobic digesters. Energy from wind is rarely an answer, since in many of the semi-desert areas of the world, there are long periods of time when the average wind speed is very low for weeks at a time and no suitable devices are available for energy storage.

For all practical purposes, the only renewable energy resource for many areas is sunlight, but using that resource effectively poses a significant problem. For example, with inexpensive and inefficient collectors, one can obtain only low-grade water and space heat. The generation of small amounts of electricity from direct sunlight is much more expensive. There are two technically viable methods: photovoltaic cells or solar-thermally operated electric generators.

A number of solar photovoltaic electric installations have been set up in various parts of the world. The costs are high but have been coming down rapidly. Ultimately, their use will depend upon the extent to which the cost of photovoltaic cells decreases in coming years and also to what extent the associated solid-state power conditioning requirements decrease. The high cost of storage components remains a serious constraint.

Solar-thermal electric generating installations of various sizes have also been built. These require parabolic, spherical, or cylindrical reflectors focusing on a heated element of some kind. The most costly parts of the system are the heat engine that uses the solar thermal energy and the piping system for the heated fluid that carries the heat from the focal point of the solar collector to the heat engine. These too are expensive. However, recent developments with regard to a free-piston, sealed helium engine, give promise of more economical systems.

- *Micro-hydroelectric units* are now being recognized as perhaps the least expensive means to produce electricity in many parts of the Third World. Countries like Malaysia are now giving this technology highest priority in their rural energy program. Promising as this potential is, further work is needed to convert this energy source to practical use for low-income rural areas. Also, transmission and usage problems need to be solved before practical application. It is possible that such units could be used to

build a hydraulic air compressor system, a technique practiced for centuries but now almost forgotten. A hydraulic ram compresses air that can then be expanded to do work, for instance to turn an electric generator. Because the expanded air becomes extremely cold, it also could produce ice and refrigeration.

- *Wood and charcoal efficiency*. Work in the United States is now being directed to better approaches in the use of wood as an industrial fuel. This technology could be of great relevance to the developing countries as their urban-based energy requirements increase. More work needs to be done to increase wood efficiency as a cooking fuel. Better charcoal-making processes offer considerable potential for more efficient use of wood. Because much of the energy in wood burning now is consumed in driving out the water, better wood-drying techniques would be of benefit. As discussed in the ISTC program section on forestry, improved silviculture could raise the use of annual forest production several times above the present rate. Wood efficiency is also related to pyrolysis and cookstove technologies discussed elsewhere in this presentation.
- *Pyrolysis*. By use of heat in pyrolysis, cellulose and lignins from a wide group of biomass sources can be converted to gaseous and liquid fuels. The products produced are hydrogen, carbon monoxide, methane, ethane, ethylene, burnable char methanol, and others. This technology was in wide use in Europe during World War II, and it might now be appropriate to determine whether it could be be reduced to practice in developing countries that have the necessary biomass.
- *Cookstoves with improved efficiency*. Much work has been done in recent years on cookstoves that can save 50 percent on wood consumption for cooking fuel. Since wood constitutes the major source for cooking and heating fuel in many rural areas and is a rapidly diminishing resource, the widespread use of such stoves could have a major conservation effect. Several agencies are beginning to apply this technology.

ISTC Program Strategy. All of the approaches for energy production discussed above have been and are being applied in one form or another in various parts of the world. Thousands of anaerobic digesters to produce biogas have been built, operated for a few days or weeks, and then abandoned. However, there is no centralized group or institute that is studying the accumulated experience, can help solve problems, and can serve as a source of information. The same can be said about alcohol production, solar thermal electric generation, pyrolysis, and charcoal production. Each of these processes can be made to work technologically and the projected economics seem hopeful. Yet attempts at implementation often bog down in a myriad of problems.

The International Rice Research Institute (IRRI), developed as a center of practical research and information, effectively created the Green Revolution in rice. Before its establishment, there were excellent but isolated studies scattered throughout the world that were directed toward developing new strains of rice. Only when IRRI took on the task of gathering the available information, adding its own research contributions, and *reducing the results to practice* was there a Green Revolution in rice. Something akin to the IRRI is now needed for renewable energy sources.

ISTC will work with other donors and international organizations to help develop this kind of activity. As noted earlier, the World Bank is currently assessing needs with regard to developing-country research capacities and energy resources. The United Nations Conference on Renewable Energy Resources in 1981 will offer further opportunity to develop coordinated worldwide programs for research and problem solving. ISTC will be actively engaged in this process.

Relationship to AID and other U.S. aid programs. ISTC's program will complement those of AID, the U.S. Departmentof Energy (DOE), and various multilateral programs. DOE has expanded its programs of basic research and technological cooperation with some of the more advanced countries. ISTC will draw on this work for help with the problems of the poorer countries and the small scale needs of rural areas. AID is helping developing countries assess their energy needs; explore alternatives to fossil fuels; use alternative technologies; and set up national experimental and distribution programs. Private organizations also assist in this effort. As more and more developing countries become actively involved in energy programs, the need for new or expanded centers like IRRI are required to help solve techno-

logical problems, to increase the efficiency of technological alternatives, and to build up the capacity of developing countries to make their own technological improvements. ISTC will seek to build on existing national centers in the Third World wherever possible for this purpose. Experimental energy centers in Thailand and India, for example, offer this potential.

In FY 1981, ISTC will provide support to two such centers in the context of recommendations in the World Bank report and in concert with other donors. In future years, this program will expand, as need arises, to other centers and to work on more technologies. In addition, ISTC will support the adaptation for use in developing countries of selected processes in which U.S. technology seems to be especially advanced. use in developing countries.

Locations/Institutions. Thailand and India, where energy centers already exist, are potential sites. Egypt, with its concentrated population in the Nile delta, is an attractive site for a center dealing with anaerobic digestion technology. Brazil is a leader in research and development on alcohol production from sugar cane. No similar level of experience or expertise exists for use of other high-starch crops. Nigeria and the neighboring Sahelian countries have the potential to produce significant quantities of these crops. However, competition with food supply would be an important consideration, for cassava is known in this region as the "bread of the poor." Nigeria would be able to provide valuable scientific, technological, and institutional support to a program dealing with the use of alcohol technology. The International Institute of Tropical Agriculture in Ibadan would add strength to an endeavor in this location.

Environment: Forestry Conservation And Development — $1.5 Million

Nature and Importance of the Problem. The close relationship between forests, soil, and water resources and development in Third World countries was clearly pointed out in the International Development Cooperation Act of 1979:

> "The Congress recognizes that the accelerating loss of forests and tree cover in developing countries undermines and offsets efforts to improve agricultural production and nutrition and otherwise to meet the basic human needs of the poor. Deforestation results in increased flooding, reduction in water supply for agricultural capacity, loss of firewood and needed wood products, and loss of valuable plants and animals."

The best available projections indicate that, unless decisive action is taken by developing and developed countries and the international community, little will remain of the closed tropical forests by the year 2000 but scattered remnants, except within sections of the Amazon Basin and Central Africa. Specific examples of adverse trends include the following:

- Deforestation and related hydrological problems in Panama are threatening water supplies essential for continued operation of the Panama Canal.
- The people of Haiti are experiencing fuelwood lumber shortages, soil erosion, and declining agricultural productivity as the result of the removal of natural forest cover.
- Irrigation canals in Java are clogged with silt washed down from deforested upland slopes, while floods and flood-related damage continues to increase.
- Major parts of many tropical countries have already been deforested, and estimates of an-

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nual world losses of tropical forests range as high as 20 million hectares per year.

The dimensions of these problems are vast, and research in these areas is required: deforestation, hydrologic system disruption, accelerated erosion, soil fertility losses, rangeland deterioration, fuelwood shortages, flooding, destructive logging methods, wasteful wood utilization practices, unsustainable land use patterns, dry season water shortages, reductions in water reservoir capacities for power and irrigation, interior and coastal fisheries' losses, declining agricultural productivity, and unsound cultivation practices.

Paralleling the problem of wholesale devastation of forestry resources is their underutilization. In some parts of the Third World, only 3 percent of the annual output of the forest is used, whereas improved silviculture could raise this to as much as 20 percent. Brazilian scientists currently estimate that only 0.3 percent of the area now occupied by rainforest in the Amazon can be brought into cultivation with present technology. Greater knowledge is needed as to how tropical forests function, what new varieties can be cultivated, and the results of alternative management practices.

Two recent analyses have provided a blueprint for research and development to address forestry problems. One is a forthcoming NAS report on "Research Priorities in Tropical Biology." The second is a U.S. Interagency Task Force report on U.S. policy, strategy, and programs for tropical forests. The background studies and recommendations in those reports will enable ISTC to begin a sound program that will necessarily involve a long period of effort.

Program objectives. Drawing on recommendations in these reports, the initial objective of the ISTC program will be to foster studies of better management systems for tropical forest resources. Examples are:

— New technology for "social forestry," i.e., community woodlots and agro-forestry, that will meet the needs for fuel, fodder, and food of the rural population. These are areas in which AID and other development agencies are currently working and where research results can be directly used.

— Reforestation technology that will save the land in terms of watersheds, timber resources, and erosion control. New varieties of fast-growing species and better management practices will be studied.

— Development and testing of new land use technologies. More knowledge is needed on the functioning of present tropical ecosystems, to avoid serious environmental consequences from development schemes. Equally important are cost-benefit studies of links between economic development and forest loss, to help clarify and articulate the values of natural forests as well as their conversion to farmland, tree plantations, and other development uses.

Research advances. Knowledge of tropical systems and organisms is seriously deficient, which limits the potential of development efforts. Recent studies, however, have produced valuable new knowledge on tree varieties of great potential, the biological mechanisms of root nourishment indispensable to successful transplanting, and more effective combinations of food crops and fuel trees.

Cooperative research now underway in seven countries (Australia, Malawi, Mexico, Singapore, Taiwan, the Philippines, and the United States) has shown that two recently discovered varieties of an evergreen tropical legume, *leucaena leucocephala*, are the most promising fast-growing trees for the low-lying humid tropics. The common variety of leucaena is a short, rugged, bushy tree a few meters high that was spread throughout the tropics by colonial plantation owners in the 19th century. It served as a "nurse" tree to provide shade and nitrogen nutrients for coffee, cocoa, pepper, vanilla, and other shade-loving crops. Because it grows so rapidly and produces seeds so readily, even when only a few months old, this variety tends to become a weed in many places, forming dense and impenetrable tangles that in East Africa are said to be an ideal breeding ground for the tsetse fly.

Within the last two decades, a remarkable new variety of *leucaena* has been discovered in inland forests of Central America. This "Salvador" or "Hawaiian Giant" variety is a tall, virtually branchless tree that can grow to a height of 65 feet in 6 to 8 years. In the Philippines it produces a greater quantity of wood than any known tree, from 12 to over 50 tons per hectare per year. With its absence of branches, thin bark, and light color, it may have commercial potential as a source of pulp and paper, roundwood poles and posts, medium hardwood for

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lumber and plywood, and as a fuel used either directly or as charcoal.

Energy plantations using leucaena could be a continously renewable source of fuel because the stumps readily regrow or "coppice" and thus "defy the woodcutter." With its deep, aggressive root system, the plant can withstand long dry seasons and can tolerate a wide variety of soil conditions, though it does not grow well in acid soils high in alumina.

Another recently discovered variety of *leucaena*, originating in Peru, produces little trunk but extremely high quantities of foliage: up to 12 to 20 tons per hectare of edible dry matter containing over 20 percent protein, compared to 8 to 9 tons per hectare of alfalfa with about the same percentage of protein. In cattle that have been fed *leucaena* and grass pastures, animal weight gains of 900 kilograms per hectare and annual milk production of 5,000 to 6,000 liters per hectare have been obtained. These yields are about twice those normally expected from tropical grasses or legumes.

Unfortunately, *leucaena* contains an uncommon amino acid, minosine, which produces goiter in cattle and loss of hair in sheep, horses, and pigs when the diet contains more than 30 to 50 percent dry weight of leucaena. But researchers in Hawaii and Australia have recently been able to produce a low mimosine *leucaena* through hybridization with another species of the same genus.

Much further research remains to be done to expand the usefulness and the range of environments of this marvelous tree. With some help from the IDRC, a number of countries — Tunisia, Nigeria, Egypt, Senegal, and Sudan — are searching for the right trees for the semi-arid lands around the Sahara and in East Africa. Sudan's Ministry of Agriculture has begun test planting the prosopis tree in the Kerma Basin of the Nubian Desert. The foliage of some varieties of prosopis is unpalatable to livestock; yet its nutritious pods can be eaten by humans and cattle.

In Nairobi the International Council for Research in Agroforestry, supported in the planning stages by the World Bank, is trying to combine the growing of trees with the growth of food crops and the pasturing of animals. Scientists from the Forestry Research Institute of Malawi have begun forestation designed to supply fuel from swift-growing trees that can be integrated with traditional crops.

In land management, progress in remote sensing and computer technology has greatly helped define land use capability and, through optimal decision-making processes, has helped planners assign the best land use. Resource allocation models have been developed that permit integration of social concerns and resource constraints in the decision-making process. Development of simulation models has enabled evaluation of complex problems and alternative management strategies at small cost, compared to long-term studies. On the biological side, there have been highly significant advances in plant breeding that offer the opportunity to increase productivity and adapt plants to inferior soil conditions. Similarly, there has been increased progress in the area of land reclamation and forest planting technology. These areas of advanced technology will be expoited to meet the objectives listed above.

The following are ISTC program activities planned for FY 1981.

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Title: Social Forestry

Purpose. Support research to provide improved community forestry systems to meet the immediate, direct needs of people for wood, fuels, and food.

Importance. The role of villages, small communities, and individual farmers is now being recognized as paramount in meeting the forestry needs of developing countries. They are facing the growing shortage of wood for fuel, and they have the potential to redress some of the most serious aspects of deforestation.

Research is urgently needed into the ways and means of engaging communities in this process, consistent with agricultural systems for food production, and in meeting both short-term food and fuel and long-term conservation needs. Work on this activity will be linked closely with renewable energy research and with farm systems work described earlier in this document. Multiple uses of different tree species such as leucaena, wood-burning conservation techniques such as charcoal processing and better cookstoves, and new social forestry management techniques will be examined together in field research.

For social forestry, innovative approaches are needed for fuelwood and wood material production on both private and communal lands. Greater use of secondary species, prevalent in areas such as the Sahel, is essential. Distinctions in approach associated with social, cultural, and institutional aspects — as well as in natural systems differences among semi-arid, mountain, and humid tropical zones — must be better understood and described to permit the design of more appropriate and more effective projects by AID and others. Research on the caloric energy requirements of different tree species, their suitability as fuels for different uses and purposes, and cultural and management techniques for sustained long-term production will be supported.

Distinctive methodologies will be devised to improve understanding of community forestry for wood production and of agro-forestry for food and fodder production. Soil and water conservation deserves special treatment in a social context.

Location. Community forestry and fuelwood production is especially important within areas of fuelwood scarcity, such as Nepal, Haiti, and the Sahel. Agro-forestry is important in many regions, and advanced work has been done in the Philippines, Kenya, and Malawi. Research in conjunction with the International Development Research Centre (Canada) and other donors will be undertaken (1) to identify and examine innovative low-cost reforestation and soil and water management methods appropriate to conditions in developing countries, and (2) to identify needs for further research into species trials and plant materials propagation techniques.

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Title: Reforestation and Afforestation: Adaptive Research on Fast-Growing Species

Purpose: To develop better techniques for reforestation and afforestation, especially greater adaptability of fast-growing species to a variety of regions, and to improve transplanting techniques.

Importance: One of the reasons forests are being denuded is the slow rate of growth of most native trees. The widespread sal-tree of India and Nepal, for example, requires 80 years to produce usable timber. Faster growing species, like leucaena, would make a substantial difference in timber production.

The introduction of new varieties raises problems about which much more must be learned. Mycorrhiza, for example, are the symbotic fungi on the roots of forest trees that extract nutrients from the soil and transfer them to the tree roots in exchange for food energy supplied by the tree. Different types of mycorrhiza are believed to be more or less specific to particular tree species, and each type flourishes only under a limited range of environments. Successful tree transplants from one country to another cannot be made unless the appropriate mycorrhiza can also be transferred or new mycorrhiza associations can be found for the tree in its new environment.

Location: Work on these activities will be carried out through a network of tropical locations. Scientists in Latin America and Asia, who have been doing mycorrhiza research under sponsorship of the International Federation of Scientists, will be involved. The several countries mentioned earlier — Sudan, Senegal, Malawi, Mexico, Singapore, Taiwan, the Philippines — that have been making attempts to adapt leucaena and other varieties will also be part of a concerted effort.

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Title: Tropical Ecosystems Management

Purpose: To analyze the ecology of selected tropical ecosystems ranging from humid to arid climatic zones, so that the impact of current activities can be evaluated and new management practices developed.

Importance: Lack of knowledge about tropical ecosystems prevents the development of better, more comprehensive management systems for forestry resources. The scope and organizational complexity of the effort needed to meet this problem cannot be understated. A 10-year, $20 million effort that will require 2 years to organize and an additional 8 years to complete is envisioned as meeting the needs of the major affected zones. It is critical that initial funds be earmarked for planning and state-of-the-art reviews of selected topics, and for coordinated programming with other interested organizations in both developed and developing countries.

As long and difficult as this effort is, its importance also cannot be understated. It is estimated that throughout the world 250 million people practice slash-and-burn agriculture on some 3,600 million acres of land. In North Africa, overgrazing and deforestation annually degrades an additional 100,000 hectares. In Brazil, various approaches are being made to try to cultivate the Amazon, amid controversy and uncertainty over the effects. A prime constraint in ameliorating man's impact is a lack of basic information about the ecosystem that could be used to determine its productive capacity and resiliency under alternative types and levels of use. Specific quantitative information is needed on nutrient cycles and species diversity, and on system stability and successional patterns, productivity and energetics. Long-term hydrological data are important for watershed management. Economic studies of alternative land use are required, based on better data on resources and resource potential. Also badly needed are syntheses of available information, with emphasis on current usable knowledge.

So that the developing countries and donors can more effectively address these problems in a cost-effective way, additional research is necessary to utilize inventory methods such as remote sensing and computer technology and for adapting land classification techniques and forest inventory methods to developing-country lands and vegetation.

Developing-country institutions will participate from the beginning in this program, expanding their capacity to undertake inventories of resources and to develop resource management systems on a continuing basis. Results of the program would be made available as they become known for use in economic development programs in the region concerned and in other similar regions. It is believed that serious costly failures in development schemes could be avoided if such a program is carried out.

Locations and Institutions. Many organizations, including several U.S. university consortiums and various foreign universities and research organizations, are ready to collaborate in this endeavor as a result of previous International Man and the Biosphere programs. Research sites have been identified in a number of tropical locations in Central America and Asia, as well as in arid regions of Africa. As noted, initial funding will support planning and state-of-the-art reviews of selected topics in this complex field. The product of the initial effort will be a fully developed and phased research program with a detailed action plan, including a full examination of other donor resources that are available for a joint effort.

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Information and Communication Systems: Capital-Saving Technology — $2.0 million

Nature and Importance of the Problem. Gaining access to information is one of the problems cited most frequently by Third World countries. At the UN Conference on Science and Technology for Development, this difficulty was noted as a major source of concern. Recommendations to remedy this problem ranged from highly centralized computer data banks at the United Nations, which U.S. experts felt to be impractical, to highly differentiated networks that link information directly to users, which most experts feel is more effective.

ISTC is particularly concerned about this problem because it affects both the use of research results from ISTC programs and the ability of developing countries in general to make sound decisions about technologies most appropriate to their needs.

A recent evaluation of research programs recommended that any agency that is not willing to fund steps toward utilization of its research results should not fund the research in the first place. Fortunately AID has been developing increasingly effective information systems for getting needed knowledge to AID missions, developing countries, and other donors. ISTC will work closely with AID as well as others to make information from its programs available for timely dissemination.

Equally important, as part of its programing process, ISTC will be concerned with the use of results during the planning, implementation, and evaluation of research programs. Part of the early planning of each program will be a determination of the potential usefulness of the research and the possible constraints on the dissemination of results to the ultimate users. These considerations will help sharpen the focus of the research on practical needs and on

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methodologies that are truly adaptable to conditions in developing countries.

The larger and more difficult problem is how can developing countries gain wider access to information — both new knowledge from research and data on existing technologies? This subject is complex, touching on questions of proprietary technology, computer and communications systems, and the differentiation between information needed for research workers and that needed for particitioners and beneficiaries. This situation will require continuing study by many different agencies and institutions, as there is no simple or single answer.

ISTC will initially address one facet of the problem that has only recently received the attention it deserves: the problem of disseminating information on capital-saving technology to the people who can use it to ameliorate immediate problems. This problem has two dimensions: the weakness of conventional communications systems to deal effectively with this audience and the failure of existing systems to process information on innovations originating in the villages that could be useful elsewhere.

Limitations of Conventional Information Systems. Little practical information on science and technology has reached the ultimate intended beneficiaries — the rural small farmers, craftsmen, and laborers who constitute the majority of the poor in developing countries. Efforts to put science and technology at the service of the rural poor have been prescriptive, with research institutes and universitites selecting technologies and then, with the help of extension services, attempting to persuade rural people to use them.

Initial disappointment with the results of these efforts led to further work to improve the training of extension workers. However, it is now widely agreed that much, if not most, technology introduced into rural populations from centralized institutions has been too costly and unable to perform the tasks for which it was intended. Moreover, it has contributed to inequalities in rural communities and has often had negative environmental consequences.

A proposed response to this difficulty has been to increase greatly the number of factors that planners consider in selecting technologies. This task, however, is difficult and requires a detailed knowledge of the skills, resources, and constraints peculiar to each small community. Moreover, this approach is based on outdated assumptions that posited a rural population without significant and useful traditional technologies, without an innovating capacity, and without the ability to marshal resources effectively for their most efficient use. In fact, an enormous variety of traditional technology already exists, ranging from primitive to cost-effective, elegant solutions to significant problems. The small farmer has often proven to be a clever manager of minute amounts of resources for survival, in some cases producing more per unit of land area and resources expended than the larger farmer.

Where can the rural inhabitant get information on other simple technologies that might be useful in addressing his problems? At present, his only sources are existing informal networks of other rural people. The narrow formal pipeline of information being deliberately channeled his way flows in only one direction because the extension agent is capable of suppling only those ideas that happen to have been included in his limited training. In brief, the rural inhabitants' effective access to the science and technology experience of the rest of the world is extremely limited. The structure of conventional diffusion of new knowledge generated by innovative programs does not allow for the recipients' initiative in seeking information.

Limitations of Informal Diffusion of Traditional Technology. Today a great variety of low-cost, effective, environmentally sound traditional technology remains undocumented in information systems, although used by millions of people around the world. These technologies have been developed through local innovation and diffused through informal human networks. Such traditional technologies, however, have tended to remain localized and unknown in many areas where they could be effectively used. For example, in the southern Philippines, rooftop water catchment tanks are quite common as a source of domestic water. On an adjacent island, however, where severe water problems exist in some communities, this technology is non-existent. Several major reasons for this lack of informal diffusion are apparent.

- Diffusion within a region is circumscribed by geographical, language, and cultural boundaries.
- Diffusion is greatly slowed where members of isolated communities have little contact with other countries.

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- The area immediately surrounding a technology pocket may block, because of its own circumstances, application of the successful technology in more distant regions where it could be useful.
- Communications flow primarily to the central cities and back, both through mass media and informal networks created by population movement. There is little communication over significant distances among rural communities that may be able to use or adapt such technology.
- Organized technology dissemination systems using extension services and commercial channels ignore traditional technology and are primarily one-way communication flows *from* centralized institutions *to* rural people.

Major Research Questions. How can existing informal networks among rural people be supplied with technology information in forms in which it can be assimilated and in a manner that builds self-confidence and self-reliance, and increases grass roots technical competence?

What efforts have been successful in providing technical assistance in a non-directive manner to rural people, to help them solve problems to which they attach high priority? How can institutionalized information systems be reorganized to allow for responsiveness to rural end-user requests for specific technical assistance?

What low-cost media technologies are best used for communication about appropriate traditional and new technologies *among* rural communitites?

What skills-based science curriculum and approaches, used in the primary school levels and non-formal education efforts, can serve to strengthen the innovation activities of millions of rural craftsmen and farmers and place them on a firmer scientific footing?

How can agricultural research stations and institutions working on other kinds of appropriate technology for development research increase beneficiary participation in problem identification and solution?

What kind of information-gathering methodologies can best be used by technology dissemination organizations to choose from a wide range of traditional and new technologies and to publicize them selectively so as not to overwhelm the end-user with information irrelevant to his needs? What approaches can best ensure that a responsive technology information and assistance system will reach the poor majority and not just the better-educated or wealthy farmers, or those who know how to seek information?

Significant Recent Research Development. Many individual experiments and experiences around the world are relevant to the question of rural access to useful scientific and technological information. For example, catalogs describing technological innovations have been an inexpensive way to make a wide range of technologies better known as potential candidates for adaptation: Liklik Buk (Papua, New Guinea), Appropriate Technology Directory (India), Village Technology Handbook (Volunteers in Asia), the Whole Earth Catalog, and Sears and Roebuck catalogs of the early part of this century have all served this purpose in different ways. Such catalogs can cost as little as $2 to $10 while supplying a significant range of ideas and technical details. This expenditure compares favorably with the cost of operating a conventional data bank/technical assistance unit, which even in developing countries show costs of $100 to $300 per request.

Small, inexpensive illustrated booklets can make the potential of technolgoy more widely known. An example is the housing design circulated in comic books after an earthquake in Bali. These books encouraged earthquake-proof rebuilding by showing the damage to brick structures and the survival of lightweight wooden-framed traditional Balinese houses.

Basic science education has been supported by science booklet/kits sold on newsstands in Brazil and the booklets of the Science Library series of the African Primary Science Program. A number of successful programs indicate that science curricula can be adapted to rural areas.

Mimeographed plans and newsletters have been used to support diffusion of ideas among village communities. The Chinese have used this approach rather successfully. Showing basic outlines of new agricultural machines, for example, they require the user to adapt the new technology while using tools and materials available to him.

Cassette tape recorders have allowed the development of low-cost grassroots radio programs, in which community-level interviews and question-answer sessions on technology development and needs can be broadcast over a small area, as in a program in the Philippines.

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Village technology fairs, exhibitions, and traveling shows have exposed rural Africans to the workings of new technologies that may prove useful to them. Slide shows and filmstrips in Mexico have been used to provide visual details of technologies and problems. They have also served to excite and motivate an audience that perceives the similarities between the problems they face and those depicted in the slides.

A wide variety of visual aids, such as flannel boards, flip charts, and puppet shows, has been developed by conventional extension agencies. For example, traditonal shadow puppets have been used in Java to communicate family planning messages.

Group problem solving, which involves the pooling of perceptions and information from the rural community, has been shown to be a successful mechanism for facilitating incremental technology improvement and adaptation while increasing the self-confidence of villagers in solving their own problems, such as the Grain Storage Project in Arusha, Tanzania.

Relevant technical extracts can be taken from university-level engineering courses and presented in easily understood language in book form, to provide access to critical design information without requiring university schooling. For example, a successful book was created by four Stanford University professors for use in the United States. In this book essential concepts and design criteria for solar energy, windpower, waterpower, waste disposal, and water supply technologies were combined in a readable reference book that can be used by anyone with a high school education.

Small libraries, equipped with 50 to 200 books, can be valuable as information reference centers and can help stimulate innovation. Small collections of booklets on literacy and village technology are being created in the villages of Indonesia. Privately operated rental libraries, in which small illustrated books, photo-novels, and comics are rented for a small fee are found in many urban fringe areas of developing countries. These may offer a useful model as well.

The "barefoot doctor" health worker has played a major role in the Chinese health care system, and similarly trained health workers are being used in rural health programs around the world. A program in rural Colombia is trying to create an analogous concept of "barefoot engineer," providing training to young rural community residents who will return to provide technical assistance.

A successful independent grassroots health network, run entirely by nonprofessional village health workers in the mountains of Sinaloa, Mexico, has been contracted by the Mexican government to train other villagers in several health care programs. Additional experiences suggest a great potential for villager-to-villager training programs.

ISTC Strategy and Relationship to Other Agency Programs.

The many experiments and experiences already noted provide building blocks to develop information-sharing strategies for the basic levels of appropriate village technologies. So far, these experiences have been neither compiled nor evaluated.

The ISTC strategy in the two initiatives described below is to develop an organized approach by which people can pool their experiences, add to that approach through ISTC-sponsored research and experimentation, and provide a way for other countries to use the approach.

ISTC's program will complement the work of AID and private organizations working to expand the use of capital-saving technology. AID has contracted with VITA, a private voluntary organization, to carry out a study on the feasibility of a worldwide capital-saving technology information network. The purpose is to provide access to the specialized focus of technical information and resources needed by capital-saving technology practitioners. VITA has already identified a number of constraints on the flow of information to users at the village level. Some of these constraints relate to the generation of request for help, some to the means of transmitting understandable information, and some to the later diffusion of successful experiences.

ISTC will support research and experimentation to overcome these problems and to help the information networks become more effective. ISTC will support research and experimentation by some of the groups and organizations now working at the grassroots, which will themselves be participants in the networks. Close cooperation with AID and AID-assisted private voluntary organizations will be maintained throughout.

The results of ISTC's program will also help many operating agencies in their efforts to help introduce the use and adaptation of capital-saving technology in individual country settings. Examples are AID's Improved Rural Technolgy Project in Africa, sup-

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port to Appropriate Technology International (ATI), and individual activities in several country programs. Many such projects are experimenting with information methods. By helping to evaluate these experiments, by supporting experiments in uses of combined information approaches, and by enabling the action agencies to learn more of others' experience in various parts of the world, ISTC's program will help increase the effectiveness of all agency efforts.

Particularly valuable will be ISTC's support to developing country institutions and practitioners experimenting with better information at the grassroots level. These indigenous sources of expertise will likely become the sources of technical assistance to other developing countries, thus giving capital-saving technology more credence and respect within the Third World. The ISTC program differs notably from the study program of the United Nations University, "Sharing of Traditional Technology." This program examines the cultural elements embodied in traditional technologies and the potential for their wider use but does not deal with information systems.

Following is a description of two key initiatives planned by ISTC to meet communication and information needs.

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Title: Media for Communicating Appropriate Technology

Purpose: To determine the most effective media for communicating capital-saving technology information among illiterate and semi-literate populations and across cultural lines.

Importance: Most of the beneficiaries of capital-saving technologies are in rural areas and are often illiterate or semi-literate. Presentations for them must be distinctly different from those intended for technology institutions or voluntary agencies. Experiments to date with picture books, slides, and the like are promising, but little has been done to capture village innovations and diffuse them from village to village and back to the networks for diffusion abroad, or to experiment with the media cross-cultural communications.

This project would systematically evaluate work with picture books, science kits, models, and other media forms. Combinations of media would be tried, and evaluation made of the importance of personal visits as follow-up. Experiments with village preparation of material on local innovations would be supported and evaluated for effectiveness in other regions.

Location Institutions: Groups such as the Science Education Program for Africa and the Tanzanian Institute for Adult Education (Grain Storage Project, Arusha) have all been involved in one or more of these programs to strengthen local innovation. Institutions in Papua, New Guinea, India, and other countries have used catalogs or packets of leaflets in such attempts. Organizations in Africa, Indonesia, and Mexico have been working on improving communications between villages.

ISTC will sponsor a collation and evaluation of these experiences and will support these groups in a program of coordinated research, experimentation, and evaluation of efforts. The goal here is to fund media that effectively reach the village level, promote experimentation with capital-saving technology, and can be used across country and cultural lines.

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Title: Participation of the Poor in Research Design

Purpose: To determine methods whereby researchers and beneficiaries can work together in the identification and selection of technological problems.

Importance: Agricultural research on small farming systems has indicated that an important step in developing better information is to include small farmers in the research process, so that their problems and needs are fully considered. Without this approach, farmers are often presented wth technical packages that do not make sense for their circumstances or are feasible only for the richest farmers.

Little technology development research outside of agriculture has incorporated poor rural people in defining problems and developing solutions. This program will research and test mechanisms for more effective involvement of rural people in technology development efforts for their benefit. It will be coordinated with the work of the International Agricultural Research Centers on the specific problems of agricultural research, but will extend beyond that to other sectors.

Elements to be studied include:

- The effectiveness of rural-based, small-technology adaptation and testing centers (such as the two units operating now in Sri Lanka and the Philippines). Goals would be to involve rural people as craftsmen and users/testers of new technology, as well as to increase their participation on advisory councils to such centers, so that technology adaptation work is carried out in cooperation between technically qualified people and the rural poor.
- Mechanisms to improve the two-way flow of information between the rural poor and researchers working in higher institutions, so as to enhance understanding by technologists of rural problems and constraints.
- The use of knowledgeable villagers to present a picture of their circumstances to students studying technical subjects in universities.
- Participation patterns and their influence on the research priorities selected and the later diffusion and utilization of results by farmers, community leaders, and others.

Location/Institutions: Rural-based technology-adaptation centers are being created in several countires, including Sri Lanka and the Philippines. These would be supported in a program of research on improved communications and methods to involve rural residents in the work of those centers.

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Program Design and Evaluation — $2.8 Million

The preceding discussion dealt with programs to be designed during FY 1980 and early FY 1981, with implementation to begin in those years. This section deals with the initial design of new programs, evaluation of those programs, and support for a range of international activities in scientific and technological cooperation that will lead to improved problem solving.

Program Design

During FY 1981 ISTC will plan and design programs in selected new areas. These efforts will lead to preparation of program plans for review by the ISTC Council and presentation to the Congress for implementation in FY 1982 and beyond. Program development will follow procedures being established by the Institute. A critically important aspect of this process is the mutal exploration of goals and strategies with developing-country research scientists and specialists from the United States and other countries.

Three areas in which planning and program design would be undertaken in FY 1981 are described below.

Math and Science Curricula. A good preparation in the fundamentals of science and mathematics is essential for students who intend to pursue specialized university studies in science and technology. An understanding of the scientific approach to problem solving is, in fact, useful to everyone in a modern society. Science education also plays a role in helping to improve nutrition and sanitation, in the adaptation of more effective agricultural practices, and in the prevention of major diseases through public health education.

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During the past two decades, unprecedented developments have taken place in producing methods to teach pre-college science and mathematics. The United States has launched much of this activity and by doing so has set new standards for others, including the developing countries. However, in recent years, curriculum centers established in the less developed countries with the help of American financial support and expertise have become isolated and fallen behind. There is a need to reestablish communication links with these centers and to set up mechanisms for future collaborative efforts to improve science and mathematics education.

In FY 1981, the ISTC will establish contact with national and regional science curriculum centers in the developing world in order to assess their needs and interests in collaborative programs. The Institute will also appraise U.S. centers of science teaching that have extensive international interests, such as the Lawrence Hall of Science and Florida State University, to determine their potential for helping centers in developing countries. Selected rural education projects with a scientific or technological orientation will be evaluated for potential application elsewhere.

Private sector cooperation to foster developing-country capacity in selection, adaptation, and management of technology. Important technology resides in the private sector, and many of the most effective programs of technical training overseas have taken place through the private sector. During the planning phase of ISTC, the U.S. business and industrial sector expressed its strong support in having ISTC play a catalytic role in improving the effectiveness of such programs. In preparation for the UN Conference on Science and Technology for Development, the Department of State sponsored seminars in Mexico, Brazil, Venezuela, and India, all of which indicated both interest in and areas of emphasis for such cooperation. Emphasis was placed on management training, improved information flows, and greater skills in choice and adaptation of imported technology. Further seminars, sponsored by the Department of State, are being held in FY 1980 to develop specific cooperative programs. The ISTC Planning Office sponsored a special survey of U.S. small and minority businesses to determine the extent of interest in such cooperation and found it to be high.

ISTC will work with representatives of the U.S. private industrial sector, including small and minority businesses, to develop arrangements for support of specific programs of cooperation. These programs will concentrate on expanding the skills needed for local production of goods needed in the domestic markets of the developing countries and for greater employment in small and medium-sized industries producing appropriate technology. Contributions to the cost of these programs will be sought from the U.S. industries participating, the developing countries, and ISTC. ISTC will help facilitate the organization, planning, and design of such programs in the developing countries. Special attention will be paid to the successful experience of Sweden's cooperative industries program, which operates along similar lines.

Oceans and Marine Science. Extended fishery jurisdiction is now a worldwide phenomenon, and developing countries are faced with the problem of implementing management systems that will guarantee the productivity of marine resources within their zones. Over 100 developing countries have coastal zones. In most cases, the intermingling of stocks in the zones of a number of countries requires a regional approach, not only with respect to management and enforcement but also in the development of information about the oceans and their resources.

ISTC's program in fisheries and aquaculture is described earlier under Overcoming World Hunger. ISTC will explore a possible appropriate role for support to developing countries on a broader range of ocean and marine resource questions.

Further ISTC programs of this kind might be linked with the Voluntary Assistance Program of the Intergovernmental Oceanographic Commission (IOC), the 103-member UNESCO body established to promote scientific investigation of the nature and resources of the oceans. Primarily a bilateral assistance scheme under a multilateral umbrella (each donor retains control over its contribution), the IOC Voluntary Assistance Program (VAP) will serve to increase the scientific competence of the majority of IOC members, which lack the expertise and equipment to understand and use their marine environment fully.

Specific opportunities for collaboration with developing countries are now being developed by the United States. An example is the IOC Association for the Caribbean and Adjacent Regions (IOCARIBE).

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Support of this regional association relates to the ISTC interest in regional development and in helping developing nations build their own scientific and technological capacity.

ISTC support could also help show U.S. commitment to scientific cooperation with other Caribbean countries; it could enable American scientists to advance our understanding of the nature and resources of the Caribbean; and it could advance the ability of all Caribbean countries to derive the greatest possible benefit from our common sea.

Another opportunity is being developed with India. In November 1978, U.S. and Indian scientists met in Goa at a cooperative oceanography workshop sponsored by the National Science Foundation and India's Department of Science and Technology. A number of projects were proposed by both sides. To carry out the objectives of the workshop, a working group on marine science was suggested as a component of the India-U.S. Subcommission. The proposal is expected to be adopted at the Subcommission meeting on February 28 and 29, 1980. Establishment of this working group demonstrates solid interest in oceanographic cooperation and will help to identify specific projects that may qualify for ISTC support.

Design efforts in each of the above areas will use a variety of techniques. Some of the essential processes are as follows:

- Overseas workshops in which developing country researchers and administrators define priorities.
- Background and state-of-the-art papers by knowledgeable and experienced persons from representative developing countries.
- Use of U.S. specialists to review the existing work in subject areas in the United States and elsewhere and to identify specialized research capacity and technological knowledge that might be used.
- Collaborative agreement grants to qualified institutions to help evaluate research stategies, such as the Institute of Medicine of the National Academy of Sciences.
- Exploratory grants to overseas research institutions and individuals to develop program design and research methodology.

Program Evaluation and Dissemination of Information

Because ISTC is essentially a problem-solving and capacity-building organization, an important collateral contribution will derive from continuing, intensive program reviews and evaluations. Evaluative results will be used for mid-course program modifications but will also be available to other research workers and institutions interested in following the course of ISTC work.

At the Institute, the evaluation methodologies will be keyed to the unique characteristics of each problem area. These include:

- Use of *ad hoc* peer review panels to assess program progress against plans and to examine plans for application and use of results.
- Grants to developing-country research institutions to evaluate ISTC-supported research programs of special relevance to their countries' needs.
- Grants to individuals or institutions to conduct intensive long-term assessments of particular programs.

Scientific and Technological Cooperation

Technological exchange and cooperation are important to both the United States and the developing countries. A large body of increasingly sophisticated talent in those countries lacks access to U.S. scientific and technological information and innovations. In some cases these countries are deeply engaged in developing new technologies in energy, food, and health that could be of value to other developing countries and to the United States. ISTC will be a principal point of contact for developing countries, or regional groupings of such countries, seeking such cooperation with the United States. The Andean Pact and the Caribbean countries, for example, have recently requested such cooperation with the United States. The Association of Southeast Asian Nations (ASEAN) is another good example where such cooperation could be fruitful. Trilateral scientific and technological cooperation between the United States, Egypt, and Israel has been encouraged by the Congress.

ISTC will help assess the best forms of cooperation in these cases and help establish links between institutions in these regions and ongoing programs, in the United States or abroad, in which the United States is

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participating. ISTC will also help these countries or groups of countries assess their capabilities, potential, and the best means to develop their capacities further. ISTC will help foster links with U.S. institutions and/or U.S. domestic agencies working on problems relevant to development in the countries where organized programs of cooperation do not already exist.

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4. Management and Operating Costs

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Management and Operating Costs — $5.7 Million

Administrative expenses include salaries, benefits, travel, office overhead, and support costs for direct-hire permanent employees of the Institute, individuals serving under the Intergovernmental Personnel Act, and Institute Fellows. Also included are travel and per diem costs for the Council on International Scientific and Technological Cooperation.

Organizational Structure

The Institute is a component of the IDCA and will relate to IDCA in the same manner as AID. In this regard, ISTC will have clear day-to-day operating autonomy within the framework of the basic policies and overall budget established by the IDCA Director. Accordingly, ISTC will design and install those basic support systems necessary for effective management and support of its program. These systems include finance and budget, personnel, and grants and contract administration. Where feasible and efficient, ISTC will, on a reimbursable basis, obtain support services from AID. Included might be such functions as payroll, health and travel services, security (investigations and property), data processing, and printing.

Internally, the Institute will be organized around major research problems, with Program Directors reporting to the Director of the Institute. Administrative functions — budget, personnel, grants, and contracts — will be under the jurisdiction of an Assistant Director. Policy analysis, program evaluation, and liaison with the private sector and with other donors and international institutions will be under a second Assistant Director. The staffing pattern projections for FY 1981 indicate a distribution of basic functions as follows:

	Percent of Total
Executive Management, General Counsel, Legislative Liaison	8
Program Management, Design Evaluation and Policy	76
Administrative Support	16
TOTAL	100

Organizational arrangements are shown schematically in Figure 4.

Work force Composition and Level

Work force estimates for FY 1980 and FY 1981 are based on the assumption that initial funding for the Institute will be available in March of 1980 and that personnel will be recruited gradually and systematically over the following eighteen months. On this basis, it is projected that the Institute will have filled 95 permanent positions by the end of the current fiscal year and 106 permanent positions by the end of FY 1981.

The Institute plans to draw heavily on the temporary professional services of individuals from the private sector who are not on government rolls. It is

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estimated that by the end of FY 1981 the Institute will be using the temporary services of 15 professionals under the Intergovernmental Personnel Act and that 20 2-year ISTC fellowships will have been awarded. Work force composition at the end of FY 1980 and 1981 is estimated as follows:

	End of 1980	End of 1981
Permanent employees	95	106
Full-time	(90)	(100)
Part-time	(5)	(6)
Intergovernment Personnel Act	5	15
Institute Fellows	0	20
TOTAL	100	141

Budget for 1981

Administrative cost projections for FY 1980 and FY 1981 are detailed in Table 2. The projections for FY 1981 are self-contained; no additional amounts are included in the AID operating expense account.

The grade structure and rates of compensation used to calculate salary costs are based on planning estimates. The grades ultimately assigned to each position will be in strict accord with standard Civil Service procedures. Similarly, all positions to be included under the Senior Executive Service will be reviewed by the Office of Personnel Management and established in conformity with standard federal procedures.

The average grade of permanent employees assumed in the budget projections for FY 1981 is 10.4. This grade compares favorably with smaller agencies involved in research and in science and technology.

Work force and budget projections for FY 1981 do not include a separate category for overseas personnel. It is the current plan that Institute staff serving overseas be attached to an existing indigenous research institution or international organization. Overseas staff would be accommodated within current work force and budget projections.

Figure 4

ISTC ORGANIZATIONAL RELATIONSHIPS

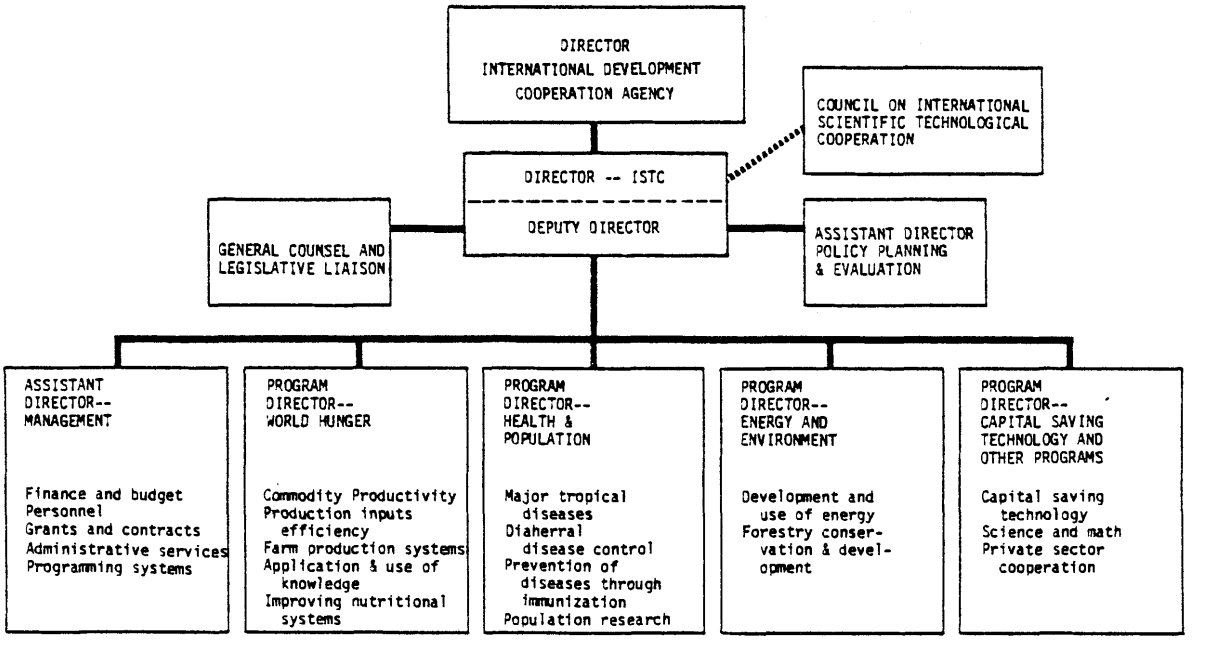

TABLE 2 — ISTC ADMINISTRATIVE COSTS
FY 1980/81
($ in Thousands)

	FY 1980	FY 1981
Personnel Compensation		
Permanent positions	605	2,613
Nonpermanent	45	911
Part-time	16	75
Overtime	5	15
Advisory Council	22	44
Subtotal	**693**	**3,658**
Personnel Benefits	**61**	**330**
Travel		
Staff Travel	155	398
Council Travel	16	32
Miscellaneous Travel	2	10
Institute Fellows	0	15
Subtotal	**173**	**455**
Transportation of Things	**10**	**50**
Rent and Communications		
Space Rental	0	500
Communications	37	190
Subtotal	**37**	**690**
Printing and Reproduction		
Institute Publications	0	20
Miscellaneous Stationery	2	10
Subtotal	**2**	**30**
Contractual Services		
Administrative Contracts	50	100
Support Services — AID (reimbursement)	35	140
Subtotal	**85**	**240**
Supplies and Materials		
Publications	2	12
Other	12	40
Subtotal	**14**	**52**
Equipment		
Furniture	0	100
Filing Equipment	10	25
Duplicating Equipment	0	25
Office Machines	25	10
Other	5	25
Subtotal	**40**	**185**
TOTAL	**1,115***	**5,690**

*For 1980 the budget estimate assumes an average of 3 months of service or a total annualized workforce of approximately 24 person years.
The 1980 estimate excludes certain costs inccurred by AID for administration of research activities that are to be transferred to the Institue at or toward the end of the year.

Appendices

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Appendix 1

Activities to be Transferred to ISTC in FY 1980

	Reference Page *AID 1980 CP*
World Hunger	
International Agriculture Research Centers	Annex 5, p.13
Livestock Production—Collaborative Research Support Program, Small Ruminants; physiology and ecology of ticks; grazing ruminants	Annex 5, p.16
Fertilizer Development—International Fertilizer Development Center	Annex 5, p.17
Fisheries and Aquaculture—Collaborative Research Support Program in Fisherries; International Center for Living Aquatic Resources Management	Annex 5, p.13
Pest Management—Root-knot nematodes	Annex 5, p.19
Soil Management—Collaborative Research Support Program In Soils	Annex 5, p.22
Cereal Grains—Collaborative Research on Sorghum and Millet; Spring and Winter Wheat Crosses; Control of Barley Diseases	Annex 5, p.24
Grain Legumes—Collaborative Research Support Program on Beans and Cowpeas; Improved Varieties of Soybeans	Annex 5, p.25
Biological Nitrogen Fixation	Annex 5, p.23
Functional Implications of Nutrition	Annex 5, p.40
Health and Population	
Tropical Diseases—malaria research network; special program for tropical disease research and training; International Center for Diarrheal Disease Research	Annex 5, p.111
Population Research	
Study of Side Effects of Prostaglandins	Annex 5, p.81
Biomedical Research	Annex 5, p.84
Program Development	
Man and the Biosphere	Annex 5, p.157

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Appendix 2

The Consultative Group On International Agricultural Research (CGIAR)

The Consultative Group on International Agricultural Research (CGIAR) is a consortium of some 30 voluntary donors who collectively support thirteen international agricultural centers and programs. The CGIAR has a Secretariat headquartered at the World Bank in Washington, D.C., and a Technical Advisory Committee (TAC) headquartered at the FAO in Rome. The centers and programs are designed to produce technology and provide services that will directly help developing countries increase agricultural productivity. In general, the activities of the centers and programs focus on (1) commodities; (2) systems of production; (3) production inputs; and (4) policies and activities that promote the application and use of research results. The centers also provide training for developing country scientists, extension workers, and policy makers. The centers work with countries to define production development programs and, with special funding, sometimes help implement them.

Each center and program has a core budget of support for its basic mandated areas of activity. In addition, special funding supports ancillary undertakings.

At its meeting in November 1979, the CGIAR accepated a proposal from its chairman that it plan continued program growth at a reduced overall rate compared with past years, projecting a doubling of total contributions over the period 1980–1984. U.S. leadership was important in reaching this consensus, which is conditional on year-to-year decisions concerning actual contribution levels.

The CGIAR Units

Below is a summary of information on the 13 centers and programs. (Dates in parenthesis indicate when established).

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CIAT International Center for Tropical Agriculture, Palmira, Colombia (1968). The principal international programs deal with cassava and field beans and the growth of tropical pastures on infertile soils, cassava and field beans. The secondary regional programs involve rice and maize.

CIMMYT International Center for the Improvement of Corn and Wheat, El Batan, Mexico (1966). The main programs involve maize (corn) and the basic wheat types. Research is also done on barley and triticale (a cross of wheat and rye).

CIP International Potato Center, Lima, Peru (1972). The program concentrates entirely on the white potato.

IBPGR International Board for Plant Genetic Resources, Rome, Italy (1973). The purpose of the Board is to coordinate an international effort to collect, evaluate, conserve, document, and use genetic material of economically important crops.

ICARDA International Center for Agricultural Research in the Dry Areas, temporarily headquartered in Cairo, Egypt (1976). The Center's principal aim is to improve rainfed farming systems for the drier regions of the Middle East and North Africa. Emphasis is on barley, lentils, broad beans, wheat, chickpeas, and forages for livestock.

ICRISAT International Crops Research Institute for the Semi-Arid Tropics, Pantacheru, A.P., India (1972). Primary emphasis is on sorghum, pearl millet, pigeon pea, chickpea, and groundnuts (peanuts). There are also research programs on rainfed farming systems and the identification of socio-economic and other constraints to agricultural development.

IFPRI International Food Policy Research Institute, Washington, D.C. (1975). Attention is given to the analysis of the status and trends in production; food production policy, including research resources, investment requirements, and fertilizer supplies; consumption policy; and trade policy including export prospects, food security arrangements, and commodity market analysis.

IITA International Institute of Tropical Agriculture, Ibadan, Nigeria (1967). The Institue studies farming systems and crops for the lowland humid and sub-humid tropics, especially in Africa. Emphasis is on three sets of commodities: cereals (rice and maize); grain legumes (cowpeas, soybeans, and lima beans); and roots and tubers (cassava, yams, sweet potatoes, and cocoa yams).

ILCA International Livestock Center for Africa, Addis Ababa, Ethiopia (1974). The improvement of livestock production in the region, including range management for cattle, is investigated through a systems approach.

ILRAD International Laboratory for Research on Animal Diseases, Nairobi, Kenya (1974). The laboratory concentrates on two cattle diseases, the fly-borne *trypanosomiasis*, and the tick-borne *thieleriasis*.

IRRI International Rice Research Institute, Los Banos, Philippines, Est. 1960). An extensive program of research focuses on rice and associated crops, including cropping systems.

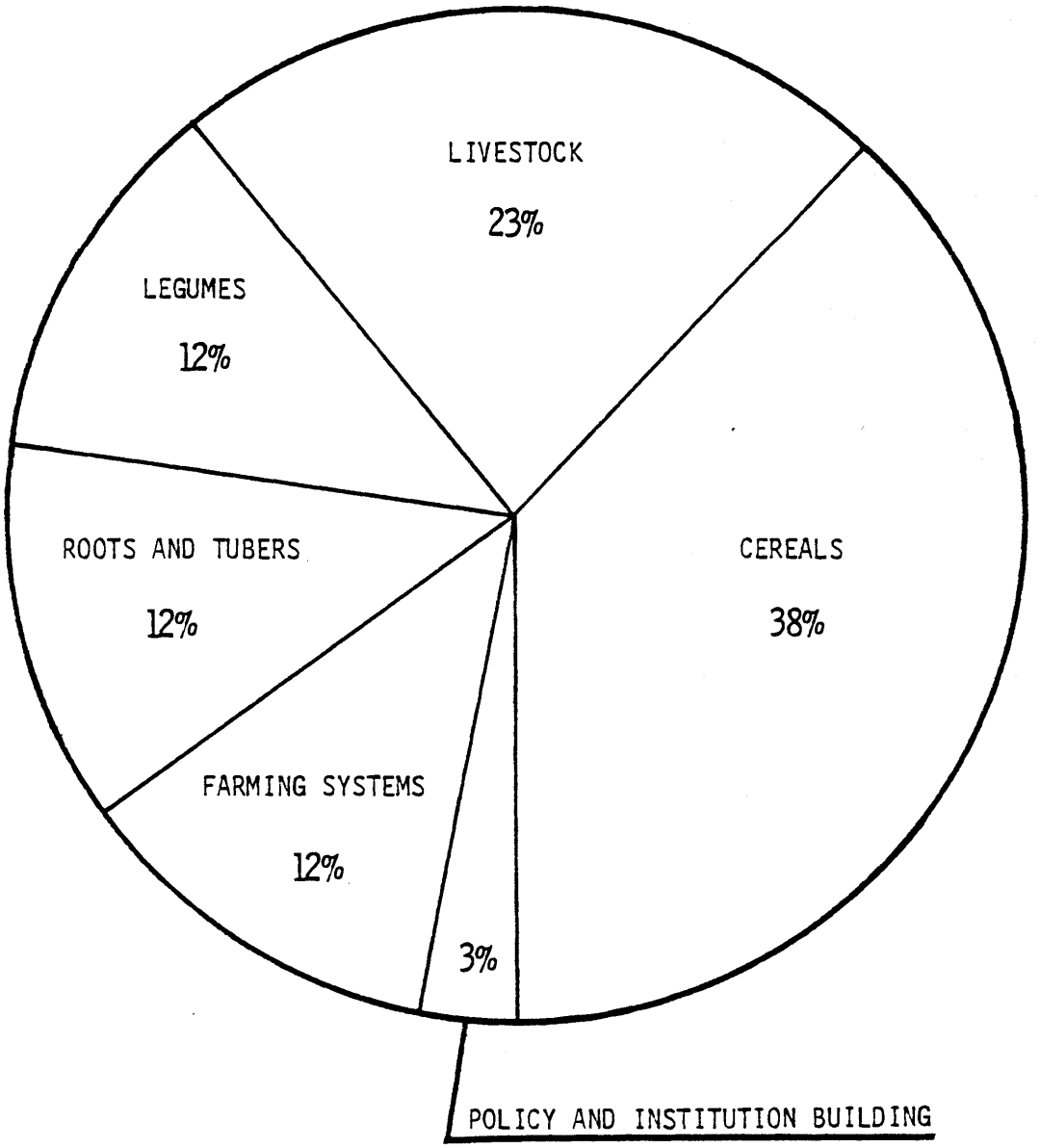
ISNAR International Service for National Agricultural Research, The Hague, Netherlands (1979). This service assists developing countries to analyze and improve their national agricultural research establishments and associated institutions.

WARDA West Africa Rice Development Association, Monrovia, Liberia (1971). This regional association of some 15 West African nations has four research stations which carry out an integrated program. It also coordinates a series of varietal trials.

Program Emphasis Within The CGIAR

The programs are decided by the governing boards of each unit, and are discussed each year at a meeting of the Consultative Group. The accompanying chart indicates the approximate apportionment of emphasis within the system as a whole. Since the study of a commodity often involves cross-cutting concerns, such as farming systems or policy and institution building, the CGIAR emphasis on such cross-cutting concerns is understated in the chart.

APPORTIONMENT OF CGIAR RESEARCH EMPHASIS
CORE BUDGETS 1980



Financial Support Of The CGIAR Units

Each unit coordinated within the CGIAR system has 10–15 donors that provide support to to core program and its special programs. The United States has traditionally provided up to 25 percent of the core support of the total set of institutions, although this has varied as to the proportion provided to each unit.

The two tables that follow show, first, the 1980 budgets for each center or program within the CGIAR. The information in Table 1 shows the net budget support provided by donor-members of the Consultative Group and the US contribution (both in dollars and as a percent of the net budget). Table 2 lists the donors active in 1979, and an indication of the proportion of the system's core program financial requirements provided by each donor in that year.

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TABLE 1 — FINANCIAL SUPPORT TO CGIAR UNITS, 1980

CGIAR Institute, Center or Program	CGIAR Support (Core Budget)	U.S. Contribution	
	($ millions)	($ millions)	(Percent)
CIAT	14.598	3.650	25.0
CIMMYT	16.161	4.250	26.3
CIP	7.311	1.700	23.3
IBPGR	3.114	.750	24.1
ICARDA	11.443	3.050	26.7
ICRISAT	10.497	2.100	20.0
IFPRI	2.388	.500	20.9
IITA	14.606	3.750	25.7
ILCA	8.974	2.250	25.1
ILRAD	10.323	2.850	27.6
IRRI	15.577	3.850	24.7
ISNAR	1.199	.300	25.0
WARDA	2.608		0.0 [1]
TOTAL	118.799	29.000	24.4

NOTE: [1]Because of the full subscription of WARDA's budget by other donors, the US made no contribution.

TABLE 2 — CGIAR: PRINCIPAL DONORS, 1979

Donor	Percent of Total
US	25.0
World Bank	10.3
Germany	9.2
Canada	6.8
IDB	6.3
UK	6.1
Japan	5.0
UNDP	4.1
EEC	3.8
Belgium	3.0
Sweden	3.0
Australia	2.7
Netherlands	2.4
Norway	2.0
Switzerland	1.9
IFAD	1.8
Denmark	1.1
Ford Foundation	1.0
All others (13)	4.5
Total	100.0

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Appendix 3

Title XII Collaborative Research Support Program (CRSP)

When Congress passed Title XII of the Foreign Assistance Act of 1975, it directed that the United States should make more extensive and effective use of the U.S. land-grant and other eligible universities in each component authorized under the Title. One of these is the long-term Collaborative Research Support Program (CRSP) in which the U.S. Government, developing-country institutions, and selected U.S. universities share a common priority interest in an identified reasearchable problem in food production, distribution, storage, marketing and/or consumption. As developed in practice, by mutual agreement, participating U.S. universities contribute at least 25 percent of the research support costs under the program. The experience to date is that the U.S. university contributions have ranged on the order of 40 percent—and probably higher.

Several priority topics have been embarked upon for research under the collaborative mode. These include work on grain sorghum and pearl millet, sheep and goats, the impact of marginal nutritional deficiences on people, fisheries and aguaculture, soils, and beans and cowpeas. These are discussed in the presentation under the sections on "Commodity Productivity" and "Improving Nutritional Status" and are to be implemented by ISTC under transfer from AID.

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