FY-1991 Title V Report

SCIENCE, TECHNOLOGY AND AMERICAN DIPLOMACY

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Executive Summary

Introduction

This annual report is an central reference reviewing a number of major international science and technology (S&T) themes during Fiscal Year 1991 (FY-1991), providing data on U.S. international S&T agreements and illustrating related U.S. Government interactions with foreign countries. This report was prepared in accordance with Title V on "Science, Technology and American Diplomacy" in the FY-1979 Foreign Relations Authorization Act.

This FY-1991 report supports judgments that, in the post-Cold War era:

- International science and technology issues, including environmental matters, are interrelated with economic and trade concerns and with traditional political and security affairs.

- International S&T cooperation contributes to U.S. foreign and domestic interests and to the advancement of science and U.S. well-being, and mutual access and cooperation with the U.S. in S&T is of significant interest to many countries.

Selected International S&T Themes

Narrative sections of this report recount significant FY-1991 developments in five important international S&T areas, from both a global perspective (Chapter 2) and for specific countries (Chapter 3). The themes are:

- Basic Science;
- Health and Life Sciences;
- Energy, Environment and Economics;
- Emerging Technologies;
- Agriculture and Natural Resources.

The U.S. continued during FY-1991 to assign high priority to bilateral interactions in **basic science**. Benefits accrued to the U.S. through interactions with foreign talent and access to foreign facilities, installations and geographic areas. International basic research extends by its nature across very broad disciplinary categories, and other countries have recognized strengths in many scientific disciplines. The basic science narrative includes discussions of biodiversity, biotechnology, large scale cooperative scientific projects and high performance computing and communication.

Health and life sciences continued to be major subjects on the international agenda. International scientific cooperation in the health field supports the well-being of Americans and others. Focus areas for discussion in this report are developments during FY-1991 in the fields of cancer, epidemiology, nutrition, drug and other substance abuse, reproductive physiology and population research, and development of new drugs from natural products.

Recognition of the complex relationships among **energy, the environment and economics** is an essential step in devising workable solutions for many problems in these areas. Energy is key to the well being of developed countries and crucial to developing economies, but environmental impacts of certain energy choices can be problematical and at times devastating. These issues are intrinsically transnational in nature and are especially pertinent areas for international cooperation, including science and technology cooperation. Many national governments, however, have yet to adopt policies which integrate these considerations as a whole. FY-1991 saw a range of activities and two large preparatory conferences leading up to the United Nations Conference on Environment and Development, scheduled to take place in Brazil in June 1992. The nature of UNCED is obliging participant countries to expand their thinking to address environment and development together.

Global scientific research and development activities are generating powerful new "**emerging technologies**" pertinent to a wide range of applications. The narrative briefly describes the current general status of emerging technologies in the areas of materials, manufacturing, information and communications, biotechnology and life sciences, and aeronautics and surface transportation; and provides illustrations of pertinent U.S. Government collaborations with selected countries. (The discussion on basic science also addresses biotechnology and high performance computing and communication. From the basic science perspective, biotechnology is strongly dependent on fundamental scientific breakthroughs for progress, and high performance computing and communication entails progress on computational challenges posed by advanced scientific research problems.)

The advantages of global science and technology interaction on **agriculture and natural resources** are well recognized for reasons similar to those underlying basic science cooperation -- utilization of foreign expertise and assets, and access to specialized sites and resources. (The narrative on basic science discusses plant and animal biodiversity and management and conservation of ecosystems.) International cooperation on natural hazards -- terrestrial, atmospheric and oceanic -- is also an area of current interest. Numerous U.S. Government agencies are extensively involved across the entire range of these subjects.

S&T Personnel Requirements, Standards, Training

State Department and U.S. embassy environment, science and technology officers (EST officers) and their colleagues in other federal agencies deal with an extremely broad range of U.S. international EST interests, reflected in the activities of a score

of U.S. agencies. The Department of State has legal responsibility for coordination and oversight of U.S. Government international S&T activities. Its ability to perform this task derives considerably from the quality of U.S. personnel involved with environment, science and technology (EST) affairs in Washington and embassies abroad. It is necessary to blend many individual capabilities -- S&T knowledge; economic, political, foreign policy, communication and intercultural skills -- to achieve success in reaping maximum U.S. benefit from international EST interactions. Training for EST assignments is key. Training through the State Department's Foreign Service Institute and periodic EST officer conferences are principal sources of structured guidance embassy EST officers receive on how to perform their jobs. Other agency personnel are invited to participate in these courses and conferences, both to impart knowledge and to benefit from the broad interplay of ideas and perspectives which takes place in them.

Chapter 4 of this report includes a number of recommendations, keyed to the Title V legislation, pertaining to:

- Recruitment, training and utilization of EST personnel;
- Continuation and broadening of U.S. international science and technology agreements and activities;
- Funding data and prioritization;
- Evaluation of science and technology agreements and activities;
- Equitable access.

Concluding Observations

While the U.S. still leads the world in many S&T areas, the number of foreign government achievements is growing in volume and significance.

In negotiating and implementing agreements, Executive agencies continued during FY-1991 to emphasize assuring access by Americans to foreign S&T, and proper allocation of intellectual property rights arising out of international cooperation.

The Appendix to this report includes databases showing more than 600 current U.S. Government international S&T agreements, both government-to-government and agency-to-agency, at the Memorandum of Understanding level or higher. The material is based on information available in the Department of State or provided by other Executive Branch departments and technical agencies. The databases are as comprehensive, accurate and complete as such information permits.

The President's budget sets forth funding proposals for support of science and technology programs of the U.S. Government.

CHAPTER 1

INTRODUCTION; PERSONNEL REQUIREMENTS, STANDARDS AND TRAINING; FUNDING, EQUITABLE ACCESS, INTELLECTUAL PROPERTY RIGHTS

Introduction

Organization of This Report

This Fiscal Year 1991 Title V report on "Science, Technology and American Diplomacy" is the thirteenth such annual report submitted by the President to the Congress. The overall concept of this report is to describe a number of important contemporary international science and technology (S&T) subjects and illustrate how the U.S. is engaged in them.

As used in this report, the term "science and technology" includes science, technology and advanced technology, environmental, health, population, oceans, fisheries and nuclear energy matters.

Chapter 1 recites the relevant Title V legislation and discusses certain issues it requires to be addressed, such as personnel requirements, functions, standards, training, funding and equitable access. Chapter 1 also briefly discusses integration of intellectual property rights (IPR) protection in S&T agreements.

Taken together, Chapters 2 and 3 assess, as required by Title V, the value of U.S. international cooperative S&T activities. Chapter 2 depicts, from a global perspective, a number of major contemporary international S&T subjects and how the U.S. was involved with them during FY-1991 through international cooperation. Chapter 2 addresses the following five thematic areas:

- Basic Science
- Health and Life Sciences
- Energy, Environment and Economics
- Emerging Technologies
- Agriculture and Natural Resources

Chapter 3 contains narratives, offered by U.S. embassies in the respective locales, on 21 countries, the European Community (EC), the Organization for Economic Cooperation and Development (OECD) and NATO. Each narrative deals with all or most of the themes listed above. (**Note:** the terms "USSR," "Soviet Union" and "Soviet" as used throughout this report refer to the Union of Soviet Socialist Republics as it existed in FY-1991).

Chapter 4 contains conclusions and recommendations.

Appendix 1 is a database of 668 U.S. Government science and technology agreements shown by countries. This appendix is a tabular catalog of agreements at the Memorandum of Understanding level or higher, currently in force between the United States and other countries.

Appendix 2 shows the same agreements arranged by agency. Appendices 1 and 2 derive from information in the Department of State or provided it by other Federal agencies and offices, and are as complete as that information permits.

Appendix 3 is a brief bibliography of selected FY-1991 agency publications.

A selective index is included at the end of the report.

Title V Legislation (as amended)

Title V on "Science, Technology and American Diplomacy" in the FY-1979 Foreign Relations Authorization Act (P.L. 95-426, 22 U.S.C 2656d), as amended by Section 5171 of the Omnibus Trade and Competitiveness Act of 1988, reads in relevant part as follows:

Sec. 503(b). The President shall study and not later than January 31, 1980 and not later than January 31 of each year thereafter, shall transmit to the Speaker of the House of Representatives and the Committees on Foreign Relations and Governmental Affairs of the Senate a report containing information and recommendations with respect to:

- (1) personnel requirements, and standards and training for service of officers and employees of the United States Government, with respect to assignments in any Federal agency which involve foreign relations and science or technology;

- (2) the continuation of existing bilateral and multilateral activities and agreements primarily involving science and technology, including: (A) an analysis of the foreign policy implications and the scientific and technological benefits of such activities or agreements for the United States and other parties, (B) the adequacy of the funding for and administration of such activities and agreements, and (C) plans for future evaluation of such activities and agreements on a routine basis; and

- (3) equity of access by United States public and private entities to public (and publicly supported private) research and development opportunities and facilities in each country which is a major trading partner of the United States.

Personnel Requirements, Functions and Standards

U.S. embassies and consulates abroad represent U.S. interests pertaining to significant S&T issues in their host countries. The embassies and consulates cover as a part of their ongoing economic and political reporting host government activities and attitudes in pertinent areas, and they present U.S. views to the host government. The Department of State assigns full-time Environment, Science and Technology (EST) Officers, generally with a Counselor or Attache title, to a number of embassies in countries of particular S&T interest and to certain international bodies such as the International Atomic Energy Agency (IAEA), North Atlantic Treaty Organization (NATO) and the European Community (EC). Where such full-time counselors or attaches do not exist, chiefs of mission and consulate

principal officers designate one or more officers, usually from economic sections, to cover environment, science and technology matters as a part of their regular duties.

During FY-1991 full-time EST officers were assigned to the 23 U.S. diplomatic missions shown in the table on the next page, which identifies ranking EST officers at each post. The countries or entities where they serve have one or more of the following characteristics:

- Substantial national resources devoted to S&T;
- Significant political or economic issues associated with S&T, including environmental issues;
- S&T activities of major interest to the United States, including cooperative bilateral programs;
- Concerns for the United States in the areas of nuclear non-proliferation, technology transfer or economic competitiveness.

The responsibilities of these officers include:

- Advising the U.S. Ambassador and the embassy country team on issues related to environment, science and technology;
- Representing the U.S. Government's interests to the host government;
- Assisting in the negotiation of cooperative agreements and implementation of cooperative programs between U.S. Government agencies and host country organizations;
- Analyzing and reporting on significant S&T developments in host countries, and on host government science policy organization, personnel changes and attitudes.

Supervision of cooperative S&T programs is a central element of many EST officers' duties. In Brazil, China, India, Israel, Japan, Poland, Hungary, the USSR and Yugoslavia, negotiation and management of major bilateral agreements is a principal duty of EST officers. (A new agreement with Czechoslovakia began in October 1991.) Under these agreements, numerous cooperative activities are authorized by management committees and commissions. Meetings of such committees and commissions provide a forum for S&T policy discussions. EST officers at the embassies play key roles in these discussions and management decisions.

In addition, personnel of certain other agencies are posted at U.S. embassies where they perform functions as part of the embassy staff, in EST-related areas. These include assignees from the Department of Energy (at Tokyo and OECD), the National Aeronautics and Space Administration (Tokyo and Paris), the National Science Foundation (Tokyo and Paris), the Environmental Protection Agency (Mexico), and the Office of Naval Research (London and Japan).

Table: Ranking Full-Time U.S. Embassy EST Officers (as of 9/30/91)

Post	Name	Status
Beijing	Andrew Onate	Foreign Service
Belgrade	Tom Hutson	Foreign Service
Bonn	Frank Kinnelly	Foreign Service
Brasilia	Barbara Tobias	Foreign Service
Brussels/EC	Anthony Rock	Foreign Service
Budapest	Lawrence Cohen	Foreign Service
Buenos Aires	Paul Maxwell	Limited Appt. (Cong. staff)
Jakarta	Sidney Smith	Foreign Service
London	Jeffrey Lutz	Foreign Service
	Otis Peterson	Limited Appt. (Los Alamos Nat'l. Laboratory)
Madrid	Robert Morris	Foreign Service
Mexico City	Ahmed Meer	Foreign Service
Moscow	Robert Clarke	Foreign Service
New Delhi	Peter Heydemann	Limited Appt. (NIST)
Ottawa	Thomas Wajda	Foreign Service
Paris/Embassy	Michael Michaud	Foreign Service
	Thomas Owens	Limited Appt. (NSF)
Paris/OECD	Daniel Dolan	Foreign Service
Prague	Rodney Huff	Foreign Service
Rome	Reno Harnish	Foreign Service
Seoul	Kenneth Cohen	Limited Appt. (Nuclear Regulatory Commission)
Tel Aviv	Charles Lawson	Limited Appt.
Tokyo	Edward Malloy	Foreign Service
Vienna/IAEA	Maurice Katz	Limited Appt. (DOE)
	Marvin Peterson	Limited Appt. (DOE)
Warsaw	Coleman Nee	Foreign Service

OES' Role

The Department of State's Bureau of Oceans and International Environmental and Scientific Affairs (OES) was established in 1974 pursuant to the Department of State Appropriations Authorization Act of 1973 (P.L. 93-126), which reads in relevant part as follows:

Sec. 9. There is established within the Department of State a Bureau of Oceans and International Environmental and Scientific Affairs. In addition to the positions provided under the first section of the Act of May 26, 1949, as amended (22 U.S.C. 2652), there shall be an Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, appointed by the President, by and with the advice and consent of the Senate, who shall be the head of the Bureau and who shall have responsibility for matters relating to oceans, environmental, scientific, fisheries, wildlife, and conservation affairs.

In 1978 Congress, in another section of the Title V legislation, stated as follows:

Sec. 504. (a) In order to implement the policy set forth in section 502 of this title (*), the Secretary of State (hereafter in this section referred to as the "Secretary") shall have primary responsibility for coordination and oversight with respect to all major science or science and technology agreements and activities between the United States and foreign countries, international organizations, or commissions of which the United States and one or more foreign countries are members.

The OES Bureau is the central U.S. Government coordinating point for international S&T activities conducted by U.S. technical agencies. The Bureau assures that international S&T interests receive appropriate consideration, focus and emphasis in overall U.S. foreign policy deliberations and conclusions. It is directly responsible for or oversees numerous bilateral and multilateral S&T agreements. It is responsible for coordinating and assembling this annual Presidential report.

To perform these functions, in FY-1991 OES had 139 on board positions, 103 of which were officer positions filled by a mixture of Foreign and Civil Service officers and personnel on excepted appointments (such as Fellows from the American Association for the Advancement of Science - AAAS), plus 36 administrative and support staff. These personnel are grouped in four Directorates, for Oceans, Environment, Science and Technology and Nuclear Affairs respectively, plus a Population Coordinator. OES is also the principal interface in Washington for the full-time Environment, Science and Technology Counselors/Attaches and Fisheries Attaches at 23 U.S. diplomatic missions abroad.

During FY-1991 OES directly managed 29 government-to-government umbrella S&T agreements and exercised oversight for U.S. S&T relations with 70 countries. "Umbrella" agreements are general in nature and denominate broad S&T areas within which the parties agree to support more specific agreements on specific subjects as needs require or opportunities permit. The majority of U.S. S&T agreements are below the umbrella level, are administered directly by U.S. Government technical agencies, and involve approximately 20 technical subjects (see following tables and Appendices 1 and 2).

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* Section 502 refers to recognition, support, assessment, and continuing review of international environmental, science and technology matters "in order to maximize the benefits and to minimize the adverse consequences of science and technology in the conduct of foreign policy..."

S&T Agreements during FY-1991 by Subject (selected)
Memorandum of Understanding Level or Higher

Subject	No. of Agreements
S&T Umbrella Agreements	29
Agriculture	16
Basic Sciences	35
Biomedical Sciences	64
Earth Sciences	79
Energy	35
Environment	23
Natural Resources	38
Nuclear Energy and Safety	75
Space and Aeronautics	57
Transportation	58

S&T Agreements (MOU or higher) during FY-1991 by Agency (selected)

Department of Agriculture		18
Department of Commerce including:		69
National Oceanic and Atmospheric Administration	37	
National Institute of Standards and Technology	17	
National Technical Information Service	9	
Census Bureau	4	
Other	2	
Department of Defense		44
Department of Energy		84
Department of Health and Human Services		72
Department of Housing and Urban Development		1
Department of Interior including:		122
Geological Survey	78	
National Park Service	20	
Fish and Wildlife Service	12	
Minerals Management Service	4	
Bureau of Reclamation	3	
Bureau of Land Management	3	
Bureau of Mines	2	

Department of State (umbrella agreements)	29
Department of Transportation	58
Environmental Protection Agency	19
National Aeronautics and Space Administration	46
National Science Foundation	31
Nuclear Regulatory Commission	74

S&T Reporting

The OES Bureau provides guidance to missions on incorporating environment, science and technology (EST) in each mission's formal annual reporting plan, and as needed. This guidance periodically identifies pertinent areas of current key policy interest to the U.S. Government and the private sector. An OES cable newsletter, redesigned and renewed in FY-1991 and issued approximately monthly, updates embassy officers on spot or continuing issues of importance.

U.S. embassy and consulate S&T reporting is addressed to the Secretary of State with reporting cables simultaneously distributed to the White House and other Departments and interested agencies. To illustrate the importance and breadth of the audience for EST reporting, OES in late FY-1991 compiled a list which was cabled to numerous posts. That list, which was not all-inclusive, encompassed the following:

Partial List of Recipient Audiences for Post Environment, Science and Technology Reporting

All or Most EST Reporting

Agency for International Development
Department of State (OES, other regional and functional bureaus and offices)
National Science Foundation
National Security Council
National Technical Information Service
Office of Management and Budget
United States Information Agency
United States Trade Representative
White House Office of Science and Technology Policy

Environmental Issues

Department of Agriculture, including
- Agricultural Research Service
- Forest Service
- Soil Conservation Service

Department of Commerce, including
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration

Department of Defense
Department of Energy
Department of Health and Human Services, including
- Centers for Disease Control
- National Institutes of Health
- Public Health Service

Department of Interior, including
- U.S. Fish and Wildlife Service
- National Park Service
- U.S. Geological Survey

Department of Transportation
Environmental Protection Agency
National Aeronautics and Space Administration
Treasury Department
U.S. Delegation to the United Nations Conference on Environment and Development
White House Council on Environmental Quality

Oceans and Polar Issues

Department of Commerce, including NOAA and NMFS
Department of Defense
National Aeronautics and Space Administration
National Science Foundation

Science and Technology Issues

Department of Agriculture
Department of Commerce, including
- Technology Administration
- National Institute of Science and Technology
- National Technical Information Service
- Patent and Trademark Office

Department of Defense
Department of Energy
Department of Health and Human Services
Department of Transportation
National Aeronautics and Space Administration
National Science Foundation
Nuclear Regulatory Commission
Treasury Department

Nuclear Energy and Non-Proliferation Issues

Arms Control and Disarmament Agency
Department of Defense
Department of Energy
Nuclear Regulatory Commission

STRIDE

Executive Order 12591 of April 10, 1987, entitled "Facilitating Access to Science and Technology," stipulated establishment of a mechanism for prompt and efficient distribution of science and technology information developed abroad to users both within the Federal government and in academic institutions and the private sector. Through the STRIDE (Science and Technology Reporting Information Distribution Enhancement) program, unclassified reporting on foreign research and development activities is distributed to the private sector, academic institutions and Federal laboratories by the Department of State and the Commerce Department's National Technical Information Service. During FY-1991 some 150 STRIDE articles were distributed directly and through publication in the NTIS weekly compilation, "Foreign Technology - An Abstract Newsletter." Topics included advanced materials, advanced manufacturing systems, biotechnology, information technology and other emerging technologies of broad applicability.

EST Careers

To increase its ability to carry out science, technology and environment policies, the Department of State has established within the Foreign Service an environment, science, and technology career path ("EST cone"). This provides a career course for interested and qualified officers in addition to the Department's traditional political, economic, consular and administrative "cones." There are currently 15 Foreign Service officers in the EST cone. (For administrative reasons, the "EST cone" has been established as a sub-cone within the economic cone.)

During FY-1991, OES undertook a process of exploring with the State Department's Personnel Bureau ways to improve the operation and efficacy of the EST cone. Simultaneously, OES' Office of Cooperative Science and Technology Programs undertook a study to assess how well the EST officer system operates. This work continued into FY-1992. As of the end of FY-1991, there were identified a number of questions to be addressed, including the following:

- How can superior junior and mid-level officers be more attracted to EST work?
- How can preparation and training for EST assignments be improved?

- What comprises a proper balance between embassy EST officers drawn from the career Foreign Service and those from other agencies, or from outside the government, assigned to embassies on temporary appointments ("outside recruitment")?

- How can it be best assured that persons assigned to EST positions abroad are the most appropriate in terms of skills, experience and interests for the slots they will fill?

- How can procedures for evaluating the performance of EST officers be improved, given that rating officers in embassies are often unfamiliar with the "untraditional" topics with which EST officers deal?

S&T Recruitment; E.O. 12591

In addition to its provisions on STRIDE (discussed above), Executive Order 12591 provides that "The Secretary of State shall develop a recruitment policy that encourages scientists and engineers from other Federal agencies, academic institutions and industry to apply for assignments in embassies of the United States..."

It is appropriate for qualified individuals from U.S. Government technical agencies and the private sector to play a role in the conduct of U.S. international EST activities, in positions both in Washington and embassies abroad. Such individuals are recruited for State Department positions, including as embassy EST officers, via appropriate channels as specific requirements are identified. It should be noted that the duties especially of embassy EST officers abroad require managerial and operational skills and policy-oriented talents which go beyond scientific expertise per se.

Numerous OES and embassy EST officers have technical agency or advanced S&T backgrounds. Approximately half of the overseas EST Counselors and Attaches have at least a Bachelor's degree in science or engineering, and a substantial number have had graduate training in fields ranging from geology to physics. In addition, as in past years, OES personnel working in the State Department during FY-1991 included several Fellows from the American Association for the Advancement of Science and numerous career Civil and Foreign Service officers with advanced scientific and technical degrees. As noted earlier, working in association with embassy EST sections abroad were a number of other officers from technical agency and other backgrounds. Of course, large numbers of highly-trained technical agency personnel in the U.S. also deal with international S&T in the course of their work, e.g., at the National Institute for Standards and Technology, Department of Energy, National Oceanic and Atmospheric Administration, U.S. Geological Survey, National Aeronautics and Space Administration, National Science Foundation, the National Institutes of Health and elsewhere.

Training

The Department of State provides training for officers handling environment, science and technology issues. A Foreign Service Institute (FSI) course on Science and Technology and American Foreign Policy has been offered annually for officers from the Department of State and other agencies. (Plans are to present the course twice during FY-1992.) The Department of State also offers university training and outside assignments for officers interested in expanding their expertise in EST matters. During FY-1991, a Foreign Service officer, with FSI support, upon completion of her assignment in OES obtained a one-year fellowship from the private Una Chapman Cox foundation to do research on how the U.S. Government handles EST affairs. The officer prepared an observational study of U.S. and foreign embassy science officers and made other useful contributions.

The 1991 FSI EST course was given at George Washington University in June to 28 officers of whom 16 were from the Department of State (including 5 from OES), two from the National Oceanographic and Atmospheric Administration, and one each from the Agency for International Development, the Department of Agriculture, the United States Information Agency, the U.S. Geological Survey, Embassies Abu Dhabi, Belgrade, Budapest, Caracas and Kinshasa, and Consulate Juarez. The 1991 iteration of the course entailed especially close preparatory work by OES, in collaboration with FSI and the course contractor, to tailor a syllabus particularly relevant both to U.S. international EST interests and to enhancing EST officer skills. Sessions were conducted with speakers and panels drawn from executive branch departments and agencies, OSTP, the private sector and Congressional staff.

A summary of the course syllabus appears on the next page. The list of topics is illustrative of contemporary international EST issues concerning the U.S.

Also in FY-1991, OES organized a major conference in Washington attended by 34 senior EST officers from 28 posts on September 23-25. The conference was part of continuing OES efforts, e.g., through providing reporting guidance and through the OES newsletter described earlier, to keep embassies and EST officers abroad abreast of U.S. views and policies on international EST issues.

Six agencies outside the Department of State made the September conference possible by pooling financial support for it with OES. Their support reflected the importance they attach to embassy EST reporting, to helping to keep the embassy EST officers attuned to Washington perspectives, and to meeting with them. An intense three-day program featured presentations by OSTP Director Dr. D. Allan Bromley, Under Secretary of State for International Security Affairs Reginald Bartholomew and OES Assistant Secretary Curtis Bohlen; a meeting with Chairman Brown and members of the House Science, Space, and Technology Committee; and panels with senior officers from executive branch departments and numerous technical agencies. A central theme which emerged from the presentations of Dr. Bromley, Under Secretary Bartholomew and others was the growing centrality of EST matters to U.S. international interests in the post Cold War era. The arrangements afforded each of the embassy officers two additional days for individual and group consultations with agencies and offices.

Syllabus (abridged) for 1991 EST Course

Environment, Science and Technology Issues
and American Foreign Policy

Monday, June 10 -- Introduction; Environment

- Theme of the Course: Salient International EST Developments: Is the U.S. Appropriately Engaged?
- Introduction to OES
- What Do End Users of Embassy EST Reporting Need?
- What Do Embassy EST Officers Do? What Should They Be Doing?
- Round Table on Environment, Energy and Economics

Tuesday, June 11 -- Environment; Science, Technology and Competitiveness

- International Environmental Issues and Tradecraft
- Science, Technology and National Security: Cooperation versus Technology Transfer
- International EST Cooperation and Competition
- Trade, Competitiveness and IPR Issues in International EST

Wednesday June 12 -- The Changing S&T Landscape

- Field trip to the National Institute of Standards and Technology (NIST)
  - Overview of NIST
  - Advanced Technology Program
  - Visit to Selected Laboratories
- Overview of Selected Leading-Edge Technologies
- Sub-National Intergovernmental Trade/S&T Activities and Foreign Policy Effects

Thursday June 13 -- International EST Cooperation; Megaprojects

- Political Change and East-West EST Cooperation
- Cooperation with Japan
- EST as an Instrument of Foreign Policy
- Megaprojects: Big Science versus Little Science

Friday June 14 -- Space; Congress and International EST issues

- Overview of Space Issues and International Space Cooperation
- OSTP Perspectives; the Title V Report
- Field trip to Capitol Hill/Meetings with House and Senate Staff Members
- Course Conclusion and Evaluation

Funding

The President's budget presents funding for all U.S. Government S&T activities by agency and program. One of the objectives of the President's budget is to assure adequacy of funding for USG international S&T activities. This report includes FY-1991 budgetary information in "remarks" sections of the databases in Appendices 1 and 2, where such information was available to the Department of State. The funding shown was based on a variety of sources, including USG-sponsored programs, programs supported by counterpart funds (e.g., rupees in India) and programs supported by foreign governments.

The OES budget for FY-1991 was $1,948,000. (This figure does not include salaries for domestic personnel; nor does it include salaries and expenses for science officers abroad, whose funding in most cases is from State Department regional bureaus.)

Most U.S. Government activities and programs involving international science and technology cooperation are managed and funded by individual technical agencies. This funding cannot be identified in detail in this report since it is usually subsumed in agency funds for programs with specific research objectives. Investigators and managers determine the degree to which international cooperation can contribute to achieving program objectives. However, in a few cases (below), funding information is available for programs which are centrally administered and have specific appropriations.

In FY-1991, for example, Department of State funding for bilateral S&T cooperation programs it administers with Hungary, Poland and Yugoslavia totalled about $4.4 million, as follows:

Hungary	$1.0 million
Poland	$1.7 million
Yugoslavia	$1.7 million

In addition, there were special programs in Israel and India based on previous appropriations. S&T and binational foundation cooperation with Israel is described in Chapter 3. For India, cooperation is based on two major bilateral agreements that are partially funded with U.S.-owned, non-convertible Indian rupees. The U.S.-India Fund currently spends about 280 million rupees annually (approximately $11 million) for collaboration in science and technology. USAID-funded programs also contribute to a broad range of collaborations with India. Chapter 3 includes a country narrative on India.

Equitable Access

During FY-1991, no significant problems were identified by the Department or by other USG technical agencies about equity of access by U.S. public and private entities to public and publicly supported private research and development opportunities and facilities in countries which are major trading partners of the U.S. In one case (Japan), a survey was performed of individuals who had participated in cooperative S&T, and access was not identified as a problem area.

The Commerce Department's National Technical Information Service (NTIS) has agreements with 19 foreign government agencies for the exchange of engineering, scientific and technical information. The most productive agreements are with China, France, Germany, Sweden, Taiwan, the United Kingdom and the USSR. NTIS has concluded an additional 68 agreements with private organizations in 47 countries for acquisition of their engineering, scientific and technical information.

Intellectual Property Rights (IPR)

Last year's Title V report discussed in detail the issue of intellectual property rights protection in S&T agreements, and included the text of a standard IPR annex for such agreements which had been produced under auspices of OSTP and the interagency Federal Coordinating Committee for Science, Engineering, and Technology (FCCSET).

During FY-1991, the IPR annex was included, with some variations, in agreements which were successfully concluded with Finland (extension, October 1990), Venezuela (December 1990), Mongolia (January 1991), New Zealand (May 1991) China (May 1991) and an agreement which was readied with Czechoslovakia during FY-1991 and signed in October. Some agreements and MOU's excluded areas where the foreign partner did not provide adequate patent protection for potential inventions.

During FY-1991, renewal of several MOU's with EC member states and the EC Commission remained stalled due to differences over IPR provisions. In March 1991, FCCSET's Committee on International Science, Engineering and Technology (CISET) authorized new provisions, in agreements with EC countries, to allow participants to negotiate joint management plans for managing IPR arising from cooperation. At the close of FY-1991 such provisions were still under negotiation with EC members states and the EC Commission.

CHAPTER 2

INTERNATIONAL SCIENCE AND TECHNOLOGY THEMES AND DEVELOPMENTS

Introduction

In July, 1991 the Title V Subcommittee of the Committee on International Science, Engineering and Technology (CISET), an arm of the OSTP-chaired Federal Coordinating Council on Science, Engineering and Technology (FCCSET), designated five current important international S&T themes as the framework for the narrative portion of this FY-1991 Title V report. Following a recitation of the themes as described by the Subcommittee, this chapter discusses each at some length. The approach is thematic rather than agency-specific, designed to illustrate for the reader the nature of the themes and how the U.S. engaged on them internationally during FY-1991. Readers desiring more agency-specific information are invited to refer to the Appendix 2 database of international S&T agreements by agencies.

Descriptions of Themes

Basic Science

The primary purpose of basic scientific research is to add to the pool of knowledge about natural and social phenomena. Basic research often leads to tangible and beneficial applications. Open communication and dissemination of basic research results are required for the system to function most effectively. As a means of advancing domestic interests through basic research in general, U.S. Government (USG) agencies support basic research projects with international dimensions in order to:

- gain access to intellectual resources abroad;
- gain access to unique geographic sites, laboratory facilities, or population groups;
- leverage USG funding in fields where expensive facilities are required;
- support U.S. foreign policy objectives.

Basic research addresses many areas. Areas of current high interest include:

- biological diversity, including research into the effect of human impacts on and rates of loss of biodiversity;
- biotechnology and fundamental life science [which can relate closely to advances in health and other applications];
- high-performance computing and communications;

- large-scale basic research projects, e.g., in fields requiring large, expensive facilities and/or programs requiring coordination of research entailing large numbers of moderate instruments and massive data handling requirements.

Health and Life Sciences

All governments are concerned with the health and physical well being of their people. While modern science has made possible great advances in the prevention and treatment of both infectious and degenerative diseases, much remains to be done to reduce infant mortality, increase life spans and provide a better quality of life throughout the world. Health and life sciences issues are of common interest to all countries, no matter what their level of development, and this makes them potentially fruitful areas for international cooperation.

The following health and life sciences topics are discussed in this Title V report:

- Cancer: as progress has been made against infectious diseases and more people are living to middle and old age, cancer has become a leading cause of sickness and death throughout the world. Major research efforts are needed to determine the causes of cancer, its prevention, and how to develop more effective and less debilitating means of treating it when this most feared of diseases does strike. International cooperation has an important role to play in this research.

- Nutrition: much of the world is still malnourished and even in developed countries poor diet is a leading cause of ill health and premature death. Diet has been implicated in a number of serious health problems such as stroke, heart attack and cancer. Science and technology cooperation can contribute in reducing malnutrition by expanding the basis of knowledge by which to adjust dietary practices positively, and by developing means to increase food yields and quality.

- Substance addiction: worldwide, drug and alcohol abuse kills thousands of people annually, does immense property and economic damage, spawns crime, and even threatens the sovereignty of governments. Substance abuse is a medical as well as a law enforcement problem, and additional research can help find ways to reduce new addictions and to block or cure addictions. There are indications that a number of nations would be interested in more systematic international cooperation to these ends.

- Epidemiology and health data for decisionmaking: international cooperation aids effective prevention and control of diseases in a rapidly changing world. Epidemiology and related statistical and data technologies are playing an increasingly prominent role in international health science cooperation. Information on the incidence and distribution of diseases is essential to understanding their natural history and means of transmission, identifying

causes of emerging problems, and planning and deciding on research priorities and allocation of scarce resources for public health programs and other health services.

- Reproductive physiology and population research: world population growth continues, and research on human reproduction as well as related sociological research are useful areas of international cooperation. Closely recurring pregnancies continue as major impediments to child survival and improved maternal health, particularly in developing countries. Access to safe and effective means of family planning is a major issue of the 1990's.

- New drug development from natural products: natural products have historically been, and remain, an important source for the development of medicinal products, notwithstanding development of chemical processes to produce drugs in laboratories. The search for natural products may yield fruitful results in finding exploitable substances to treat diseases such as cancer, cardiovascular disease, tropical diseases [e.g., malaria] and AIDS. The world's biodiversity makes the development of drugs from natural products an activity in the international domain. Such activity is an important component of international health cooperation.

Energy, Environment and Economics

In assessing solutions to environmental problems, the fundamental relationship between energy, the environment, and economics has become apparent. The energy sector has been linked to such environmental problems as air pollution, oil spills, acid rain, detrimental changes to aquatic systems, and possible global climate change. In recent years these issues have increased in international visibility, and efforts to solve them have become a high priority for many governments.

Energy is vital to nations' economic viability, development and competitiveness, and to improving or maintaining the quality of life in both developing and developed nations. Energy production, transmission and use, while essential, can sometimes contribute to environmental degradation. Measures in the energy sector to respond to environmental concerns can impose heavy social and economic costs if actions are not chosen wisely. It is important, therefore, to capture the benefits of energy production and consumption in an environmentally sound manner.

Because many environmental issues are global in nature, international cooperation is essential for gaining understanding to reduce the scientific uncertainties. International science and technology cooperation plays a key role in addressing energy, environment and economic problems.

Emerging Technologies

A newer field in international S&T cooperation entails advanced or emerging technologies of interest both in terms of science per se (for example, high temperature superconductors; advanced ceramics) and with respect to potential practical applications. This report briefly discusses emerging technologies in six broad areas: materials, manufacturing processes and technologies, information and communications technologies, biotechnology, aeronautics and surface transportation systems, and energy and environmental related technologies. All include fields where international S&T cooperation can have a role.

Agriculture and Natural Resources

There is a global interdependence in the biology, husbandry and economics of agriculture and attendant benefit to the U.S. from international cooperation on agricultural and related research. U.S. Government involvement in relevant international science and technology cooperation is compelled by, in addition to productivity-related considerations, the fact that the vast majority of U.S. crop, livestock and, to a lesser extent, pasture, forage and forest resources originated abroad. Their relatively uniform genetic composition makes them highly susceptible to diseases and pests newly arriving from abroad. For example, respective USG agencies are interested in the breadth and depth of plant and animal diversity, and their tolerance for and resistance to physical, chemical, pest and disease stress.

There is also a global interdependence in the identification, exploitation and conservation of natural resources. Cooperation in earth sciences has an important role, also with respect to natural hazards. U.S. agencies carry out natural resources research on the use, management and protection of land, water and air resources, appraise natural resource conditions and trends, and conduct basic and applied research on maintaining biological diversity and habitats.

Discussions of these themes follow.

BASIC SCIENCE

The Character of Basic Science

The primary purpose of basic scientific research is to advance the store of human knowledge about natural and social phenomena. Open communication and dissemination of results, including internationally, are essential features. Each scientist builds on the work of others, and scientists involved in basic research comprise a truly international community. In the United States, since most basic research is performed at universities, the basic research system serves the dual purpose of providing new knowledge and helping to ensure future availability of high-caliber scientists and engineers.

Motives for U.S. Government Support

The U.S. Government supports and encourages international cooperation for several interrelated reasons, thus advancing the U.S. research system.

First, the United States does not have a monopoly on well-trained scientists and engineers with good ideas. Expertise and investments in basic research abroad have vastly expanded the global reservoir of scientific knowledge and talent.

Second, international cooperation facilitates U.S. scientist access to unique and often expensive research facilities abroad. Many such facilities are one-of-a-kind and provide special opportunities to pursue specific lines of research. In view of the increasing costs of instrumentation in fields such as high energy physics, materials science, earthquake engineering, and optical astronomy, for example, the prevalence of one-of-a-kind research facilities is likely to increase.

Third, many important problems in the environmental, health, earth, biological, and social sciences, as well as in engineering, require access to specific geographical research sites or populations. Cooperative arrangements with scientists and engineers from the countries involved can facilitate U.S. access to those sites.

Finally, an increasing number of significant problems, such as possible global climate change, AIDS, nuclear waste management and earthquake prediction are intrinsically transnational or global in character. Obtaining and analyzing the requisite information therefore requires coordinated international efforts.

Approximately one-eighth of the discretionary portion of the U.S. Government's annual budget is devoted to research and development (R&D). By far the largest portion is devoted to defense-related expenditures. However, in FY-1990 22 percent of the discretionary portion, about $12 billion, or approximately 19 percent of the total Government research and development (R&D), budget was devoted to the support of basic research.

U.S. International Basic Research Activities

Among the approximately one dozen U.S. Government agencies that invest in basic research to help fulfill their respective missions, five account for over 90 percent of all Federal expenditures: the National Institutes of Health (NIH), the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the Departments of Energy (DOE) and Defense (DOD). These agencies also account for the bulk of international basic research expenditures by the Federal Government.

At the international level, Federal expenditures largely support cooperative research and research-related activities of U.S. investigators, including advanced education and training abroad. Research activities include, for example: field research at foreign sites (usually with participation by local scientists); extended residencies at foreign laboratories by U.S. students and senior scientists; small-scale cooperative research projects involving a single U.S. investigator and a foreign colleague working in the U.S. or abroad; larger-scale cooperation between U.S. research centers and those abroad; and large complex multinational collaborations in fields such as high energy physics and oceanography.

The United States has bilateral agreements that focus explicitly on cooperation in basic research with over twenty countries. Basic research is also an important component of cooperative research conducted under the auspices of bilateral agreements in other areas such as health. In addition, basic research is conducted under the terms of broader agency-to-agency and general umbrella agreements between governments that do not explicitly refer to it as such.

Through these and less formal arrangements, the U.S. continues to assign high priority to its bilateral interactions in basic research. Noteworthy in FY-1991 was a National Science Foundation-supported U.S.-Federal Republic of Germany Seminar on Bilateral Cooperation in Science and Technology. Organized by the American Association for the Advancement of Science (AAAS), the Deutscher Verband Technisch-Wissenschaftlicher Vereine (DVT) and the Alexander von Humbolt Foundation, participants exchanged views on new opportunities for joint research and development activities, including the participation of East German researchers in future cooperation.

Also in FY-1991, two important science policy workshops were convened in Washington and in Tihany, Hungary, under the basic research agreement NSF has had with the Hungarian Academy of Sciences since 1972. The workshops explored broad science policy issues relevant to the two countries' national research systems and the bilateral relationship. Another noteworthy FY-1991 development was the growth in access to Soviet scientists and research sites, especially in the fields of mathematics and the geosciences, provided through the NSF-Academy of Sciences of the USSR Memorandum of Understanding (MOU) concluded under the 1989 U.S.-USSR Agreement in the Basic Sciences.

Four Key Areas during FY-1991

Four particular areas of international basic research during FY-1991 warrant special discussion as noteworthy in promoting U.S. national science and technology interests. These are biological diversity, biotechnology, high-performance computing and communications, and large-scale "megascience" projects.

Biodiversity

The terms biological diversity or biodiversity, as generally accepted, refer to the variety and variability of life forms, the genetic material they contain, the assemblages they form, and the ecological roles they perform. Estimates indicate an ongoing loss of the variety as well as absolute numbers of organisms, from the smallest microorganism to large mammals. Although loss of biodiversity is global, it is greatest in tropical developing nations, where biological diversity is most concentrated and where ecosystems, including species-rich rain forests, are being permanently lost to human populations and associated activities, especially farming.

The potential consequences are significant. Impacts on food, agriculture, and health may be serious. For example, only about 150 kinds of plants worldwide are extensively used for food (and perhaps only 5000 have ever been used). But there are thousands of other plants which, if their properties were fully explored and cultivated, could be useful in assuring stable food supplies -- as food themselves, or as sources of useful genes for protection against stresses such as pests, weeds, drought and salinity.

Fisheries provide a significant source of human nutrition. They supply 14% of the animal protein in the world's diet and almost 60% in Japan's diet. Many artisanal and subsistence fisheries depend upon nearshore and coastal waters. These fisheries are an integral part of coral reefs, sea grasses, and related ecosystems. However, the world's marine and freshwater fisheries are moderately to heavily exploited. As the world population increases, greater pressure will be put on the world's fisheries to provide needed protein.

We do not understand how changes in the population of one species might affect other species, particularly the prey and predators of the target species. Changes in community structure might result in a loss of diversity and productivity within the ecosystem. For example, krill are a key species in the Southern Ocean food web. Increased harvesting resulting in their reduced abundance could affect all mammals, birds, and fish in the Southern Ocean ecosystem.

Tropical plants have also been a rich source of pharmaceuticals, including oral contraceptives (originally produced from Mexican yams), muscle relaxants (based on curare, a product made from several species of tropical vines and trees), and drugs used in treating childhood leukemia and Hodgkin's disease (vincristine and vinblastine), derived from the Madagascan periwinkle plant. The potential for future discoveries could be vast.

The importance of biodiversity goes well beyond these aspects. Deforestation in the tropics may contribute to global climate change. Deforestation prevents absorption of an estimated 10% of total annual emissions of carbon dioxide from all sources.

Loss of biological diversity can be addressed only through novel economic, social, and political actions based on sound knowledge of ecosystems. Though a great deal is known about the causes of biodiversity loss, not enough is known about how ecosystems function to be able to formulate development strategies that are based on, and simultaneously conserve, the biological resources that sustain those ecosystems. This is especially true in marine ecosystems where even less is known than in terrestrial systems.

Events of the late 1970's and early 1980's began to turn biological diversity loss into the global concern it is today. One turning point was a USG-sponsored 1978 Conference on Tropical Deforestation, which engendered early recognition of the destructive effects of increasing deforestation rates in tropical latitudes. Awareness heightened in 1980 with publication by the U.S. National Academy of Sciences (NAS) of the report Research Priorities in Tropical Biology, which warned of perils to human well-being if biological diversity loss continued at its then rate.

During FY-1991, biological diversity research attained a significant place in Administration efforts to encourage environmentally sustainable economic growth in the United States and abroad. In order to respond better to biodiversity as a global issue, the Administration coordinated its biodiversity efforts more cohesively. The Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) moved toward creating a cross-governmental forum for discussion of global biodiversity loss, through establishment of a Subcommittee on Environmental Biology under FCCSET's Committee on Life Sciences and Health. Global loss of biodiversity and ecological risk would be the first areas to be considered by the Subcommittee, to be composed of NSF, USDA, NIH, NOAA, DOE, EPA, USAID, the Smithsonian Institution, and other relevant agencies.

FY-1991 also saw publication by the U.S. National Academy of Sciences of a major new volume dedicated to biological diversity as a global resource. The new work, Conserving Biodiversity in Developing Countries, presents an agenda for research in biological monitoring, conservation research, information needs, and human resources, designed to provide the critical information needed by decision makers to design policies and programs to conserve biodiversity.

NSF plays a dominant Federal agency role in biodiversity-related research, providing 90% of the Federal support for systematic biology work at colleges and universities and 75% of the support for ecological sciences. NSF's Directorate for Biological, Behavioral, and Social Sciences (BBS) has significantly expanded its role in biotic survey and inventory work. Other NSF programs focus on biodiversity research. For example, in FY 1991,

NSF supported a joint workshop between American and Philippine scientists to discuss and exchange information on contemporary concepts and methods in algae/seagrass systematics and ecology, and to explore new directions in basic research.

In FY-1991, a USAID collaborative program with NSF, mandated by Congress the previous year, was further strengthened by USAID funding of $1.5 million. Support has been provided for 33 biodiversity projects around the globe having high scientific merit as judged by the NSF review system. USAID and NSF jointly assess that these projects are contributing tangibly to the conservation of biological diversity in USAID target countries, and to development objectives of USAID.

USAID's Biodiversity Support Program (BSP) supported a World Resources Institute survey of U.S.-based government and private organizations to solicit data on the biological diversity research and conservation activities they undertake in developing countries. Published in FY-1991, the survey of activities during 1989 showed 1093 projects underway in 127 developing countries. Of $62.9 million invested by the United States in developing countries, projects in Latin America received 60%, Africa 17%, Asia and Oceania together 10%, and global or multiregional projects 6%.

Although USAID and NSF are the leading sources of U.S. Government funds for biodiversity projects in developing countries, other agencies play major roles. The Developmental Therapeutics Program of the NIH's National Cancer Institute (NCI) has a longstanding involvement in the discovery and development of anticancer agents from natural products, involving a worldwide program of sample collection. The effectiveness of agents from natural products in ovarian and probably other types of cancer has generated enthusiastic support for continued, thorough exploration of natural products.

Through its international germ plasm maintenance and preservation programs, the U.S. Department of Agriculture (USDA) places a major focus on sustaining and preserving biological diversity. Exploration programs are undertaken with developing countries to identify and collect new plants and microorganisms of potential benefit. For example, the USDA and China have developed and maintain an extensive collection program to preserve and expand the diverse genetic material being maintained at germ plasm repositories in Beijing, China and Fort Collins Colorado.

The State Department-managed U.S. National Committee for the Man and the Biosphere Program (MAB) has devoted major attention to biodiversity-related research for over a decade. The objective of MAB is to develop a scientific basis linking the natural and social sciences for the rational use and conservation of that portion of the Earth which contains living organisms, the biosphere. The U.S. National Committee collaborates with MAB Programs of 110 other nations both bilaterally and through the international MAB secretariat at UNESCO.

U.S. MAB supported planning for a major new international "Program on Biodiversity," established in FY-1991 jointly by the International Union of Biological Sciences (IUBS), the Scientific Committee on Problems of the Environment (SCOPE) of the International Council of Scientific Unions (ICSU), and UNESCO's MAB program. The general objectives are to identify scientific issues that require international cooperation on the role of biodiversity in ecosystem functioning; and address general questions about how knowledge of species and ecosystem diversity can contribute to global ecology. A first priority is to establish strong links with other international programs addressing biodiversity conservation, and national biodiversity efforts. The program is viewed as a major step towards evolving a scientific basis for a global conservation strategy.

Much of U.S. MAB's research relating to biodiversity utilizes units of the International Network of Biosphere Reserves. The network contains 300 units in 75 countries (47 units in the United States), including many of the world's outstanding areas for biodiversity conservation and ecological research. U.S. MAB supports international cooperation in monitoring biodiversity in biosphere reserves as well as interdisciplinary research to help provide the scientific basis for conserving biological diversity in the context of sustainable ecosystem uses.

Other worldwide efforts on biodiversity concerns accelerated in FY-1991. Begun in 1988, elaboration continued on the United Nations Environment Programme-piloted International Convention on Biological Diversity.

In 1991, the United States joined other countries in finalizing the 1983 Cartagena Convention's new Protocol on Specially Protected Areas and Wildlife in the Wider Caribbean Region (SPAW). The SPAW protocol calls for the establishment of a regional network of protected areas to conserve, maintain and restore ecosystems, in particular, to maintain the ecological and biological processes essential to the functioning of the wider Caribbean ecosystem. In addition, the parties agreed to protect key ecosystem components such as coral reefs, sea grasses and mangroves.

Biotechnology

Biotechnology is the use of living organisms or parts of organisms to make or modify products, improve plants or animals, or develop microorganisms for specific uses. Biotechnology relies both on basic research contributions of diverse scientific and engineering fields, and on the application of resultant knowledge to the bioprocessing and bioconversion of materials to provide useful goods and services.

U.S. Government biotechnology related research has traditionally emphasized human health care. The majority of biotechnology research expenditures by major Federal agencies currently come from the Department of Health and Human Services. Other agencies that support biotechnology research include the Departments of Agriculture, Commerce, Defense, Energy, Interior, Justice and Veterans Affairs, the Agency for International Development, the Environmental Protection Agency, the National Aeronautics and Space Administration, and the National Science Foundation.

Biotechnology Research and Regulation

In FY-1991, regulatory policy and research priorities and a flourishing free market for biotechnology moved to the forefront of Administration attention as Vice President Quayle, who chairs the President's Council on Competitiveness, presented the Council's Report on National Biotechnology Policy to President Bush. The Report recommended that Federal biotechnology funding allocations be examined in the fields of agricultural, biomedical, energy, and environmental research, and areas of opportunity be identified for support.

For several years, the United States has been working internationally toward a harmonized approach to biotechnology oversight based on sound scientific, risk based and product based principles. The Report on National Biotechnology Policy stated Administration policy on biotechnology regulation, and set out principles that guide the U.S. in the international arena. The report concluded that existing regulatory regimes for plants, animals, pharmaceuticals, chemicals and toxic substances provide an adequate framework for regulation of biotechnology.

The Vice President's report described principles for the scope of Federal oversight of introductions into the environment of organisms with modified heredity traits. The report stated that, unless otherwise required by law, introductions need oversight only when the information available about the new product indicates that it poses an increased risk to health, safety, or the environment.

The United States has been cooperating with the OECD, EC and participating governments to minimize differences in approaches to regulating biotechnology, and to exchange scientific information and experience on evaluating field trials. In regard to scientific cooperation, the July 1991 meeting of the U.S.-EC Task Force on Biotechnology Research provided an opportunity for biotechnology related discussions on research, including mechanisms which would allow U.S. researchers who receive grants for Environmental Protection Agency (EPA) and USDA research programs to work more closely with their European counterparts. The focus of this effort would be on answering scientific questions about introducing modified organisms into the environment.

The Third Session of the UNCED Preparatory Committee (PrepCom), held in Geneva, August 12 - September 4, 1991, included a focus on environmentally sound management of biotechnology. Discussion of biotechnology safety reflected strong divergences of opinion, not only along north-south lines but among industrialized countries. The United States was in general agreement with stated PrepCom objectives to facilitate the safe development of biotechnology techniques and products and their application to problems of human health and environment.

In hopes of bridging the widely varying international views on safety issues and encouraging a sound science basis for safety regulation, the United States continued to emphasize recent initiatives by the Consultative Group on International Agricultural Research (CGIAR) to develop biosafety guidelines or principles for biotechnology regulation. These initiatives address the interests of developing countries in respect to international guidelines on biosafety concerns.

The Human Genome Project

Scientists refer to all the genetic material in the cells of a particular organism as its genome. The Human Genome Project (HGP) is an international research effort whose goals are to produce a variety of biological maps of human chromosomes, and determine the complete chemical sequence of human DNA, the substance that makes up genes. The HGP is spawning new research tools--chromosome maps, DNA sequence information, laboratory technology, and computer databases--that are expected to become the foundation of biomedical science in the 21st century.

Knowledge gained from genome project research helps scientists to understand, and will help eventually to treat, many of the more than 4000 genetic diseases that afflict human beings. Genome research also sheds light on the mechanisms of many other common but complex diseases, such as heart disease, cancer, and Alzheimer's disease, in which genetic predisposition plays an important role.

In the United States, the HGP receives financial support from the National Center for Human Genome Research (NCHGR) of the NIH, and the health and environment branch of the Department of Energy's Office of Energy Research. Other U.S. agencies currently supporting genome programs include the National Science Foundation and the Agriculture Department. The Human Genome Organization (HUGO), established in 1988, is an international consortium of molecular biologists working to ensure that the genome project is coordinated internationally, and that the information gained by project researchers is freely accessible to scientists worldwide.

As of FY-1991, human genome programs had already begun or were about to begin in many nations. These included the United Kingdom, Italy and other members of the European Community (EC), Japan, the Soviet Union and South Korea. France's Center for the Study of Human Polymorphisms (CEPH) is a focal point for researchers developing genetic linkage maps of

the human genome. CEPH maintains a large number of reference DNA samples, which can be used by gene mappers in Europe, North America, and Africa. The Japanese are focusing efforts on developing automated technology for DNA sequencing.

Plant Biology

Another important international cooperative large-scale biotechnology project is the Multinational Coordinated Arabidopsis thaliana Genome Research Project, aimed at improving knowledge about plant biology. The project was developed on the recognition that a more profound understanding of plant biology is essential to meet the challenges facing world agriculture and the global environment; that the use of Arabidopsis as an experimental model system is extremely effective in studying the biology of flowering plants; and that international coordination is necessary for rapid advances. The project seeks to determine the complete sequence of the Arabidopsis genome by the end of the century.

By FY-1991 important progress had been made. Research on Arabidopsis in the United States was substantial. NSF took the lead in developing the Arabidopsis Genome Research Project as a research initiative for the United States, with increased funding. In FY-1991, NSF, NIH, USDA, and DOE provided approximately $7.5 million.

Smaller-Scale Biotechnology Collaborations

In FY-1990, the United States and the EC established a Task Force on Biotechnology Research, to improve scientific cooperation and exchange information and advice on biotechnology regulation. Task Force sessions during FY-1991 stressed the importance of biotechnology research in potentially helping to solve societal problems, and the need for advanced information systems to facilitate dissemination of research results to the biotechnology community.

The 1988 U.S.-Japan bilateral science and technology agreement identified bioprocess engineering as a priority area for cooperation. The Life Sciences Liaison Group established under the agreement has responsibility for assessing opportunities for cooperation in this field.

During FY-1991, members of the liaison group from NIH and USDA participated in a Japanese Technology Evaluation Center (JTEC) panel to assess bioprocess engineering in Japan. The JTEC was established more than five years ago by NSF, in cooperation with the Defense Advanced Research Projects Agency (DARPA), the Department of Commerce (DOC), DOE, NASA, DOD, and NIH, to identify Japanese science and technology strengths and contribute to enhanced scientific and technological cooperation between the United States and Japan. Also in FY-1991, NSF supported the "Third Conference to Promote U.S.-Japan Joint Projects and Cooperation in Biotechnology," held in January at the Asilomar Conference Center in Monterey, California.

A five-year agreement for multidisciplinary basic research into the evolution of microbes was announced during FY-1991 between NSF's Science and Technology Center for Microbial Ecology at Michigan State University (MSU), and the Japan Research and Development Corporation (JRDC).

While much of U.S. collaborative research in biotechnology has taken place with Japan and Western Europe, other countries are beginning to surface as having high potential for international cooperation. More than 200 research facilities and 50 different colleges and universities perform biotechnology and related research in China. During the past five years, the Chinese government inaugurated two new types of research centers to promote the development and commercialization of this field. The first are biotechnology bases at Jiangmen and Shanghai, which are meant to bring research results to the production stage. The second are key research and university laboratories, which provide research training for scientists throughout China.

Among U.S. government agencies, USAID's Science and Technology Bureau provides the largest support for biotechnology-related efforts with developing countries. International Agricultural Research Centers (IARCs), sponsored primarily by USAID, conduct comprehensive, long-term research programs on major food crops and key production systems in Asia, Africa, and Latin America. Biotechnology is increasing in importance in the research programs of these institutions; for example, plant biotechnology investment has been increasing at an annual rate of nearly 30% in recent years.

High Performance Computing and Communications

Unprecedented computational power and capability is needed to investigate contemporary science and engineering "grand challenge" problems such as assessment and prediction of weather and possible climate change, determination of molecular, atomic, and nuclear structure, understanding turbulence, pollution dispersion, and combustion systems, mapping the human genome and understanding the structure of biological macromolecules.

The design and development of computer networks has entailed one of the most elaborate international science and technology collaborations that has ever taken place. While much of the work has been accomplished on a local basis, the growing importance of networking led to increased movement to coordinate national developments. Within the United States, research-support networks of several Federal agencies, including NSF, Defense Advanced Projects Agency (DARPA), NASA, and DOE are coordinated by the recently-established Federal Networking Council (FNC).

The Administration's cross-cutting R&D initiative proposed in FY-1991, the High Performance Computing and Communications Program (HPCC), entailed recognition that formal international collaboration in high performance computing and communications was still in its early stages. With roots in today's rapidly growing interconnected national and international computer networks serving the scientific community, the HPCC has set the

stage for enhanced international scientific research computing and networking for the next decade. This is part of a major effort to make high performance computing more available to researchers, accelerate the development of the next generations of machines, develop improved software tools for computational research, and create a high-speed data network for researchers to use for access to the high-performance systems.

With funds allocated among nine agencies, the goal of the Administration's proposed five-year HPCC program is to accelerate significantly the availability and utilization of the next generation of high performance computers. The nine agencies are: the Defense Advanced Research Projects Agency (DARPA), DOE, NASA, NSF, Department of Commerce/National Institute for Standards and Technology (DOC/NIST), Department of Commerce/National Oceanic and Atmospheric Administration (DOC/NOAA), EPA, the Department of Health and Human Services/National Institutes of Health (DHHS/NIH) and the Department of Education.

The High Performance Computing Systems (HPCS) component of HPCC is the development of technology required for parallel computing systems capable of sustaining trillions of operations per second to solve large scientific problems. The Advanced Software Technology and Algorithms (ASTA) part is the development of generic software technology and algorithms for grand challenge research applications. The National Research and Education Network (NREN) portion of the initiative is the development of a high speed network to provide distributed computing capability to research and educational institutions and to advance research further on very high speed networks and applications. The Basic Research and Human Resources (BRHR) component is the support of long term basic research and education in computational science.

The 1990 decision reached by the President's Science Advisor, D. Allan Bromley and EC Commission Vice President Filippo Pandolfi to list Information Science and Technology (IST) as one of the priority areas for possible future research collaboration between the United States and the EC was a factor significantly advancing cooperation.

NSF has initiated an advanced computing systems program to create several national supercomputer centers and expand the capabilities of NSF's fledgling science computer network. The Defense Advanced Reseach Projects Agency (DARPA), NSF, and other science agencies began informal coordination and cooperation in developing both their computer architecture research programs and networking. An elaborate web of interconnected national, regional, state, and local computer networks to serve the scientific community has developed and grown rapidly.

NSF now has in place NSFnet, a major backbone communication service for the research community, which integrates a large number of local computer networks into a host network known as Internet. Academic investigators may exchange data and information and access computer facilities throughout the country, including NSF-supported Supercomputer Centers. NASA and DOE are also operating networks to support their missions, and contribute additional backbone facilities to Internet in the form of the NASA Science Internet (NSI) and Energy Sciences Network (ESNet) respectively.

In Europe, major international backbones such as NORDUnet and others provide connectivity to tens of thousands of computers on a large number of networks. Research networks are now used by investigators in most science and engineering disciplines throughout Western Europe, North America, Japan and Australia. Rapid further spread is expected throughout Eastern Europe, the Soviet Union, Latin America, China and the Pacific Rim as networks become established and grow in those countries.

A number of services provide international connectivity among national networks. The most widespread (e.g.BITNET) permit electronic mail and file transfer among users throughout North and South America, Western Europe, and Japan by connecting relatively low-speed networks within those regions. The higher speed, broad-band NSFNet currently links 3500 local, regional and national networks, one-third of which are non-U.S. With 32 countries represented, including Canada, Australia, major European nations, Mexico, Japan, Israel, Korea, and Chile, NSFnet has a global reach.

Some scientific disciplines have developed their own, specialized international research networks, such as HEPNET for high energy physics, and SPAN for space and astrophysics. By early 1991, the global Internet, to which NSFnet is linked, had grown to link over 315,000 computers used by as many as 3,000,000 people.

Megaprojects

The rising costs of research and the resulting desirability for international cost and knowledge sharing have contributed new names for large-scale projects: "megascience" or "megaproject." A megaproject can be defined as one which a) addresses a set of scientific problems of such extraordinary significance, scope, and complexity as to b) require elaborate or extensive facilities, instruments, human resources and logistic support, to the degree that c) both special governmental policy involvement and an unusually large scale collaborative effort are necessary.

Megaprojects can entail large capital facilities such as particle accelerators, synchrotron radiation sources, magnetic fusion devices and space-based science facilities. Megascience also encompasses projects, typically in the earth and ocean sciences (such as the global change research project), whose scientific character requires geographically dispersed research. Dispersed activities such as the international Human Genome Project can also be viewed as megaprojects (see discussion under Biotechnology above).

The Superconducting Super Collider

The Superconducting Super Collider (SSC) is a world-class particle accelerator and laboratory which will have an unprecedented capability to advance understanding of the origins and basic constituents of matter.

When completed, the SSC will accelerate proton and anti-proton beams to speeds approaching the speed of light and store those counter rotating high energy beams in a single circular tunnel approximately 86 kilometers (53 miles) in circumference. Superconducting magnets employing frontier technologies will guide the particle beams to interaction

regions where up to 100 million collisions will take place per second. Massive yet highly sensitive detectors will collect the resultant sub-nuclear particles and, by reconstructing the details of the collisions that produced them, scientists will be able to probe the fundamental interactions that have taken place.

The SSC was first seriously contemplated in 1983 and its total construction cost has been estimated at $8.3 billion. The operating costs after commissioning are estimated at $500 million per year. Both the Administration and the Congress have determined that the U.S. Government should not provide more than two thirds of the total construction cost. The state of Texas, where the SSC is to be located, has committed $1 billion; an additional $1.7 billion is being sought from foreign sources.

Delegations of U.S. scientists and government officials have visited Western European and Canadian laboratories and government offices to provide in-depth briefings on the SSC and to seek participation and support. European interest, however, is limited by a proposal for a smaller, less costly facility having significantly less scientific capabilities, the Large Hadron Collider (LHC), for the European Center for Nuclear Research (CERN) laboratory. CERN is a high energy and nuclear research organization located on the border between France and Switzerland and is supported by several mostly Western European countries together with Yugoslavia and, recently, Poland. The U.S. also participates in several of the major projects at CERN.

A substantial partnership in the SSC is being sought from Japan. The U.S. has proposed that Japan become a partner of the United States in the SSC laboratory. While the Japanese government remained non-committal as of the end of FY-1991, as a result of discussions between President George Bush and Prime Minister Miyazawa a Joint Working Group on the SSC has been formed. Discussions have been initiated with several other countries, including the former Soviet Union, Korea, Brazil, and India. India has undertaken to contribute to the development of the project, and substantive negotiations about the auspices and character of that support continued during FY-1991.

Space Station Freedom

NASA is working on a variety of projects that further knowledge in a number of areas. Ongoing Space Shuttle missions and development of the international Space Station Freedom lead NASA's current activities.

Space Station Freedom was conceived as a multinational megaproject collaboration from the outset. Following NASA briefings in 1983, President Reagan announced in his January 1984 State of the Union address that the U.S. intended to build an international space station. The space station was subsequently discussed during the 1984 economic summit, and in more detail at two international workshops in June and September of 1984. At the workshops, Japan, Canada and the European Space Agency (ESA) were invited to submit proposals on international agreements to cover the coordination of system definition and preliminary design of the space station.

In 1988, the United States signed an Intergovernmental Agreement and a supporting Memorandum of Understanding entailing participation in the space station by nine European governments through ESA. The Japanese and Canadians also signed the Intergovernmental Agreement and implementing Memoranda of Understanding covering their very substantial commitments. After joining the program at U.S. invitation, the partners have participated fully in the project, including a recent redesign. The foreign contributions total nearly $8 billion, of which in excess of $1 billion has already been spent. The international partners have further agreed to share in the operating costs over the projected 30-year lifetime of the project.

In 1991, the United States signed a Memorandum of Understanding with the Italian Space Agency to provide a pair of mini-logistics modules and, possibly, a mini-laboratory. In exchange, the U.S. will provide the Italians access to a portion of Space Station resources allocated to the U.S.

The U.S. Global Change Research Program (USGCRP)

Another kind of megaproject has resulted from the Administration's goal to develop a comprehensive process on issues associated with the profound economic and social implications of global change and possible responses to those changes. Due to the complex, multidisciplinary character of the scientific problems involved, in 1989 the FCCSET Committee on Earth and Environmental Sciences (CEES) working group on global change developed a comprehensive, multi-year research program, the U.S. Global Change Research Program (USGCRP).

The USGCRP arose out of the perceived need to study global atmospheric/oceanic/terrestrial processes and interactions to understand better the natural Earth system and human impact on that system. Recent scientific findings that project future depletion of Earth's protective ozone layer and/or possible warming of the Earth's climate have underscored the importance of these studies. In these and other environmental questions, a salient feature is the significant scientific uncertainty associated with predicting the complex behavior of the coupled ocean-atmosphere-land system.

The goals of the multi-agency USGCRP are to understand and describe the interactive physical, chemical, and biological processes that regulate the total Earth system, the unique environment it provides for life, changes occurring in this system, and the manner in which human action may be related to such changes. The USGCRP entails activities of the White House Office of Science and Technology Policy and the Council on Environmental Quality, the Office of Management and Budget, National Space Council, and agencies including the following:

Department of Agriculture
Department of Commerce (NOAA)
Department of Defense
Department of Energy
Department of Health and Human Services
Department of Housing and Urban Development
Department of the Interior
Environmental Protection Agency

National Aeronautics and Space Administration
National Science Foundation
Tennessee Valley Authority
Smithsonian Institution

Extensive international interactions have been central from the outset to planning and implementation of the USGCRP. The USGCRP serves as the U.S. National Committee for the International Geosphere-Biosphere Programme (IGBP) of the International Council of Scientific Unions (ICSU). Also involved are other ICSU committees such as the Scientific Committee on Oceanic Research (SCOR) and the International Social Science Council (ISSC) Committee on the Human Dimensions of Global Environmental Change. Planning also proceeds through intergovernmental organizations such as the World Meteorological Organization (WMO), UNESCO's Intergovernmental Oceanographic Commission (IOC), and the United Nations Environmental Programme (UNEP). The World Climate Research Programme (WCRP) is jointly undertaken by ICSU and WMO. During FY-1991, WMO, IOC and UNEP endorsed the global climate observing system, including the climate component of the global ocean observing system. Interagency coordination of the international components of the U.S. GCRP is conducted when appropriate through the FCCSET Committee on Earth and Environmental Sciences' Task Group on International Coordination and Development.

The U.S. has taken an active role in the Committee on Earth Observation Satellites (CEOS). CEOS encourages complementarity and compatibility among space-borne Earth observing systems through coordination in mission planning, promotion of full and non-discriminatory data access, setting of data products standards, and development of compatible data products, services and applications. In addition, U.S. agencies that fund global change research are developing direct ties with funding agencies in other countries, in particular, through the newly created informal International Group of Funding Agencies (IGFA). On the non-governmental side, the CEES works closely with the U.S. National Academy of Sciences (NAS) which represents the U.S. science community, and in particular, the Committee on Global Change Research (CGCR).

Assessing Megaprojects

The increasing complexity of many proposed megaprojects, as well as cost concerns, have led to an Administration decision to examine the megaprojects issue in depth. Much of the public policy debate in the U.S. about megaprojects has been cast in terms of "big science versus little science." Some have argued that, at a time of scarce budget resources, support for traditional small science in a wide variety of fields may erode because of support for very large and expensive megaprojects in a relatively few fields. Until quite recently, the focus of this debate was almost entirely domestic. However, costs of highly visible megaprojects such as the SSC, Space Station Freedom and the Global Change Research Program have moved the debate into the international arena.

In FY-1991, the President's Science Advisor created two key new groups to look at national and international issues associated with megaprojects. One is an interagency committee, the Subcommittee on Science Megaprojects, of the FCCSET Committee on International Science, Engineering and Technology (CISET), with representation from the principal non-defense agencies that support large-scale projects in addition to the State Department and the Office of Management and Budget (OMB).

The second is a panel on Megaprojects in the Sciences under the auspices of the President's Council of Advisers on Science and Technology (PCAST), a Presidentially appointed group of twelve distinguished non-government individuals, chaired by the President's Science Advisor. The purpose of the panel is to develop information and policy options to provide a base for PCAST advice to the President on national and international policy issues related to the planning, financing and organization of large scale science projects.

The panel has been asked to advise whether a comprehensive international framework for coordination and cooperation is desirable, and how countries could cooperate to ensure that the cost and benefits of megaprojects are shared equitably. The panel was also asked to suggest the most appropriate international fora, governmental and scientific, in which such cooperation could be further discussed and coordinated (for example, OECD, United Nations, International Council of Scientific Unions (ICSU), and/or the group of seven economic summit countries (G-7 plus the Soviet Union)).

Related activities were to continue into FY-1992, including an October 1991 "workshop on International Collaboration in Science Megaprojects," sponsored jointly by NSF and the European Community (EC) Directorate for Science, Research and Development (DG XII). In March 1992, the Ministers of Science of the OECD countries are scheduled to meet in Paris. Primarily at the suggestion of the President's Science Advisor, the megaproject issue will be the principal topic for discussion.

LIFE AND HEALTH SCIENCES

Introduction

International cooperation is essential to assuring sustained and efficient research advances, including appropriate and effective application of new methodologies and technologies to improve human health. Moreover, the need for communication and collaboration internationally has grown in proportion to the rapid advances in scientific technologies and research progress. International cooperation in life and health sciences benefits both Americans and citizens of other countries alike. The study of diseases in diverse populations around the world allows epidemiologists and others to compare differences in the amount or severity of disease, thereby pointing to biological or behavioral factors which could lead to cures.

Following the pattern initiated in the FY-1990 Title V report, this chapter focuses on selected areas in the health and life sciences field seen as important for international cooperation in the 1990's. The focus areas for 1991 are: cancer, epidemiology, nutrition, alcohol and drug abuse, reproductive physiology and population research, and development of new drugs from natural products.

General Comments

The two U.S. Government agencies most actively engaged in international health cooperation are the U.S. Public Health Service (PHS) of the Department of Health and Human Services and the U.S. Agency for International Development (USAID). Other federal agencies, including the Walter Reed Army Institute of Research of the Department of the Army, the Department of the Navy, and the National Science Foundation (NSF) are involved in international health science cooperation as well. The Department of State, through the OES Environmental Directorate's Office of Ecology, Health and Conservation (OES/EHC), provides a central coordinating focus among U.S. Government agencies dealing with international health issues.

Each of the agencies of the Public Health Service -- the Agency for Health Care Policy and Research; Agency for Toxic Substances and Disease Registry; Alcohol, Drug Abuse and Mental Health Administration; Centers for Disease Control; Food and Drug Administration; Health Resources and Services Administration; Indian Health Service; and National Institutes of Health -- cooperate with institutions in other countries. In general, PHS programs seek to advance the status of knowledge in the health sciences and to promote the application of that knowledge to real-world health problems both in the U.S. and other nations. Many of these programs involve important technology transfer components.

USAID seeks to improve health care in developing countries and to reduce the effects of poor health which act as major barriers to economic and social

development. A significant part of USAID's efforts includes the support of programs in maternal and child health, nutrition, international family planning and control of AIDS.

The agencies of the Public Health Service alone are engaged in bilateral relationships with some fifty countries. These include, but are not necessarily limited to, programs under umbrella science and technology agreements, "ministry-to-ministry" level agreements for health cooperation, as well as agreements and arrangements at institute, center or bureau levels. Principal among these bilateral relationships are those with the Peoples Republic of China, Egypt, France, India, Israel, Italy, Japan, Eastern Europe and the (former) Soviet Union. Additionally, the PHS agencies, primarily the National Institutes of Health, award a substantial number of grants and contracts to foreign as well as domestic institutions for projects which have a foreign component. These awards are made as part of the normal research programs of the agency in pursuit of research solutions to U.S. domestic health problems. An estimated $60 million in awards were made in FY-1991. Additionally, the PHS agencies received close to 3,000 foreign visitors, 2,000 of whom were visiting scientists.

PHS' international health interests encompass but are not necessarily limited to the following subjects:

Arthritis
Biomedical resources development
Cancer
Cardiovascular disease
Child health and development
Dental health
Disease prevention and control, including tropical medicine and vaccine development
Emergency medical services
Environmental health and toxicology
Food and drug consumer protection, including quality control of biologicals
Genetics
Gerontology
Health services research, including manpower development
Immunology
Mental health and neurology
Medical library science
Metabolic disorders
Pulmonary disease
Reproductive physiology
Substance addiction
Vision research

The past year presented a number of important challenges due to the rapidly changing political situation in the world, particularly events in Eastern Europe and the Soviet Union, Africa and the Middle East. PHS and USAID worked to meet this challenge by planning and developing new program approaches relevant to the new situation. This included a greater focus on health policy issues, including

health financing, in the dialogue with eastern Europe and the former Soviet Union. In Africa, greater attention was focused on AIDS and, as a follow up to the September 1990 World Summit on Children, problems particularly relevant to the survival and development of children. In the Middle East, attention was drawn to the environmental health situation in the Gulf area caused by the large number of oil well fires in Kuwait.

Cancer

Although the international health community has made major strides in controlling infectious diseases and subsequently increasing life spans throughout the world, growing numbers of people who reach middle and old age are being stricken with cancer, a leading global cause of sickness and death. In the United States alone, cancer is the cause of more than a half million deaths each year.

The National Cancer Institute (NCI) of the National Institutes of Health (NIH) has intensified its efforts, through a wide range of international bilateral and multilateral activities, to find new methods for detecting, preventing and treating the various cancers and advancing the international medical community's fundamental knowledge of cancer biology. By 1991, on the eve of the twentieth anniversary of the signing of the National Cancer Act, the NCI led campaign against cancer reached virtually every corner of the globe. In the former Soviet Union, several clinical trials concerning the treatment of colorectal and breast cancer had been initiated, in parallel to trials conducted in the United States. Information on state-of-the-art treatments is now being disseminated freely for the first time in the former East-bloc nations.

New insights into the mechanisms of cancer, fueled largely by rapid advances over the past decade in DNA technology, have enhanced this global effort. The ability of scientists to cut, splice and recombine DNA -- the genetic material of all living things -- has provided a molecular window on the way in which healthy cells may become warped into malignancy. Scientists now know that viruses can trigger or play active roles in the development of some cancers. Life-style factors such as cigarette smoking in lung cancer and sun exposure in skin cancer have been linked closely to the process of malignant transformation. More recently, diet has also been implicated in some forms of cancer.

As more is learned about genetic and environmental factors that promote cancer, new strategies are being devised for prevention and treatment both in the United States and abroad. For example, in 1991, physicians at NIH used gene therapy for the first time in an effort to treat advanced melanoma, a skin cancer for which no effective therapy is currently available. Although the treatment is highly experimental and currently offered only in the United States, the concept that the body's natural immunity can be bolstered to fight cancer is offering hope where none existed before.

Meanwhile, on the international front, NCI is pursuing a number of bilateral activities designed to heighten understanding of cancer and improve existing treatments. NCI participates through its Office of International Affairs in many of the 73 bilateral agreements that NIH has forged with 39 other nations. Highlights of these bilateral activities include: work in the United Kingdom where U.S.-supported trials are the world's most advanced in the evaluation of neutron therapy for the treatment of cancers of the prostate, lung, head, and neck; a collaborative effort with investigators at the German Research Center in Heidelberg to develop vaccines against human papilloma viruses, a known environmental trigger in the development of cervical cancers; and an agreement with the Japanese Society for the Promotion of Science and the Japanese Foundation for Cancer Research to hold state of the art workshops on as yet unpublished results in cancer etiology, biology, diagnosis and treatment.

An NCI contract with the Finnish National Public Health Institute in Helsinki supported epidemiologic studies assessing the role of fats, selenium and vitamins A, E, and C in breast-cancer development and the role of other nutrients on subsequent development of colon and lung cancers. Under a collaborative agreement with NCI, investigators in China examined whether multivitamin and mineral supplements can prevent esophageal cancer.

Through a joint initiative between the U.S. and Canada, 22 communities in the U.S. and Canada are participating in the Community Intervention Trial for Smoking Cessation (COMMIT). Under this four-year program, which targets heavy smokers, half of the COMMIT communities were randomly selected to receive a smoking-cessation intervention protocol. The results of this trial are considered vital to future efforts to expand smoking-control activities in communities across North America.

Multilaterally in 1991, NCI continued to maintain close working relationships with numerous international health agencies, including the European Organization for Research and Treatment of Cancer (EORTC), the International Agency for Research on Cancer (IARC), the International Union Against Cancer (IUAC), the Organization of European Cancer Institutes (OECI), the Pan American Health Organization (PAHO) and the World Health Organization (WHO).

One of the most important research issues being addressed internationally is that of breast cancer screening and mammography quality control. The NCI is working with the WHO, the IUAC and a dozen other nations to develop an International Breast Cancer Screening Database. This database will provide information on alternative breast cancer treatments and screening procedures and will promote screening efficacy and effectiveness in the diverse health-care environments found in the participating countries. NCI has also been at the forefront of research into occupational risks in the development of certain cancers. For example, a study of underground tin miners in China exposed to high levels of radon found that exposure during the early teen-age years was no more hazardous than exposure in later life, and that damage to one's health was largely a function of length

of exposure to a given total dose. Other collaborative studies in Sweden and the United States including innovative approaches to dosimetry (measurements of radiation), should provide new information on the possible level of risk from residential radon.

An important component of the international medical community's effort to combat cancer is the scientific exchange of ideas. Toward that end, nearly 700 foreign scientists participated in the NIH Visiting Program during 1991 and an additional 140 came to the United States as exchange scientists through funding from the Office of International Affairs of the NCI. The NCI's International Cancer Information Center's on-line database called Physicians Data Query (PDQ) is providing scientists from around the world access to vital up-to-date cancer information. The computerized database includes active investigational and standard protocols for cancer treatment and enables clinicians to quickly learn of promising new developments and to provide patient care based on the most recent and accurate information. Future plans call for a wider distribution of this and other databases, through CD-ROM and other technologies to under served populations both in the United States and abroad. Access to these databases was provided to scientists in India and selected African countries in 1991.

The continued combined efforts of leading investigators from around the globe are essential to further gains in diminishing the suffering and reducing deaths caused by the many feared and highly formidable types of cancer.

Epidemiology

Epidemiology is the science that investigates the cause and control of diseases by analyzing statistics and comparing traits of individuals and populations. Epidemiologists are detectives who uncover the causes of disease outbreaks and their findings often reveal ways to prevent further cases. Epidemiologists can also determine the impact and effectiveness of health-promotion and disease-prevention programs. In addition, epidemiological data is particularly useful to governments when setting health policy. Epidemiological methods can identify new disease threats both within populations, and from one population to another, a particularly important capability in an era when diseases such as cholera and AIDS penetrate national borders with frightening ease.

The Centers for Disease Control (CDC), National Institutes of Health (NIH) and the U.S. Agency for International Development (USAID) are all involved in a variety of international epidemiological programs, ranging from the study of disease patterns abroad, to the training of epidemiologists and helping health leaders and policy makers use epidemiological data in decision-making.

In conjunction with the World Health Organization and others, CDC's Division of Reproductive Health published an updated version of the Reproductive Health Epidemiology Manual in 1991. Using earlier versions of the manual, CDC conducted more than a dozen workshops in Thailand, Bangladesh, Mexico, Kenya, China, Indonesia, and Cameroon. These workshops provide training in reproductive health epidemiology and assist public health professionals in designing research projects with direct impacts on maternal and infant health outcomes. For example, a randomized trial of antibiotics given at the time of intra-uterine device (IUD) insertion, developed in one of these workshops, led to policy and programmatic improvements in Kenya. That study is being replicated in the U.S. with funding from the National Institute of Child Health and Development.

Epidemiology, Heart Disease and Cancer

Among the most important epidemiology initiatives are those involving heart disease and cancer. Heart disease is the number one killer in industrialized nations and is becoming a major cause of death in the developing world. In 1990, the estimate of people dying in the U.S. from heart disease was 725,000. Cancer is in next place with half a million deaths a year. It was classical epidemiological studies of populations in the United States and abroad that first confirmed the contribution to these diseases of lifestyle factors, including diet and occupation. Ongoing epidemiological studies are adding further knowledge on both diseases, and could contribute to treatment and prevention programs in the United States as well as abroad.

Over the past year, the National Heart, Lung and Blood Institute (NHLBI) collaborated with more than 20 countries, one-third of which are developing nations, in the study of heart and lung disease. For instance, U.S.-Japan collaborative studies are exploring the relationship between cholesterol and stroke. The prevalence of stroke is three times greater in Japanese men living in Japan than in men of Japanese descent in Hawaii. U.S. and Japanese researchers are carrying out epidemiological and pathological studies to determine the cause of this phenomenon.

There has been a three way collaboration in cardiovascular epidemiology underway since 1972 between NHLBI and its counterpart in the former Soviet Union, and the University of North Carolina. Under this program, 12 lipid research centers were set up in the Soviet Union to study cholesterol and patterns of atherosclerosis. One of the most striking findings so far is that there is a dramatic difference in cholesterol and triglyceride levels between Soviet and American men aged 40-59. Men in the U.S. samples had higher triglyceride levels which increases the risk of cardiovascular disease. The Soviet men had higher levels of high-density lipoprotein, the so-called "good" cholesterol, reducing their risk of heart disease. Researchers are continuing data analysis to find reasons for the difference in an attempt to help reduce the incidence of atherosclerosis.

The National Cancer Institute is conducting epidemiological studies in a number of countries to better understand risk factors for cancer. In China, for instance, three occupational studies evaluating cancer incidence among 200,000 workers exposed to benzene, silica, radon or arsenic are near completion and two other recent collaborative studies have clarified the role of air pollution in lung cancer risk.

Training in Epidemiology

Recognizing that protecting the health of Americans is enhanced through better control of disease worldwide, the U.S. Centers for Disease Control have created important programs to strengthen epidemiological capabilities abroad. This is carried out both bilaterally and in cooperation with the World Health Organization (WHO). CDC is considered the world leader for training in epidemiology and maintains a program designed to train epidemiologists in their own countries. The Field Epidemiology Training Programs (FETP) are two-year, postgraduate medical training programs operated within the host country's ministry of health. Since 1980, when CDC and WHO began an FETP with Thailand, FETPs have been established in Indonesia, Mexico, Taiwan, the Philippines, Saudi Arabia and Peru.

Even the best epidemiological information may do no good if it does not help a country's senior decision-makers to set health policy. In 1991, USAID and CDC inaugurated the "Data for Decision Making Program" to increase the proportionate role of scientific data in national leaders' health policy decision-making. The program offers workshops, seminars and short courses for government leaders and for technical support personnel. This program receives support from USAID.

The Fogarty International Center at NIH has established two international training programs to increase the expertise of U.S. and foreign scientists in the epidemiology of acquired immune deficiency syndrome (AIDS). These programs are intended to improve scientific expertise globally, with particular emphasis on the developing countries, as part of the effort to combat the AIDS crisis. The programs have recently been expanded to include the Soviet Union and the countries of eastern Europe.

Other Epidemiology Research

The Epidemiology Branch within the AIDS Division of the National Institute of Allergy and Infectious Disease (NIAID), NIH, conducts an extensive research grants program. This program supports U.S. scientists as well as those from numerous developing countries in studies of risk factors, transmission patterns, and other aspects of the disease. The International Center for AIDS Research (ICAR) aims to build collaborative links between the United States and foreign scientists and to develop foreign centers of excellence in AIDS research. ICARs are supported in Brazil, Malawi, Mexico, Senegal and Zaire. Epidemiological data gathered by these ICARs are now being used in a new NIAID program to support AIDS vaccine trials and sexually transmitted disease (STD) intervention research.

Epidemiologists worldwide are also analyzing population trends in age groups from newborns to the elderly. An example of such work is that of researchers at the National Institute of Child Health and Human Development (NICHD) in collaboration with their Danish counterparts, in a study of Danish girls to determine whether those who were born premature or small are at increased risk of giving birth to pre-term or growth-retarded children.

Issues of aging are expected to share more of the research spotlight as the percentage of the global population made up of the elderly increases. The number of persons 60-and-over is expected to triple to an estimated 1.1 billion by the year 2025. With this in mind, the National Institute on Aging (NIA) is providing grants worldwide for the study of aging in specific populations. In Finland, Italy and the Netherlands, scientists collaborating in one such NIA backed study are analyzing the long-term effects of sociodemographic, behavioral and biological factors which may lead to transition from good health to diseased or disabled health status.

The Neuroepidemiology Branch of the National Institute of Neurological Disorders and Stroke, in cooperation with the International Association of Research and Teaching in the Neurosciences, will soon issue the first international research criteria for the diagnosis of vascular dementia. This disorder, also known as multi-infarct dementia, is the second most common cause of dementia in the elderly. It is caused by restricted blood flow to deep areas of the brain. The new criteria will help not only in diagnosis of specific cases, but in designing new international studies needed to help understand and prevent the condition.

Nutrition

U.S. scientists are cooperating with their colleagues around the world to determine how what we eat affects our health, our life span, and how food-related factors may either increase or decrease the likelihood of certain diseases. Study of the many variations of diet in individual countries abroad and the effects of malnutrition often give important insight into conditions that afflict inhabitants of all nations, including the United States. Diet has been implicated in a number of serious health problems, such as stroke, heart attack and cancer. Another important dimension of U.S. efforts is to help ameliorate malnutrition, particularly in the developing countries.

One of the most pressing health problems, especially in the developing world, is malnutrition. This condition is estimated to be a contributing factor in up to 60 percent of child deaths. A related problem, Vitamin A deficiency, remains the most significant cause of childhood blindness in developing countries. Because their diets lack sufficient vitamin A, half a million preschool-age children worldwide develop severe eye disease each year. In addition, forty-three million other children under age 5 (7% of all children) experience milder forms of vitamin A deficiency.

Among USAID's projects are valuable studies related to vitamin A deficiency, including an important intervention study in Nepal, whose preliminary results suggest that nutrition education and diet change can be as successful as vitamin A supplementation in controlling eye disease resulting from vitamin A deficiency. These findings complement results from a southern India study, in which scientists of the National Eye Institute assisted, which found that weekly consumption of vitamin A at recommended levels dramatically reduced (by 54%) the risk of preschool children dying from common childhood infections.

Anemia due to iron deficiency is the world's most prevalent nutrition related malady, striking particularly hard at women and young children. The estimated global population of iron deficiency anemia sufferers is 1.3 billion people, 24 percent of the world's population. Infants born to severely anemic mothers have lower birth weights and are at increased risk of death. Recent reports indicate that iron deficiency anemia contributes to a reduction in both physical capacity and productivity in adults, and in children a decrease in cognitive performance. If the deficiency in children is not corrected early, its effects may be irreversible.

USAID is helping to develop new ways to make sure that women and children in the developing world consume enough iron. USAID is supporting several projects that distribute iron supplements and is field testing a unique slow-release iron capsule. USAID is also exploring the possibility of projects that would add iron to commonly used foods such as whole wheat flour and other cereals, legumes flours and condiments.

USAID contributes to programs in some 53 countries to improve infant and child feeding practices. The Agency has pioneered programs to teach mothers what and how to feed children, how to feed them during bouts of diarrhea, and how to monitor growth. USAID also uses education and social marketing techniques to promote breast feeding, a key to good infant nutrition and health. The Agency now sponsors 75 projects in 28 countries to boost vitamin A consumption, concentrating on four kinds of activities: distribution of high-dose supplements, food fortification, home production of vitamin-rich foods and nutrition education and marketing.

In the aftermath of the Persian Gulf War malnutrition was widespread among the Kurdish children refugees along the Iraq/Turkey border, and CDC researchers found it was associated with the severe, prolonged diarrhea occurring during residency in mountain camps. Scientists from USAID and CDC cooperated with the United Nations to distribute oral rehydration therapy -- which replaces salt and liquid lost during diarrhea -- and nutritional supplementation.

NIH supports collaborative studies abroad focusing on nutritional risk factors for heart disease and cancer, the leading causes of death in many industrialized countries. Since there are greater nutritional variations abroad than found in the United States alone, these studies offer an important opportunity to learn how food-related factors may increase or decrease the likelihood of heart

disease and certain cancers. NIH support has included grants for international research and cooperation with scientists in other countries, as well as participation in meetings and workshops. For instance, the National Cancer Institute is supporting studies in Linxian, China, to determine whether vitamin and mineral supplements can help prevent esophageal cancer incidence. In Finland, NCI supported researchers are assessing the role of fats, selenium and vitamins A, E and C in breast cancer development. In another study, beta-carotene and vitamin E are being tested as lung cancer chemopreventive agents among 29,000 male smokers. NCI researchers working with scientists in Italy studied the high prevalence of stomach cancer among inhabitants of northern provinces, finding increased risk was associated with high consumption of cold cuts, seasoned cheeses and dried, salted fish, while decreased risk was associated with consumption of fresh fruits and vegetables, including garlic. A similar study of stomach cancer in China confirmed the protective role of fresh produce.

The National Heart, Lung and Blood Institute (NHLBI) continues to sponsor large-scale studies and intervention programs to study the origins of heart disease in certain populations and test the effect of lifestyle and dietary interventions. Since 1981, U.S. and Chinese scientists have collaborated on large-scale studies, supported by NHLBI, that compare trends, rates and risk factors for cardiopulmonary disease among 11,000 workers from Beijing and Guangzhou. The researchers found that serum cholesterol and triglyceride levels in Guangzhou workers increased during the course of the study, suggesting a deterioration in dietary and lifestyle habits that could raise the incidence of heart disease. Intervention studies are being carried out to assess the effect of reducing the workers' salt and fat intake, and additionally having them lose weight and quit smoking. In Germany, NHLBI has collaborated with German investigators to test the ability of a concerted intervention strategy to modify cardiovascular risk by promoting weight reduction and consumption of less salt and fat.

Other conditions are under study as well. The National Eye Institute has sponsored studies in India, Italy and the United States to identify possible nutritional and environmental risk factors and assess their importance in the development of age-related cataracts. Among the findings are that dietary consumption of vitamins C and E, and carotene, plus riboflavin, niacin, thiamine and iron are associated with a reduced risk of some types of cataracts.

The National Institute of Arthritis and Musculoskeletal and Skin Diseases continues to collaborate with Italian researchers in designing national epidemiological studies in Italy on osteoporosis. In a preliminary analysis of the data, deaths attributed to fractures were found to be significantly higher in the northern and central regions than in the southern part of the country. In another study in Peru, National Institute of Dental Research scientists found that infants who suffer malnutrition in their first year of life are extremely susceptible to decay in their first set of teeth.

The Public Health Service, USAID, and USDA are collectively preparing for the International Nutrition Congress to be held in 1992. Among the important preparatory activities was a conference in 1991 on micronutrient deficiencies, a particularly important problem in developing countries. U.S. agencies also participate actively in nutrition related work of agencies of the United Nations system, including the World Health Organization, United Nations Children's Fund and Food and Agriculture Organization. This participation includes assignment of personnel to those organizations, participation on their technical advisory bodies and conduct of studies. There is, for example, a new emphasis on iodine deficiency, the cause of goiter and cretinism in large population groups.

Alcohol and Drug Abuse

Alcohol and drug abuse continue to destroy hundreds of thousands of lives throughout the world, causing untold damage to society and economic development, and even threatening the political stability of some nations. In many countries, the costs to society in terms of premature death, lost worker productivity, injuries and violence, as well as increased health care and other infrastructure costs are sizeable.

Alcohol is the number one drug of abuse in the United States. Approximately 15 million Americans may suffer from alcohol abuse and alcoholism, and about 43 million Americans may be adversely affected as a result. Alcohol abuse is responsible for an estimated 100,000 deaths per year in the U.S., and the annual cost to the nation has been estimated to be in the range of $86-$113 billion. The consumption of alcoholic beverages and alcohol-related problems are increasing in many developing countries as well. In Nigeria, Zambia, Tanzania, Kenya, and many other African nations rapid urbanization and industrialization have resulted in changes in alcohol consumption patterns, and producing alcoholic beverages is often seen as economically attractive in the early stages of industrialization. In those regions now experiencing rapid cultural, social, and economic change (Africa, eastern and central Europe, and the former Soviet Union), increased stress is leading to higher alcohol consumption and misuse. At the same time traditional defenses against alcohol-related problems, such as cultural values and the influence of family and community, are being undermined by rapid social change. Furthermore, the existing health care systems in these areas do not have sufficient resources to handle this growing problem.

There are some positive signs. As evidence of the international community's growing recognition of the severity of the alcohol and drug abuse problem, many countries are now for the first time conceding that the problem represents a threat to their citizens. Alcohol and drug abuse are no longer strictly national problems but of international dimensions and importance. In recent months, for example, a growing number of nations have expressed keen interest in joining the U.S. in a systematic international approach focusing on scientific and public health cooperation on alcohol and drug abuse. In short, growing numbers of

nations are beginning to realize that alcohol and drug abuse are clearly medical as well as law-enforcement problems. India, for example, expressed interest for the first time in adopting a wide range of U.S. programs, including detoxification programs in jails and specific regimens for the treatment of drug addiction.

U.S. health agencies are forging close relationships within the international community to help find solutions to the alcohol and drug abuse problem that shows little signs of abating. Playing leading roles are the National Institute on Drug Abuse (NIDA) and the National Institute on Alcohol Abuse and Alcoholism (NIAAA). These two agencies are part of the Public Health Service and operate within the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA).

Of the scores of projects conducted by the two agencies, one of the most ambitious new programs to encourage international cooperation is the International Visiting Scientists and Technical Exchange Program (INVEST). Aimed at furthering collaboration within the international community of scientists engaged in drug-abuse research, INVEST was launched in October 1990 by NIDA and is comprised of four components: training, technical assistance, collaborative research and information exchange. The goal of the training component of the INVEST Program is to promote an international network of scientists who are familiar with NIDA's research and its methodologies.

Training opportunities are also available to foreign researchers through the post-doctoral INVEST Research Fellowship Program. Fellows are selected from the international community to study and conduct drug abuse research at universities or other institutions in the United States which receive NIDA research grants and contracts. In cooperation with the United States Information Service (USIS), NIDA also sponsors the post-doctoral NIDA Hubert H. Humphrey Research Fellowship Program. The NIDA fellowships differ from the traditional Humphrey Fellowships in that the training has research as well as a policy orientation, and applicants must possess a doctoral degree in either a health or social science field and have documented experience in conducting drug abuse research. To date, NIDA has sponsored Hubert H. Humphrey and INVEST Fellows from Mexico, Panama, Brazil, Hungary, Nigeria, Czechoslovakia, and Chile.

Other important mechanisms for exchanging scientific information and promoting international collaboration in the area of drug abuse research are binational and international conferences. Binational symposia with Israel and Spain have been held within the past two years. Currently, planning is under way for a U.S.-Mexico Binational Symposium which will focus on issues pertaining to drug abuse along the U.S. Mexico Border. In September 1991, NIDA sponsored a collaborative workshop on neurotransmitter and opioid receptors in New Delhi. In October 1991, a NIDA sponsored International Conference on Prevention Research was held in Lexington, Kentucky, the site of NIDA's Prevention Research Center. Scientists from the United States, Latin America, Europe, and Asia convened to discuss

methodology issues in conducting drug abuse prevention research and to identify areas of commonality which could lead to mutually productive collaborations among U.S. and foreign researchers.

At the end of FY-1991 the Department of State issued invitations to an international scientific conference, organized by NIDA and co-sponsored by State, aimed at broadening the base of knowledge about addiction's biological bases by foreign government science policy officials who influence research agendas in their countries. The conference, scheduled for early 1992, should help to enhance international scientific collaboration in this field.

NIDA has longstanding associations with a number of major international and regional organizations, including the Pan American Health Organization, the Organization of American States, and the Council of Europe, and also serves as a World Health Organization Collaborating Center for Drug Abuse. Joint projects undertaken with WHO include a large international study of the diagnosis and classification of mental and addictive disorders; an international meeting of experts which reviewed the question of AIDS and intravenous drug abuse; and a meeting of experts on cocaine abuse. Two new NIDA-WHO projects are being planned. These are a project to assist WHO in revising the existing WHO manuals on drug abuse epidemiology and a regional conference on drug abuse research in Eastern Europe to be held in late 1992.

NIDA has played a significant role in revising and improving the data collection system used by the United Nations to compile information on drug abuse from by its member nations. This resulted from a 1987 U.N. International Conference on Drug Abuse and Illicit Trafficking recommendation to develop internationally comparable data collection methods. The following year, at the meeting of the U.N. Commission on Narcotic Drugs, the U.S. delegation introduced and successfully promoted a resolution to establish an International Drug Abuse Assessment System (IDAAS) within the U.N. Division of Narcotic Drugs. IDAAS promises major improvements in the procedures and instruments that the U.N. uses to collect, analyze, and report data on the nature and extent of drug abuse and health related consequences in member states.

In tackling the problems of alcohol and drug abuse on an international level, U.S. agencies along with the cooperating governments and organizations are confronted with differing cultural-value systems that in some nations not only condone the use of drugs, especially alcohol, but encourage it. For example, the roots of drinking in Japan are long established in religious customs and beliefs. Japanese, in growing numbers, are now re-examining their approach to alcohol consumption. Indeed, these changing attitudes make Japan a productive environment for examining the relative contributions of genetic and environmental factors to alcohol-related problems. Japanese investigators are on the cutting edge of alcohol research. In several biomedical and pharmacological areas related to the different genetic forms of enzymes for the metabolism of alcohol, they have joined scientists from the United States in hypothesizing that the lower incidence of alcoholism among east Asians may be due to genetic enzyme activities.

Other U.S.-sponsored international programs are flourishing as well. For example, a three-year agreement between NIAAA and the All-Union Research Center on Medico-Biological Problems of Addiction in the Soviet Union was restructured to put added emphasis on social issues, epidemiology and prevention. To underscore the U.S. commitment to cooperation with the Soviets on addiction problems, NIAAA led a delegation of alcoholism researchers to the Soviet Union in late 1990 to help inaugurate the opening of a new narcology (addiction) headquarters building. In addition, a scientist exchange program established between NIAAA and the Soviet Addiction Center in mid-1990 continued this year with the arrival of a third Soviet scientist at the Scripps Clinic and Research Foundation in La Jolla, California.

Other ongoing activities involving NIAAA included the sponsoring of a didactic workshop on alcohol epidemiology for young researchers from Eastern Europe and the Soviet Union; the publication of a joint report with the Japanese National Institute on Alcoholism that examined drinking patterns and related behavior in Japanese and Japanese-American populations; and the continuation of work with WHO and the other ADAMHA institutes (NIDA and National Institutes of Mental Health [NIMH]) on a major program dealing with the diagnosis and classification of alcohol, drug and mental disorders.

WHO provided early support for the Collaborative Alcohol-Related Longitudinal Project, a wide-ranging study which is now primarily sponsored and funded by an NIAAA grant. In the project, scholars from several countries are collaborating on the secondary analysis of previously collected data examining the impact of age, sex, and other factors on drinking patterns. WHO in cooperation with, and support from, NIAAA, NIDA, and NIMH has also devoted considerable effort over the last few years to the development of psychiatric epidemiology diagnostic interview instruments for international use in both clinical and epidemiological research.

Reproductive Physiology and Population Research

As the world's population continues to soar well beyond the 5 billion mark, the Department of State's Coordinator for Population Affairs, serving in the OES Bureau (OES/CP), promotes U.S. international population policy in international fora. Intense research activities through applied research programs of three U.S. agencies, the Agency for International Development (USAID), Centers for Disease Control (CDC) and the National Institutes of Health (NIH), complement U.S. policy. These three agencies have participated in a wide range of bilateral and multilateral programs in scores of countries. At the forefront are cooperative efforts to broaden access to safe and effective means of family planning and to increase understanding of human reproduction and population growth.

One of the oldest and most durable of the reproductive physiology and population research projects, the Operations Research (OR) program funded by USAID,

continued to prosper in 1991. Founded in 1974, the OR program focuses on enabling non-medical personnel outside of clinical settings to provide family planning information to large segments of the population in developing countries who ordinarily have no access to such services. Currently, a major goal of the OR program is to facilitate efforts to solidify and streamline a variety of service delivery models in a number of developing countries. In 1991 the OR program made an especially significant impact on sub-Saharan Africa and on Latin American and Caribbean countries. An example is an OR project in the Ivory Coast in West Africa which made significant progress in reducing that country's alarming maternal mortality rate by providing family planning services for the first time at government maternity centers. In another African country, Rwanda, an OR project has enabled more than 17,000 community volunteers to provide family planning education to remote regions of the country.

In Latin America, scores of women in Peru took advantage for the first time of family planning services when they were offered to clients of a Lima social security hospital. And in the Caribbean country of Grenada, home visits aimed at providing family planning counseling and methods to post-partum women resulted in increased levels of contraceptive knowledge and use among the women visited.

During 1991, while continuing to offer family planning services to growing numbers of people in developing countries, USAID also maintained its considerable funding of biomedical research in contraceptive development and introduction. The Norplant R Subdermal implant was approved by the Food and Drug Administration and became the first truly new contraceptive method introduced in the United States in many years. USAID supported approximately half of the development work done by the Population Council, a U.S. non-governmental organization, on Norplant, including the U.S. clinical trials. Work continued on an improved Norplant R system called Norplant R II. Among USAID's other major related accomplishments are development of the tubal band for tubal occlusion in the sterilization of females; evaluation and introduction of progestin-only oral contraceptives for breast feeding women; and initial development of the vaginal sponge.

Despite the gains being made in contraceptive approaches, major challenges still remained in 1991. Nonetheless, in a March 15, 1991 report to the Senate Appropriations Committee, a USAID spokesperson concluded on a positive note as follows: "It took nearly 60 years in the United States for total fertility to drop from 6 to 3.5 children per woman, but that drop occurred between 1842 and 1900, long before any modern methods had been developed. Contrast this with the rapidity of an identical fertility decline in countries in which women were able to achieve desired smaller families by using modern methods. For example, the same decline in Sri Lanka took about 27 years (1952 to 1979) and in Colombia only 12 years."

Fiscal Year 1991 was especially productive for the Division of Reproductive Health of the Centers for Disease Control (DRH/CDC). Under the auspices of its Resources Support Services Agreement with USAID, nineteen DRH/CDC staff

members made 33 research and evaluation trips to 16 countries in the first half of the year alone. The number of USAID supported DRH/CDC projects initiated by the agency's Division of Reproductive Health in various corners of the world, including Africa, Asia, Latin America, and the Caribbean, has grown dramatically. Projects in Africa upgraded and installed computerized contraceptive-planning systems in Kenya and Zaire; taught government and university personnel in Mauritius how to conduct a contraceptive prevalence survey; undertook a survey of the contraceptive supply in Mozambique; worked with the Rwandan National Family Planning Program in reviewing and revising contraceptive commodity requirements; and worked with the Zimbabwe National Family Planning Council in determining necessary condom supplies to combat the growing HIV/AIDS threat. In Latin America and the Caribbean, DRH/CDC's Division of Reproductive Health provided technical assistance on a variety of family planning topics to governments and volunteer groups in Belize, Brazil, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti and Jamaica.

Also at the forefront of population research in 1991 was the Center for Population Research (CPR) of the National Institute of Child Health and Human Development (NICHD), a part of the National Institutes of Health. Among the projects funded by the NICHD in 1991 were a WHO collaborative study of neoplasia and steroid contraceptives in 13 countries, a study of the rapid fertility decline in Taiwan and reproductive research activities with the Indian Council of Medical Research which included an innovative workshop held in India entitled "In-Vitro Systems for Measurement of Reproductive Hormones for Reproduction Research." Other projects included a genetic-analysis study by an investigator at Toronto's Mount Sinai Hospital that is providing a powerful new approach to genetic analysis of development; and a study of the impact of familial behavior and the local availability of maternal and child-health services on the health and survivability of children in Guatemala during the 1980s.

While gains in reproductive physiology and population research in 1991 were many, the rapidly growing world population has sparked increasing concern about environmental degradation, sustainable economic growth and regional stability in the decades ahead. Continued efforts to expand the knowledge of reproductive physiology and introduce more effective family planning methods will remain high priority areas for USG and international research programs.

New Drug Development from Natural Products

Tropical and temperate forests contain numerous diverse plant and animal species that are playing an increasingly significant role in the discovery and development of new drugs. New treatments may become available from such natural sources for a number of diseases such as AIDS, cancer, malaria, parasitic infections and diarrheal disorders. The progress made in developing new drugs from these natural sources has generated considerable interest on the part of the scientific community. In particular, the effectiveness of taxol (from the bark of the Pacific yew tree) in treating patients with ovarian cancer has sparked much recent enthusiasm.

There is an increased effort by the National Cancer Institute (NCI) to identify and collect natural products from more than 30 nations as sources of new drugs. Previously, these naturally occurring substances were little used medicinally outside of the developing world. Typically, many traditional compounds now under investigation were for centuries part of the pharmacopeia of indigenous tribal peoples. The eventual goal is to use and/or adapt these same compounds to treat, control and possibly cure diseases of both industrialized and developing nations.

Many tropical plants are threatened with extinction due to destruction of tropical forests in the developing countries. In response, workers engaged in several National Institutes of Health (NIH) programs are working vigorously to ensure that the potential knowledge and benefits that may be derived from natural product resources do not vanish forever. NCI is working with USAID, NSF and the United States Department of Agriculture (USDA) to strengthen the capabilities of institutions that catalog and monitor biological diversity in developing countries, develop inventories of native species and indigenous knowledge of them, encourage training in biodiversity activities and address the priority health needs of developing countries rich in biological diversity. In addition, NIH and NSF are working to establish a new program for the development of drugs from natural sources from around the world.

In its attempt to preserve these resources for drug research, NCI has stepped up its effort to collect, preserve and study a wide range of biological materials. The Frederick Cancer Research and Development Center has funded research and categorization activities, and visits by scientists from many of the developing countries where natural compounds are gathered. Many of the plant samples and marine macro-organisms collected are kept in cold storage at NCI's Natural Products Repository at Frederick, Maryland. In a typical research project there, extracts from raw materials are tested in vitro (in test tubes) for their effectiveness against human cancer cell lines. Similar tests to detect agents active against human immunodeficiency virus (HIV) are also being performed.

A database of natural as well as synthetic compounds is kept by the National Institute of Allergy and Infectious Diseases (NIAID). There are over 3,000 compounds in the database, more than 200 of which are natural and some of which have been tested in vitro against the HIV virus. The results have been reported in the medical literature.

Another NIH institute involved in natural substance research, the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), is continuing work on a poison secreted by a genus of frogs found in Central and South America that appears to have analgesic properties that could be more powerful than those of morphine. Studies are now underway to determine if the substance is as addictive as morphine.

In securing materials for screening, NCI has forged agreements with a number of other independent agencies and universities that are also gathering plants and marine organisms for evaluation. For example, NCI has awarded plant-gathering contracts totaling nearly $4 million to the Missouri Botanical Garden for work in Latin America; and to the University of Illinois at Chicago, Harvard University's Arnold Arboretum and the Bishop Museum in Honolulu for work in Southeast Asia. NCI has also launched collaborative studies with China's Kunming Institute of Botany for the study of Chinese medicinal plants; with the Seoul National University for the study of Korean medicinal plants; with the Smithsonian Oceanographic Sorting Center for the collection of Philippine marine organisms; and with Tel Aviv University for the study of Red Sea marine invertebrates.

NCI is exploring creative and innovative approaches to utilizing some portion of the profits generated by the sale of drugs developed from research on natural products to support continued research by host country institutions. This distribution of profits, which will be accomplished through a series of formal agreements, could serve as an effective means of utilizing market-driven monetary incentives to promote local institutional capabilities and develop an advocacy for conserving biological diversity.

As NIH's work in this area has intensified, cooperation with many of the nations of the developing world has grown as well. From Cameroon's Institute for Medical Research and Studies of Medical Plants to Peru's Instituto de Investigaciones de la Amazonia Peruana, scientists are beginning to realize that the answers to managing and possibly controlling many of the diseases plaguing their countries may be "right in their own back yards," and intimately related to preserving biological diversity.

ENERGY, ENVIRONMENT AND ECONOMICS

Introduction

Recognition of the complex relationships among energy, the environment and economics is an essential step in devising workable solutions for many environmental problems. Environmental issues have increased in international visibility, and efforts to address them have become a high priority for many governments. This section discusses the nature of the relationship among energy, the environment and economics and its amenability to international cooperation. As an item of particular interest during FY-1991, this section also briefly describes international cooperation on environmental aspects of the Persian Gulf War.

Energy investments can impose heavy environmental, economic and social costs if they are not chosen wisely. Market factors and poorly conceived economic policies can and do compound deleterious impacts of energy use on environmental quality. For example, fossil fuel market prices frequently do not fully reflect the total costs, including environmental costs, of using those energy sources. Energy subsidies further complicate the problem, leading to wasteful use of energy resources and technology choices which are less than optimal from both environmental and economic perspectives.

While energy production and use are linked to air pollution, acid precipitation and other forms of environmental degradation (e.g., oil spills) and possibly to global climate change, they are nonetheless crucial to the economic vitality of the U.S. and other nations, for development, and for maintaining and improving the quality of life of people in developing and developed countries alike.

Many environmental issues are transnational and even global in nature, thus international cooperation is essential. Through international cooperation, intellectual and other resources can be more efficiently employed to deepen comprehension about pertinent relationships, acquire better knowledge to reduce the scientific uncertainties about, for example, global climate change, and devise considered measures for progress.

Economic Growth, Energy and the Environment

Environmental Effects of Energy Sources

Virtually all forms of energy production and consumption (in both developed and developing countries) impact on the environment in some way. However, the effects and magnitude can vary dramatically.

Fossil fuels have been the dominant energy source since the dawn of the industrial revolution and are likely to retain the number one ranking for the foreseeable future. Fossil fuels account for upwards of two-thirds of world energy consumption

in the proportions of about 23% for coal, 29% for oil and 15% for natural gas. The environmental effects of fossil fuel utilization are more obvious in some instances than others. Oil spills and problems of strip mining are two obvious externalities of fossil fuel production. The largely carbon monoxide, nitrous oxide and sulfur dioxide air pollution which afflicts specific areas of the Earth can be linked directly to automobiles and other fossil fuel combustors. Recently the problem has become more pronounced in some developing countries. Combustion of fossil fuels also contributes to acid precipitation and possibly to global climate change. However, precise analyses have yet to be performed to define adequately a comprehensive resolution of some of these issues. Nonetheless, these environmental issues have become topics of global concern.

Nuclear powered electricity generation has increased and now represents approximately 5% of world energy production. There are currently some 426 nuclear power station reactors in service worldwide with over 318,000 megawatts of electric generating capacity. In some countries, such as France, nuclear power is the dominant form of electric power generation (74.6%), and it has a significant share in other major industrial countries such as Germany (29%), Japan (27.8%) and the U.S. (19.1%).

Properly operating nuclear power plants do not emit gases and particulates that may contribute to the possibility of global climate change, acid precipitation or a general decline in air quality. Nuclear power does have some environmental and health drawbacks associated with the radioactive and toxic aspects of the nuclear fuel cycle -- the mining, enrichment, milling, transportation and use of radioactive materials, and storage and disposal of spent nuclear fuel. In addition, while extremely rare, nuclear power reactor accidents such as the one at Chernobyl can contaminate large amounts of land, food, and water, with related health impacts and dislocation of inhabitants.

Hydroelectric power accounts for approximately 20% of the world's energy production. Hydroelectricity is a relatively low current-cost energy source once it is operating, but hydroelectric facilities entail high initial costs for their development and construction. Smaller mini- and micro-hydropower plants are now being used in developing countries to provide power where it is needed but in an environmentally sustainable manner. As with all sources of energy production, there are advantages and disadvantages associated with the development and operation of hydroelectric power. Advantages include the fact that no fuels are burned and hence no potentially dangerous emissions are released. Hydroelectricity has the advantage of using a renewable non-polluting resource. Dams with hydroelectric power plants also are often designed for multiple purposes, for example, flood control, navigation, water supply for municipal, industrial and agricultural users, recreation opportunities, and greater regulation of stream flow to provide for improved water quality and fish habitat.

Disadvantages caused by dam construction and resultant impoundments can include inundation of existing ecosystems and human settlements, changes in the natural flow and sediment regime of the watercourse and, if the impoundment is large, local climate changes. Dams may change water level and natural water flow as well as become a physical obstacle to migration. These changes could have serious impacts on species reproduction and survival. Egypt's High Aswan Dam, while successful in expanding energy supplies and mitigating disastrous annual flooding, has also caused some serious environmental problems such as erosion of the Nile Delta, proliferation of waterborne pests and diseases and disruption of natural well systems.

Other energy sources include solar, wind, geothermal and wave/tidal power. These sources represent only a small portion of total world energy supply, but they are especially relevant in developing countries, where environmentally sustainable alternatives to fossil fuels are economically urgent. While these sources do not amount to a large proportion of total world energy production and are mainly concentrated in electricity generation, they have become more important in recent years and some are dominant in certain areas.

Solar energy, while environmentally benign, is still not a significant source of energy supply. The Earth receives solar radiant energy at the rate of 1,300 watts per square meter. However, natural phenomena and technological limitations such as inefficient solar to electrical conversion rates, as well as high production costs for solar facilities, reduce the amount that can be converted to useable energy to only a tiny fraction of this figure. Solar electric energy (photovoltaics) has proven to be cost effective in remote areas (in both the U.S. and developing countries) where the extension of power lines is not technically or economically practical. Solar thermal energy has proven effective as a means to reduce the cost of space heating, hot water and thermal energy for commercial processes.

Recent commercial breakthroughs in large wind turbines make it possible to generate electricity from winds of variable speeds, thus opening up the potential for grid access. As have photovoltaics, smaller wind turbines have proven to be cost effective in remote areas where the extension of power lines is not technically or economically practical.

Geothermal energy, the Earth's natural heat, is being tapped as a commercial source of energy in parts of the U.S., Japan, New Zealand, and Europe where geologic conditions have resulted in exploitable subterranean steam deposits. Although the total amount of thermal energy locked up in the Earth's crust is enormous, tapping into it with current technology is difficult and expensive. Geothermal energy production has few serious environmental consequences, although hot geothermal water can contain large amounts of corrosive chemicals.

A Special Problem for Developing Countries

While scientists may (and should) continue to debate the meaning and implications of "sustainable development," political realities dictate that governments must pursue policies that promote economic growth. This is particularly true in developing countries where populations are both young and increasing at very rapid rates. Even in the most developed countries where living standards are very high by world standards and environmental quality is an important political issue, there is little political support for parties espousing "no-growth" policies.

Developed economies are high per-capita energy consumers. Likewise, raising living standards in developing countries will require large increases in their levels of energy production and use (although not necessarily to levels currently prevailing in the West). Annual per capita energy consumption in oil-equivalent ranges from 2,860 liters in Japan to 6,520 liters in the United States. By contrast, the figure for India is approximately 200 liters. India's per capita electric power generation is about 300 Kwh per year, versus 12,000 Kwh per year in the U.S.

Developing economies are caught in a "triple bind" of capital resource constraint, weak institutional performance and environmental degradation. Developing countries are finding that "business as usual" energy sector development strategies no longer generate the capital resources necessary to provide adequate electric power for development and sustained growth. This capital crisis is attributed to the financial performance of many developing countries' utilities, hampered by factors including poor planning practices, accounting, billing, operations and maintenance.

Increasing concern over environmental degradation is adding to the worsening capital problem. Energy activities are the most significant contributors to gas and particulate emissions that may affect climate change, and contribute to acid precipitation as well as a general decline in air quality, particularly in urban areas. Increased contributions of such emissions from developing countries will accompany the rapid development of their power sectors. Adding new equipment in order to address these environmental concerns will cause an increase in the initial capital cost of new power plants as well as the cost to recondition or retrofit existing aging power plants.

Fertile Ground for International Cooperation

Energy, environment and economic issues are intrinsically transnational in nature and an especially pertinent area for international cooperation, including science and technology cooperation, to the benefit of humankind. Much energy-related environmental degradation crosses borders. For example, acid precipitation has become an issue between source and recipient nations, e.g., Canada and the United States, each of which is both a source and recipient. On March 11, 1991 the United States and Canada signed the U.S.-Canada Air Quality Agreement, removing a major irritant to bilateral relations.

Still other energy-related environmental impacts affect large areas of the Earth for which responsibility is shared among nations. Examples of such problems are oil spills on the high seas and in polar regions.

As reflected in the country narratives in Chapter 3, many countries have yet to grasp the complexity and totality of the relationships among energy, the environment and economics. Countries' approaches tend to be oriented toward environmental protection and cleanup and/or energy production and/or economic development, but rarely to all as an interrelated whole. Nonetheless, FY-1991 saw movement toward greater international comprehension of the interrelationships and toward pertinent international cooperation.

In the United States, energy, environment and economic issues are a central focus of the Administration's National Energy Strategy (NES). The NES lays a foundation for a more efficient, less vulnerable, and environmentally sustainable energy future. It defines international, commercial, regulatory, and technological policy tools that will substantially diversify U.S. sources of energy supplies and offer more flexibility and efficiency in the way energy is transformed and used. The NES contains specific initiatives to:

- achieve greater energy security;
- increase energy and economic efficiency;
- secure future energy supplies;
- enhance environmental quality; and
- fortify the foundations of research and development, technology transfer and human resource development.

The United States recognizes that economics and economic research play an integral role in our ability to understand global change processes and evaluate critical national and international policy issues. The United States, as part of the U.S. Global Change Research Program, has planned a government-wide economics research program relating to global change, focusing on economic forces affecting or affected by global environmental decisionmaking under conditions of uncertainty, technological forces and policy, and evaluation of policy instruments. This effort has both a national and international focus, with special emphasis on developing countries and economies in transition. Links with other international economic research programs are being established and expanded.

Energy and environment issues are to be a major topic of the United Nations Conference on Environment and Development (UNCED), scheduled to take place in Brazil in June 1992. During FY-1991, there were a range of activities and two large international preparatory conferences leading up to this Conference. The nature of UNCED obliges the participant countries to expand the degree to which they take cognizance of environment and development together. Although UNCED itself will not result in a legally binding international

agreement and direct energy and environment consequences, the preparatory negotiations and activities during FY-1991 pointed to the possibility of significant conceptual and political breakthroughs at the conference on, for example, an agreed definition for environmentally benign "sustainable development."

Certain international agreements, now being negotiated, may be signed during UNCED. Most applicable is the work of an Intergovernmental Negotiating Committee for a Framework Convention on Climate Change, established in 1990 by the U.N. General Assembly. Although many details remain to be negotiated, the convention is expected to create a process by which parties adopt environment and energy measures that address in a comprehensive way sources and sinks of greenhouse gases.

Under World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) auspices, the Intergovernmental Panel on Climate Change (IPCC) worked during FY-1991 to prepare an update of its 1990 report on the science and impacts of climate change and potential response strategies. Among the topics being addressed in this supplement, which was expected to be completed by June of 1992, are issues concerning energy and industry. The IPCC is assessing existing energy-efficient technologies, and is conducting country-specific technology use studies as well as thematic studies to identify differences between actual and potential uses of energy-efficient technologies.

Other international science and technology cooperation relevant to energy, the environment and economics generally falls into two categories: accumulation of data to determine whether or not energy production and consumption may be damaging the environment; and technical efforts to reduce the environmental impact of energy use, including the development and dissemination of energy technologies that are more environmentally benign to countries lacking these technologies.

Bilateral S&T Activities

The U.S. is cooperating with other countries on a bilateral basis in two general areas:

- Development, adaptation and technology cooperation toward efficient use of less polluting energy sources, and

- Assistance and training in the policy and planning areas, particularly toward rationalizing energy pricing, tax and incentive policies and choosing economically and environmentally sound energy investments.

A number of bilateral activities are being undertaken to assess energy use and impacts as well. For example, EPA, in conjunction with DOE's Lawrence Berkeley Laboratory, is working with Brazil, Mexico, Venezuela, Nigeria, India, Indonesia, Thailand, China, and Malaysia to examine energy use in these countries, develop policy options to increase energy efficiency, and estimate the cost of these different

options. In Brazil, EPA is working with the Brazilian national utility, Electrobras, to study the potential for increasing energy efficiency in the electricity end use sector. EPA is also working with both China and Poland to examine means of reducing methane emissions from coal mines. With China, India and the Philippines, EPA is cosponsoring a program to develop a more reliable estimate of emissions from the small cookstoves and woodstoves used for cooking in most of the world's households.

The Department of Energy (DOE) and the Agency for International Development (USAID) are also active. With China, eastern and central European countries and a number of other developing countries, DOE is developing an energy use model in the transportation and industrial sectors in order to assess long-term energy demands. USAID is conducting a project with Morocco that undertakes energy audits of major industrial energy users, prepares feasibility studies of potential investments to improve efficiency of energy use by these users, and finances applications of proven technologies in selected firms.

A number of Federal agencies are undertaking cooperative efforts with other countries to pursue less polluting conventional energy systems. There are DOE agreements (see Appendix) that deal with research into ways to make the burning of fossil fuels more environmentally benign. DOE also has agreements with other nations to develop new sources of energy. Prominent among them is the International Thermonuclear Experimental Reactor (ITER) project with Japan, the Soviet Union, and the European Community for the development of a nuclear fusion reactor. The heavy hydrogen (deuterium) fuel for such a reactor is potentially cheap and plentiful, there would be far less radioactive wastes than produced by a fission reactor, and no emission of greenhouse gases. Realization of economically viable energy from fusion, though still far in the future, would be a major step forward in accommodating concerns.

The Department of Energy and the Nuclear Regulatory Commission also have numerous agreements with other nations aimed at improving the safety of nuclear fission reactors and finding solutions to the problem of radioactive wastes.

Technological improvements in energy-use efficiency, and the transfer of these improved technologies to other countries, are also important objectives. Basic research in generic technologies has a role in both the search for clean and economical sources of energy and utilizing energy efficiently. USAID, for example, is supporting with India a Program to Accelerate Commercial Energy Research (PACER), which supports the commercial development of innovative energy technologies. Again with India, USAID is undertaking the Energy Management Consultation and Training (EMCAT) project, which is designed to introduce technology, financing, and management innovation in the Indian power supply and end use sectors, to permit enhanced productivity, improved delivery of energy services and reduced environmental impacts.

USAID is also supporting a Regional Energy Efficiency Project for eastern Europe, which supports the development of policy and institutional frameworks for energy investments and east-west energy trade. Also in eastern Europe, USAID is providing assistance to Hungary with regard to energy supply and end uses, including the promotion of energy price reform.

The Interior Department cooperated with national agencies in Poland and Yugoslavia to characterize coal deposits by studies designed, through content identification, to determine the coal's economic usefulness and its potential impact on the environment. Such information will allow leaders to make better informed decisions on the use of such energy resources in relation to potential environmental degradation.

USAID is working with Egypt both to strengthen Egypt's capacity to collect and analyze data needed for energy policy planning, and to conduct field tests of renewable energy technologies and promote their use in a variety of agricultural, food processing and village energy applications. With USAID funding support and technical assistance from the Interior Department's Bureau of Reclamation, the U.S. private sector is providing the necessary technology and equipment to the Egyptian Electricity Authority to rehabilitate and modernize the High Aswan Dam complex to increase energy production from the existing power plant.

USAID's Energy Training Program (ETP) offers training for qualified energy professionals in oil, coal, gas, electricity generation, hydropower, energy planning, energy management, mining safety, resource analysis and utilization, environmental management and monitoring, conservation and renewable energy technologies.

USAID is collaborating with the U.S. Environmental Protection Agency, the Department of Energy and the Department of Commerce to establish a Technology Transfer Clearinghouse on environmental technology. Initially, the Clearinghouse will be an on-line computer-based service. The first test of the Clearinghouse will be with Mexico.

Assistance in technical innovation is only a part of the picture. USAID also considers as significant developing countries' abilities in energy planning, and assessment of the economic implications of energy use. Energy planning methodologies, variously called integrated resource planning or least-cost planning, as well as the rationalization of energy pricing, are included in USAID programs ranging from feasibility studies and technical assistance to professional workshops and training seminars.

The Department of Energy is leading an active multi-agency program, the Committee on Renewable Energy Commerce and Trade (CORECT), to promote technology transfer of renewable energy technologies. DOE has also initiated a program to spur the export of more efficient coal technologies to developing countries and promotes, in cooperation with other agencies, export of U.S. energy technologies and services. DOE is also working with Poland to retrofit existing coal-powered plants with technologies to reduce their impacts on the environment.

EPA is also cooperating in a number of projects in this area. With Mexico and India, it is assessing the potential of renewable energy to reduce carbon emissions by displacing conventional fuels. These two countries are of particular importance because of their growing energy demand, availability of indigenous fossil fuel resources, and demonstrated interest in renewable energy.

The use of biomass as a renewable energy source is being promoted in a number of countries. In conjunction with China, DOE is undertaking a project to determine the feasibility of an integrated biomass energy system to supply energy, reduce deforestation, and reduce net emissions of greenhouse gases. USAID is supporting research in India on woody biomass by providing training, technical advisory services and specialized research equipment. In a number of other developing countries, USAID is promoting investments in commercially-proven technologies to recover energy as a byproduct from disposal of crop, wood and municipal solid wastes. Funds for this project are devoted to applied research, analysis of proposed investments, implementation of investments, and analysis of local policies likely to affect the success of these investments.

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International Cooperation on Environmental Aspects of the Persian Gulf War

The aftermath of the January-February, 1991, Persian Gulf war, particularly the deliberate destruction of Kuwaiti oil facilities by Iraqi occupation forces, left a very serious regional environmental situation that required a major multilateral response from the international community. Large amounts of crude oil had been released into the Gulf threatening not only its wildlife and fragile ecosystem, but also the water supplies of states in the region which obtain their water from desalination plants. In addition, over six hundred Kuwaiti oil wells were set afire, spreading a thick blanket of smoke and soot over the region and raising fears over effects on the health of the region's inhabitants.

With State Department coordination, the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA) took the lead within the USG in dealing with the situation. NOAA, in cooperation with the National Science Foundation and other agencies, including DOE and EPA, and with the international community, played a major role in the World Meteorological Organization (WMO)'s monitoring plan for tracking the smoke plume and modelling its potential health consequences. U.S. agency studies of the oil fire plumes were structured to help understand and predict environmental and health consequences of the plumes in the Persian Gulf area.

NOAA worked with the Kuwaiti and Saudi governments and meteorologists, and installed an array of solar-powered meteorological towers to provide data to help predict episodes of high pollution and to track the recovery of the atmosphere as the oil fires were extinguished. Shortly after the fires were set, EPA sent an emergency response team to the region to assess possible acute health risks from the fires and worked with regional governments on air monitoring.

A major success was achieved by the international effort, in which U.S. companies were key, to extinguish the burning oil wells. While many experts feared that extinguishing all of the fires could take as long as three years, the task was actually completed in less than nine months.

As part of the UN Intergovernmental Oceanographic Commission's (IOC) program of investigation of the marine environmental impacts of the oil spills, plans were made to deploy NOAA's research vessel, the Mt. Mitchell, to the Persian Gulf in January 1992 to conduct scientific studies of the region's oceanography and ecosystems over an approximately 100-day period. The research will be performed principally by scientists from the region, with some expert assistance from the U.S. government, the international scientific community and private sectors.

EMERGING TECHNOLOGIES

Introduction

Global scientific research and development activities are generating powerful new technologies useful in a wide range of products and processes in different industrial sectors and likely to provide the foundation for the next generation of technological innovations. These emerging technologies, if effectively deployed by U.S. firms, can play a major role in strengthening our economic competitiveness, improving the quality and length of life of our citizens, and maintaining our nation's pre-eminent position in the international system.

It must be emphasized that, however important, developing technology prowess alone cannot ensure economic prosperity and national security. New technologies can make important contributions only if U.S. industry learns to utilize them effectively in the development of innovative, high quality, cost-competitive products. The technologies themselves will continue to evolve, probably quite rapidly, and the commercial relevance and opportunities they present will change rapidly as well. U.S. industry must be prepared to meet the pace of technological advance, and the Government should support a policy framework which encourages firms to capitalize on the benefits of emerging technologies in all industrial sectors (e.g., the Research and Experimentation tax credit).

One way in which the United States is seeking to exploit its existing technological base is in cooperation with other countries. The following narrative briefly describes six sample technology areas, and gives illustrations of pertinent U.S. Government collaborations with selected countries. More detailed country discussions can be found in the individual country narratives in Chapter Three, which also describe significant host country developments, activities and accomplishments.

Materials

The development, synthesizing and processing of new types of materials has revolutionized products in a wide range of industries. New electronic and photonic materials have made it possible to build computers and communications systems that are both more powerful and more reliable than their predecessors. Developments in ceramics research hold out the promise of important new products ranging from lighter and more durable engine parts to high temperature superconductors. Composites and high-performance metals and alloys are gaining increasing importance in the aerospace industry and hold the key to aircraft of the future such as the proposed hypersonic transport.

Several cooperative efforts in the materials area took place between the United States and its global partners in 1991. For example, in Yugoslavia, a joint project between the Commerce Department's National Institute for Science and Technology (NIST) and the Jozef Stefan Institute was undertaken which will deepen the

understanding of rare earth doped titanate ceramics. It will also devise proper ceramic fabrication technology which will result in controlled densification and optimal microstructure. In India, collaborative studies between the Naval Research Laboratory (NRL) and various Indian laboratories have led to the development of several new products including synthesis of a new quasi-crystal phase, and the characterization of several friction-reducing carbide and nitride films. Indian scientists also collaborated with NRL on the development of advanced high strength ferrous alloys.

Based upon an independent evaluation and decisions of its eight-nation Steering Committee in 1991, a five-year renewal is underway of the Versailles Project on Advanced Materials and Standards (VAMAS). This cooperative program was initiated in 1987 following the Versailles Summit by the Group of Seven Countries and the Commission of the European Communities. VAMAS works through international cooperation on standards research and harmonization toward accelerating the introduction of advanced materials into manufactured high technology structures and products. In the U.S., the National Institute of Standards and Technology coordinates this research under the guidance of OSTP.

Manufacturing

New manufacturing processes and technologies are enabling industry to bring a stream of innovative, cost-competitive, high-quality products into the marketplace. The growing importance of flexible, computer integrated "intelligent" manufacturing and processing equipment has been reflected in a wide range of industries from electronics to automobiles. Micro and nano-fabrication technologies now under development have great potential for spurring advances in both the electronics and medical fields.

U.S. companies and the U.S. Government were both active in this area during FY-1991. For example, recognizing the need to encourage U.S. industry to monitor Japanese technology, Commerce's Under Secretary for Technology led a group of industry leaders on a study mission to investigate Japanese manufacturing technologies in September, 1991. The mission visited nine manufacturing facilities in Japan and met with officials of the Ministry of International Trade and Industry (MITI), the Science and Technology Administration (STA), and a number of private organizations with industrial interests. Topics such as strategic planning, technology integration, and industrial philosophy were discussed.

Both Japanese government agencies and private companies actively continued to initiate new cooperative arrangements with the United States and other technology leaders. The U.S. government, led by OSTP and the Commerce Department's Technology Administration, successfully positioned these initiatives under the auspices of the umbrella U.S.-Japan S&T Agreement, thereby enabling the United States to seek equitable benefits for all potential participants in Japanese industrial technology project proposals.

Possibly the most important initiative, and the one in which discussions with the Japanese government have progressed the farthest, is on Intelligent Manufacturing Systems (IMS), a high visibility initiative with global implications for manufacturing technologies, and a potential model for international collaboration in other areas. The Department of Commerce drafted terms of reference for a feasibility study to determine the ways, means and technical areas for a possible collaborative IMS program. The terms of reference have been accepted by Japan as well as the other participants, Canada, Australia, the EC and the European Free Trade Association. The first International Steering and Technical Committee meetings, which will constitute the formal start of the feasibility study, were scheduled for early 1992.

Japan also opened to foreign participation a ten-year project to develop technology for high-performance micromachines for such applications as medical diagnosis and sensors. In response, at the October 1991 Joint High Level Committee talks held under the auspices of the U.S.-Japan Science and Technology Agreement, OSTP Director Dr. Bromley raised this project as one that would require dialogue to ensure the establishment of an equitable and mutually agreed framework for implementation.

The National Institute of Standards and Technology (NIST) and the European Strategic Programme on Research and Development of Information Technology (ESPRIT) sponsored two international workshops on collaboration for manufacturing technologies. The purpose of these workshops was to bring together projects in Europe and America that have common interests in information technology applied to manufacturing research in its precompetitive and prenormative, i.e., prior to standardization, phase. By the end of the second workshop last August, numerous such projects had been identified and a number of collaborations were forming over a wide range of computer-integrated manufacturing areas. The common theme is the use of computing and information technology to improve quality and productivity in manufacturing.

Information and Communications

New information and communication technologies have continued to evolve at a breathtaking pace, permanently changing our approaches to communication, education, and manufacturing. In this area, microelectronics and optoelectronics advances have made it possible to increase the power of computers vastly while greatly decreasing both their size and cost. High-performance computing and networking, as well as computer simulations and modeling, have allowed scientists and engineers to work together to tackle computational problems ranging from designing safer automobiles to studying the evolution of the cosmos through modeling that was previously considered far too complicated even to attempt. Work around the world on high-definition imaging and displays is focusing on developing high definition television (HDTV) systems with the potential not only to revolutionize consumer electronics, but to have important medical and industrial applications as well. Other important areas in this category are sensors, signal processing, data storage and peripherals. Such new hardware will be only as

good as the software that controls it, and maintaining the flow of increasingly complex software will continue to be an important task.

During FY-1991, the U.S. government held discussions with Japanese officials concerning another project sponsored by Japan's Ministry of International Trade and Industry, the New Information Processing Technologies (NIPT) initiative, informally referred to as the Sixth Generation Computer Project and recently renamed Real World Computing. In response to the Japanese initiative, the United States and Japan plan to undertake a feasibility study on cooperation on optoelectronics technologies for advanced computing research.

In the framework of the U.S.-EC Joint Consultative Group, cooperation was initiated on standards in information technologies including networking and infrastructures, systems engineering, opto-electronics, databases and high performance computing, and other cooperative work was identified.

In the Middle East, the U.S.-Israel Binational Industrial Research and Development (BIRD) Foundation supported joint projects between U.S. and Israeli companies for industrial R&D leading to the introduction of new products and processes into the marketplace. Total funding of $13.7 million was allocated during FY-1991, about half of which was targeted for computer software and communications technologies.

Biotechnology and Life Sciences

Biotechnology and life science advances will permit new approaches to major problems in such diverse fields as medicine, agriculture, manufacturing and the environment. A particularly exciting field in this area is applied molecular biology, which has allowed scientists to engineer new organisms for uses as diverse as increasing food production and cleaning up oil spills. Probably the greatest breakthroughs in biotechnology have been in medical technology where discoveries hold out promise for new treatments for such deadly diseases as cancer, cystic fibrosis and muscular dystrophy.

U.S. Government agencies and private sector entities have both been active in international cooperative activities in the life sciences. For example, the U.S./EC task force on biotechnology research recently convened its second meeting to review activities in this area, including promoting public acceptance of biotechnology products. In the OECD, the Science and Technology Policy Committee has an active program seeking improved international collaboration on biotechnology issues.

The Human Genome project is a major collaborative effort in biotechnology that involves a number of countries, including the United States, in an effort to produce functional maps of human chromosomes, and determine the complete chemical sequence of human DNA, the substance that makes up genes.

The Basic Science narrative earlier in this report includes additional material on biotechnology and the Human Genome Project.

Transportation

In the area of surface transportation, the United States cooperated in research efforts with several countries on new high speed rail systems. In a joint venture with France, the United States will receive information on the design of the TGV (Train a Grande Vitesse) train to enable the United States to approve its installation in a project in Orlando, Florida. The U.S. and Germany have an agreement which provides for U.S. observation and examination of Germany's certification of its Transrapid magnetic levitation technology, to enable the U.S. to approve its installation in a project in Orlando, Florida. Japan is proceeding with the further development and deployment of its superconducting magnetic levitation train technology for service around the end of the decade. The U.S. is reactivating a program of technical information exchange with Japan in this field. The U.S. is also involved in experiments integrating use of a unique testing facility in Poland with special stress measurement techniques to assess how much residual stress can be put into a rail by certain manufacturing processes or by the action of railroad cars. (Residual stress is a high risk factor for rail failures and derailments).

Research and cooperation in Intelligent Vehicle/Highway Systems continued in several countries. The Federal Highway Administration (FHWA) conducted a "Round Table" meeting that brought German government and private sector officials together with U.S. counterparts to discuss roadway investment opportunities in the newly unified country. The FHWA also negotiated cooperative agreements with Japan, Sweden and the World Bank that are designed to provide the basis for sharing technical road information.

Energy and Environment

As suggested also in the discussion of Energy, Environment and Economics earlier in this report, new energy and environmental technologies are those which have the potential to provide safe, secure and enduring sources of energy, ensuring that a healthy environment is preserved for future generations. Important new energy technologies may allow greater exploitation in the near future of solar power, fuel cells and improved nuclear fission reactors. During FY-1991, intense international research efforts also continued on nuclear fusion, which may become a commercially viable source of energy sometime in the next century.

In the environmental area, research addressed the development of technologies applicable to pollution minimization and remediation, as well as waste management. In the area of technical cooperation related to global climate change alone there were over 115 individual projects, totalling over $140 million in FY 1991. The projects are bilateral and multilateral in nature and cover energy efficiency and supply, agriculture, climate science, coastal zone resources and a variety of related energy and environmental problems.

Conclusion

International cooperation in emerging technology fields is increasing and is often seen as essential to long-term economic competitiveness. Because international R&D collaboration provides an opportunity to improve access to, and utilize, foreign technologies and technical information, such collaboration can build upon and improve a country's technological base. This can contribute to enhanced economic performance, national security and public welfare.

Because advanced R&D is growing exponentially in cost while product life cycles continue to shorten, even the largest multinational firms recognize they can not be technologically self-sufficient in every area. As a result, more companies and countries perceive that R&D collaboration, if equitably structured, can benefit all participants by pooling resources to reach long-term goals and speed the development of new technology. Traditionally, the U.S. government has taken the lead in dismantling international barriers to trade and investment, and this has facilitated the collaboration of U.S. based firms with overseas partners in the development of new technologies. The U.S. is also a leader in championing intellectual property rights which, by protecting the interests of innovators, spurs the development of new technologies. More recently, the U.S. is breaking new ground in developing mechanisms, as with the IMS initiative, which will provide equitable access for U.S. private entities.

Commercialization of technologies for civilian use is best accomplished by dynamic private sector firms operating in a competitive market. The Government can assist by pursuing regulatory policies that are conducive to innovation, investment, and risk taking. The United States continues to be a world leader in the development of new technologies and remains a fertile ground for start-up firms.

AGRICULTURE AND NATURAL RESOURCES

Introduction

The advantages of global science and technology interaction on agriculture, natural resources and earth sciences are now well recognized for reasons similar to those underlying basic science cooperation -- utilization of foreign expertise and assets, access to specialized sites and resources, etc. Although the Department of State has lead responsibility for the conduct of U.S. foreign relations, other USG departments and agencies work extensively with foreign countries to provide assistance in areas of expertise.

The Department of Agriculture (USDA), the Commerce Department's National Atmospheric and Atmospheric Administration (NOAA) and the Agency for International Development (USAID) have significant roles in international S&T cooperation in the agricultural area. Natural resources engage a number of other U.S. agencies, in particular NOAA, and agencies of the Interior Department including the U.S. Geological Survey and others. NASA as well as NOAA have roles to play in space-based monitoring of agricultural and natural resources matters. The international activities of many agencies draw considerably on USG foreign assistance resources provided through USAID, which also directs and supports collaborative development-related research of its own.

This chapter is designed to convey in a thematic way the substance and flavor of U.S. Government S&T cooperation with international partners on agriculture and natural resources, including earth sciences and natural hazards. This narrative is not an agency catalog of activities, although much of the material, necessarily, is drawn from and keyed to particular agencies. Appendix 2 (database of international S&T agreements by agencies) is the principal agency-specific element of this Title V report, and readers are invited to refer to it as desired.

The narrative is divided into two sections: agriculture, and natural resources (including earth sciences). These subjects are not mutually exclusive nor is there intent to portray them so. The narrative also briefly addresses international cooperation on natural hazards such as earthquakes, volcanoes and tsunamis (previously known as tidal waves).

The narrative on Basic Science earlier in this report discusses plant and animal biodiversity and management and conservation of ecosystems.

Agriculture

An illustration of the scientific focus on agriculture is the fact that, in the last two decades, the global number of agricultural researchers has doubled to over 100,000 and agricultural research expenditures have more than doubled to $7.5 billion worldwide. Congress, USDA, USAID and the U.S. land grant colleges and universities now speak in terms of the globalization of agriculture. This has affected how U.S. participants perceive American interests in the development of new products and processes that will help the U.S. to compete in world markets.

Simultaneously, there is growing awareness that the agricultural development of Third World countries helps their economic growth and per capita income gains, which, in turn, benefit U.S. trade. Also, information and knowledge gained by U.S. scientists from participating in the process of development in many countries can be extremely important factors in the future growth of U.S. agriculture.

Recent USDA and USAID Developments

Administrative responsibility for programs involving technical assistance to low income countries was assigned to the Agency for International Development following the enactment of the Foreign Assistance Act in 1961. However, a number of activities for implementing international cooperative programs in agriculture were retained in USDA because they were logical extensions of USDA domestic missions. Appropriations to implement the Foreign Assistance Act administered by USAID have been the principal source of funding for U.S. programs of international agricultural research, education and technical assistance since 1961. In practice, the majority of the international programs funded by USDA's appropriations have involved collaboration between USDA and USAID-graduate and other more institutionally advanced countries.

Early in 1990, the Secretary of Agriculture made an important policy statement on the need for the USDA to become more active in global science, education and development, as part of a U.S. strategy to promote economic growth, trade expansion and stability worldwide. In November 1990, Section 1613 of the Food, Agriculture, Conservation, and Trade Act of 1990 (the 1990 Farm Bill) broadened further USDA's authorities to enter into collaborative arrangements with sister departments and agencies around the world. These included those of developing countries and the emerging democracies currently receiving economic support and development assistance from USAID.

Section 1458 and other amendments enacted by the 102nd Congress also broadened the Department's global responsibilities related to international agricultural research, technical cooperation, animal and plant health, international forestry and global warming. However, Congress, with minor exceptions, has not yet provided funds for such programs.

USDA and USAID: Collaborative Development of New Initiatives

Section 1613 requires the Secretary to carry out related USDA international policy "in consultation with the Agency for International Development." The two agencies agreed to form a Joint Steering Committee (JSC), co-chaired by USDA's Assistant Secretary for Science and Education (S&E) and USAID's Assistant Administrator for Science and Technology. The focus will be on five initial areas of mutual interest: soil and water management, plant genetic resources, animal and plant disease and pest management, high value cash crops, and agricultural information bases.

Working groups have identified priority activities for each area. The groups also recommended increased levels of USDA networking with the International Agricultural Research Centers (IARCs), and highlighted the need to access global information and technologies in cooperation with developing countries and emerging democracies. FY-1991 activities included better definitions of USDA's global priorities and more effective U.S. institutional collaboration therein, and identified and overcame bottlenecks to collaboration across national boundaries. USDA is developing a new mode of operation based upon its knowledge of the U.S. agricultural research system, other significant international and global agricultural research systems, and the benefits to the U.S. and the world from international agricultural research and technology transfer.

USAID Support for International Agricultural Research.

USAID's international agricultural research program has three major components, which together constitute an integral part of an emerging global agricultural research system. These components include: (a) centrally funded programs, developed through USAID's Research and Development (R&D) Bureau, which work with public and private centers of excellence in the United States; (b) the multilaterally funded International Agricultural Research Centers (IARCs); and (c) regional and bilateral efforts to strengthen and improve research capacity within developing countries supported through USAID's field offices. Each cooperating institution brings a particular comparative advantage to the research effort.

There is extensive involvement by the wider U.S. agricultural community. Projects are designed to enhance sustainable productivity of the agricultural sector while more effectively managing its natural resource base. For example, Collaborative Research Support Projects (CRSPs) link university and USDA scientists from every region of the country and provide research efforts with diverse expertise. These institutions, along with developing country partners, conduct collaborative research on topics of mutual interest and benefit.

New initiatives in biotechnology, sustainable agricultural practices and integrated pest management are being developed by fostering both open competition and peer review. This has caught the attention of leading scientists and administrators from the private for-profit sector, universities and USDA. For example, a new project (Agricultural Biotechnology for Sustainable Productivity) was jointly awarded to a premier land-grant university and a state-of-the-art commercial tissue culture laboratory following extensive external peer review.

These are examples of how USAID-financed international research is planned and administered in conjunction with prominent governmental and private U.S. agricultural and natural resource institutions. Much demonstrated mutual benefit has derived from this unique type of collaboration. However, both USAID and USDA are seeking ways to enhance cost effectiveness and collaboration in USAID-funded international projects. One such way entails funding "special constraint" research where U.S. institutions assist IARCs in overcoming specific obstacles in their research efforts on key problems.

Another critical component in this international research system is institutions at national levels. Broadly taken, national programs constitute both private and public sector agricultural and natural resources research. National programs are fundamental to the application of results and improvement of production systems and peoples' lives. However, in many cases national programs are weak. They sometimes lack human resources and almost always lack adequate funding.

Especially through its bilaterally funded projects, USAID has been a major partner in developing stronger national research programs. These projects typically contain both research and training components. Research linkages are fostered with U.S. institutions, IARCs or other national programs, increasingly through collaborative research networks. Centrally and regionally funded projects also contribute to these efforts, often by providing technical assistance. New efforts are being provided to strengthen the private sector base. For example, a new centrally-funded biotechnology project is linking directly with private sector efforts in developing countries identified through bilateral projects.

USDA agencies provide a substantial resource in support of U.S. programs of international economic assistance and cooperation. In the past decade, some 15 USDA agencies have responded to requests for technical services from USAID and others. In addition, USDA professional staff have assisted on short and longer term reimbursable details in USAID Washington bureaus.

USDA agencies also directly administer a variety of international programs authorized in the farm bill legislation. While these do not in themselves fall in the category of development assistance, they constitute a small but critical component of U.S. programs of cooperation for development.

International Agricultural Research Networking and the U.S.

USAID-sponsored programs, including those in cooperation with USDA, link extensively to the sixteen International Agricultural Research Centers (IARCs) sponsored by the Consultative Group on International Agricultural Research (CGIAR). (CGIAR is a 41-member group of nations, foundations and multinational/international organizations, co-chaired by the World Bank, the Food and Agriculture Organization, and the United Nations Development Programme.) Some 40 international donors support the IARCs, the U.S. providing around 20% of the CGIAR systems' $230 million annual cost. The IARCs are internationally staffed (20% Americans, of whom 47% are PH.D.s) and located at sites around the world.

The IARCs work on key commodities and agro-ecosystems, developing improved germplasm and other technologies for adaptation by national programs and ultimately by farmers in developing countries. The centers are primarily applied research institutes, although increasingly they are involved in new biotechnologies.

The linkages between IARC scientists and their U.S. counterparts are wide ranging and have been mutually beneficial. The U.S. Foreign Assistance Act/Title XII legislation, which provided the basis for the Collaborative Research Support Projects (CRSPs), has also enhanced this type of collaboration. This legislation stated that, in order to prevent famine and establish freedom from hunger, the U.S. should strengthen the capacities of the U.S. land grant schools in program-related agricultural institutional development and research, and should apply more effective agricultural sciences to the goal of increasing world food production.

In FY-1991, the U.S. agricultural system, through USDA, initiated discussions with the IARCS and USAID on how to expand ties to the IARCS network. Several modest and low-cost steps were agreed upon to initiate USDA's formal participation in, and support of, the programs of the IARCs. In addition to working to facilitate access by IARCs to USDA's own Current Research Information System (CRIS), these included:

- participating with the IARCs in facilitating sabbaticals or special study exchanges for scientific as well as administrative staff;

- participating in collaborative research, exchange of materials, and sharing knowledge about methodologies, techniques and information on current research;

- filling long-term IARC vacancies at all levels with personnel from the U.S. system;

- participation by top USDA-system agricultural scientists on IARC Boards of Directors, where they will be able to recommend means to strengthen collaboration in the expanding global research system that will contribute to the economic self-sufficiency of developing countries; and

- seeking funds that would allow USDA's junior scientific staff, including those at the land grant colleges and universities and 1890 schools, to undertake post-doctoral and special studies at the IARCs.

A similar mechanism is under consideration to link USDA more closely with other international systems such as the Food and Agriculture Organization (FAO) and the Interamerican Institute for Agricultural Cooperation, as well as selected national agricultural research and technology systems overseas.

USDA funds to undertake the significant international networking role necessary to have a global impact, and to link into current global knowledge that will help to keep U.S. agriculture competitive, amount currently to less than $5 million yearly. This compares with USDA's annual budget for domestic research of more than $1 billion.

Other Programs

As indicated earlier, most formal scientific linkage programs in agricultural research and product development are funded by USAID and implemented through a variety of collaborators including universities, USDA and, more recently, commercial agricultural researchers. One example is the Scientific Liaison Officers program coordinated by USAID in cooperation with USDA. This program selects leading U.S. scientists to be posted with the IARCs to improve links with them. Many of these scientists are from land grant colleges, universities or experiment stations.

USDA scientists located on American university campuses and at experiment stations across the country participate in Collaborative Research Support Programs, co-funded by USAID and the Title XII universities, to carry out research whose results also benefits developing countries. Several of these collaborations are linked into the USDA Current Research Information System (CRIS) network and into some of the 16 International Agricultural Research Centers worldwide. USDA scientists also participate with colleagues from the land grant colleges and universities in the USAID-funded International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) and the Improved Biological Nitrogen Fixation Through Biotechnology (NIFTAL) network.

Another important USAID-funded network is the Soil Management Support System (SMSS) program, which performs the critical soil science and classification research that identifies similar soils around the world, with special emphasis on developing countries. SMSS feeds the basic information on soil climate and ecology into CRIS and into the networks of IBSNAT and, more recently, NIFTAL, where crop response and other production-related information is added. This system of networks is very important to USDA and the IARCs because it offers the potential for the identification of both crop response patterns and better management techniques that can be transferred to similar soil and ecological areas, and then be locally adapted to produce cost-effective and environmentally sound improvements. The potential for savings on crop varietal trials, field experiments, and needless duplication are probably several million dollars yearly.

The National Sea Grant College Program of the Commerce Department's National Atmospheric and Oceanic Administration (NOAA) has funded mariculture research in the Pacific Islands (Belao, Micronesia and Northern Marianas Islands), and funds and helps to coordinate cooperative research between U.S. and Chinese and Japanese scientists. Research activities have included development of giant clam hatcheries on Belao and the Marshall Islands, research on the pathology, nutrition and growth of penaid shrimp, and algae culture. Work in the Pacific Islands is funded through the Pacific Island Network, DOI and USDA. Work with China and Japan is coordinated and funded through NOAA under respective agreements with those countries.

NOAA and USDA together operate a Joint Agricultural Weather Facility (JAWF). NOAA meteorologists at JAWF provide USDA's World Agricultural Outlook Board with weather and climate information it needs to issue estimates of agricultural commodity production.

Space-Based Agricultural Monitoring

There is growing global interest and demand for satellite technology capable of providing early warning information on the health and vigor of vegetation. Such information is utilized by national government agencies involved with issues of food security and disaster relief. NOAA plays an important role. Scientists at NOAA's National Environmental Satellite, Data and Information Service (NESDIS) Climate Applications Branch (CAB) apply data from polar orbiting satellites to methods which monitor and assess vegetation conditions on a global basis.

A successful early-warning system for monitoring vegetation conditions depends on how quickly problem areas and impacted regions can be detected. Traditional field surveys, though generally reliable, are time-consuming and expensive. Earth resource satellites such as LANDSAT and SPOT and weather satellites, such as the NOAA-n series, can provide assessors with timely, qualitative estimates of crop and pasture conditions over large areas. NOAA's Climate Applications Branch has used advanced equipment aboard NOAA-n satellites, in conjunction with precipitation data and statistical crop yield models, to provide near-real time assessments of vegetation in southeast Asia and in the Sahel region of Africa. Recently, NOAA's Climate Applications Branch conducted a satellite crop monitoring technology transfer project in southeast Asia; this activity was jointly funded by USAID's Office of Foreign Disaster Assistance and the United Nations Economic and Social Commission for Asia and the Pacific. CAB has also been successful in devising assessment processes useable on personal computers, and transferring that ability to developing countries.

Locusts ravenously consume agricultural raw products and are a formidable contributor to famine in sub-Sahel Africa. The Interior Department's U.S. Geological Survey (USGS), under a contract with USAID, used "greenness" mapping capability from NOAA satellites to assist in grasshopper/locust control by predicting potential outbreaks of these insects.

USGS' National Mapping Division (NMD) continues to conduct under USAID auspices a Famine Early Warning Systems Program to spotlight populations at risk of famine in Burkina Faso, Chad, Ethiopia, Mali, Mauritania, Niger and Sudan. The program consists of the application of remote sensing and information system technology to target populations at risk of famine. Other USAID-funded NMD technical assistance activities in Africa include time series monitoring of vegetation conditions for grasshopper and locust habitat identification in Algeria, Chad, Mali, Mauritania, Morocco, Niger, Sudan and Tunisia; and implementation of remote sensing and information systems for research and monitoring of Sahelian Africa.

Recent Developments

It seems reasonable to expect that there will be a growing awareness in the U.S., including in the private sector, of the value of the technological improvements possible through greater international scientific networking led by prominent U.S. agricultural institutions. Various analyses also show significant trade benefits to the U.S. when the economies and per capita income of developing nations gain.

There were several actions underway in FY-1991 to bring about an improved climate for international S&T cooperation in agriculture. After extensive deliberation within USDA's congressionally-mandated Joint Council on Food and Agricultural Sciences, the Department proposed, the Administration adopted and Congress subsequently authorized a Policy on International Science, Education, and Development (administration proposal, 1990 Farm Bill and Section 1613 of the 1990 Food, Agriculture, Conservation and Trade Act -- FACT). The policy emphasizes the:

- new worldwide importance of agriculture as a key means to revitalize and expand the economies of many countries;
- high priority of agricultural science and education in this process; and
- importance of U.S. participation.

Two basic motives underlie this policy: a) skills and talents of U.S. agricultural scientists can help speed the process of development in many countries of the world, and b) the information and knowledge to be gained by these same scientists can be of inestimable value to U.S. agriculture.

Some Representative Cases of Cooperation

Nearly 350 collaborative international agricultural research projects were active in FY-1991, involving but not limited to the following countries: Antigua, Argentina, Brazil, China, Costa Rica, Egypt, France, Greece, Guadeloupe, Hungary, India, Ireland, Israel, Italy, Japan, Mexico, Morocco, Pakistan, Poland, Portugal, Singapore, Soviet Union, Taiwan, Turkey, United Kingdom and Yugoslavia. These activities were in pest and disease control and prevention, crop germplasm genetic improvement, soil and water resources, forestry and wood products, post-harvest technology and utilization, animal improvement, dry land agriculture, aquaculture, and human nutrition.

The majority of these projects included significant co-funding by the cooperating foreign institutions. Those that were for the most part funded by USDA addressed significant problems immediately affecting U.S. agriculture. An illustrative sample list of such projects during FY-1991 involving other countries (shown in parentheses) includes:

- biological controls for leafy spurge (Italy) and knapweeds (USSR), involving non-herbicidal approaches using insects;
- weevils for biocontrol of snakeweeds (Argentina);
- moths for biocontrol of bindweeds (Italy, Greece);
- wasps against Gypsy Moths (Europe);
- rust disease for biological control of musk thistle (Turkey);
- molecular marker identification of parasites and predators of the Russian wheat aphid (several countries);
- new durum wheat germplasm resistant to Hessian Fly (Morocco);
- European honey bees resistant to parasitic mites (Yugoslavia, U.K.);
- biological control of rangeland weeds (Europe, Soviet Union, China);
- cattle and sheep genetic resistance to parasitic nematode infection (St. Croix; other tropical countries).

CRSP scientists and their collaborators have developed and released dozens of new cultivated varieties (cultivars) of bean, cowpea, millet, peanut and sorghum, with greater productivity, disease and insect resistance, drought tolerance and improved nutritional quality. New and improved breeds of sheep and goats have been developed and are being utilized. Plant and animal (including aquatic) genetic resources have been preserved and are being used in improvement programs. New technologies for soil and water management, improved soil nutrient utilization and control of soil erosion have been developed.

The activities described above are all essential components of an interagency agricultural research effort which, given the necessary resources, can and does mount substantial programs to seek solutions to major food and natural resource management problems. Widespread famine, thought inevitable just 20 years ago, has been largely averted in many areas. Very significant advances have been made -- conservative estimates cite that some 500 million people are fed due to advances in the rice-wheat green revolution alone. But population growth, combined with pressure on the natural resource base, mean that more challenges lie ahead. The international agricultural research system supported by the U.S. through USAID and USDA will be key to meeting them.

Natural Resources

The work of the Commerce Department's National Oceanographic and Atmospheric Administration (NOAA) entails significant international cooperative activities pertaining to natural resources and earth sciences. The Interior Department also has bureaus engaged in relevant international cooperative activities They are: U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service, National Park Service, Bureau of Mines, Bureau of Land Management, Bureau of Reclamation and the Minerals Management Service. NOAA and USGS also carry on important international S&T cooperative activities in the areas of natural hazards; USGS principally on earthquakes and volcanoes, and NOAA on ocean phenomena (e.g., tsunamis) and weather.

In the Department of State, the Office of Ecology, Health and Conservation (OES/EHC), located in the OES Bureau's Environmental Directorate (OES/E), works with other U.S. Government agencies and provides advice and coordination on U.S. policy for promoting the long-term sustainability of the earth's natural resources base, including forests, wetlands, wildlife and biological diversity.

Illustrative accounts follow of international collaborative work during FY-1991 of a number of agencies. As noted in the introduction, these descriptions are not all-inclusive but are representative, intended to convey the flavor and benefits of such activities. Readers are invited to refer to Appendix 2 for further agency details if desired.

Department of Commerce

National Oceanographic and Atmospheric Administration

The Commerce Department's National Oceanographic and Atmospheric Administration (NOAA) plays an important role in earth sciences and natural resource management -- as a participant in the Global Change program, a key repository and manager of environmental data and information on earth systems, and, in the natural resources area, as steward of the nation's ocean space, including management of marine fisheries.

The National Marine Fisheries Service (NMFS) is a part of NOAA. Many important fisheries resources range beyond the areas in which the U.S. exercises exclusive management jurisdiction and require international cooperation for assessing and ensuring their conservation. NMFS engages in U.S. international conservation activities, such as in the 17-member International Council for the Exploration of the Sea (ICES) pertaining to the North Atlantic area, and cooperative bilateral scientific observer and enforcement programs regarding the high seas driftnet fleets of Japan, Korea and Taiwan.

NOAA projects of interest during FY-1991 included the following (see also under Natural Hazards, below):

Joint cruises of the USSR's research ship Khromov and NOAA's ship Surveyor studied northern Pacific waters in the Bering Strait region, where there are noteworthy still unexplored phenomena. For example, unique climate and sea-circulation interactions may contribute to the fact that the area has the highest marine biological productivity in the world.

NOAA continued to engage in cooperative research programs with other nations such as the USSR and Japan in support of its Deep Seabed Mining Environmental Research Program and to promote environmentally sound deep seabed mineral exploration. NOAA's environmental research efforts have focused on determining the biological effects of the increased sedimentation on the seafloor that would result from deep seabed mining operations.

Ongoing NOAA cooperation with Japan continued to enhance scientific exploration at the frontiers of marine exploration in, for example, seafloor venting, plate tectonics, material fluxes, living marine resources, deep seabed manganese nodules, and related technologies.

NOAA worked with France on exploration of the Mid-Atlantic Ridge.

Under a project funded by USAID, NOAA helped Egypt to address its water management problems with development of a state of the art river forecast system for the Nile.

NOAA's Coast and Geodetic Survey (C&GS) continued to produce various charts and publications required for international air traffic control. A member of the International Hydrographic Organization (IHO), it participated in related hydrographic work and publications.

C&GS provided positioning and other data key to the operation and accuracy of the NAVSTAR Global Positioning Satellite (GPS) array, used by persons on at least four continents to obtain highly accurate positions for surveying, mapping, transportation and navigation applications. It also assisted Saudi Arabia in work to create a unified geodetic reference for mapping and land information systems.

Department of Interior

U.S. Geological Survey (USGS)

As an important adjunct to its domestic programs, USGS' international cooperative S&T activities during FY-1991 continued to be directed toward assessing worldwide mineral, energy and water resources; increasing knowledge of geology, geophysics, geochemistry, hydrologic and geological hazards (including seismology and vulcanology); improving cartography; and improving the knowledge and expertise of earth scientists. USGS conducts cooperative international activities in the forms of jointly-funded scientific investigations with developed countries, or as technical assistance to a developing country under auspices of other U.S. government agencies, international scientific or financial organizations, or foreign governments.

During FY-1991, USGS engaged in cooperative programs under the aegis of bilateral S&T agreements between the U.S. and the governments of China, Hungary, India, Italy, Japan, Mongolia, Poland, the Soviet Union and Yugoslavia. These covered a wide range of geological, earth sciences and mapping topics, many of which entailed very specialized areas of scientific and natural resources interest. Some USGS projects of notable interest during FY-1991 included the following:

USGS foreign data acquisition pertinent to possible global climate change centered on Lake Baikal in southeastern Siberia. Because of its high latitude location (increased sensitivity to global temperature changes), unique sediment accumulation through widening of the major continental rift in which it is located, and the fact that it has not been glaciated, this largest, deepest at 1600 meters (one mile) and oldest lake in the world contains an unparalleled record of climate change in its five kilometer (three mile) thick sedimentary sequence.

Deep continental drilling was continued on the Kola peninsula and provided USGS geologists with samples from depths previously inaccessible, whose study contributes to the understanding of deep-crustal processes. The USSR has conducted scientific drilling to depths of as much as 14 kilometers (8.75 mile) at Kola and at Krivoy Rog (Ukraine).

Comparative studies using water level changes in wells as indicators of strain to predict earthquakes were conducted in the Caucasus area of Soviet Georgia and on the San Andreas fault near Parkfield, California.

USGS and the Saudi Arabian Directorate General of Mineral Resources conducted a 31st year of cooperative studies in that country. Work continued on the discovery and assessment of non-fuel mineral resources, technical, data and computer support, determination of the mining feasibility of gold and phosphate rock, and training of Saudi and other regional scientists in field and laboratory studies.

At the request of the U.S. Embassy and Government of Abu Dhabi Emirate, USGS provided support in water resources research in the arid Arabian environment. Objectives are to assess ground water resources of the Emirate, train personnel in assessment methodologies, and to establish an organization for water management.

Under USAID funding, USGS continued a technical assistance program begun in 1985 in Pakistan on coal resource assessment and training of Pakistani geologists.

In the Western Hemisphere, USGS (together with the Bureau of Mines) continued a significant involvement in activities of the Center for Interamerican Mineral Resources Information (CIMRI). This involves exchanges of information and expertise on geologic, geochemical, geophysical, remote sensing and other information on non-fuel mineral resources in Central and South America and the Caribbean, and the production of publicly available databases. Training programs have been initiated in Bolivia, Chile, Venezuela and Peru and, during FY-1991, were under discussion with Argentina, Honduras, Mexico, Nicaragua, Panama and Uruguay.

U.S. Fish and Wildlife Service (FWS)

The U.S. Fish and Wildlife Service (FWS) is the U.S. management agent for implementation of the important Convention on International Trade in Endangered Species (CITES). FWS is also engaged in the implementation of several other significant international conventions pertaining to conservation and ecology, in particular, the International Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (the Western Hemisphere Convention). This convention pertains to virtually all migratory bird management activities carried out in Latin America and the Caribbean. 21 countries are engaged. FWS also conducts an extensive array of research on endangered species and their habitats, for example, in India, Pakistan and Egypt.

During FY-1991, FWS' Office of International Affairs continued to conduct international cooperative research programs such as (with the Soviet Union): expanded joint monitoring by satellite of collared polar bears and walruses, nesting and migration studies of waterfowl, wildlife disease research, wetlands management, determination of genetic characteristics of Pacific salmon, and research on the biology, ecology and population dynamics of marine mammal species.

National Park Service (NPS)

The National Park Service participates in cooperative monitoring and research on ecosystem processes, ecological communities and wildlife populations involving units of the National Park System and ecologically similar protected areas in other countries. Emphasis is on cooperation along or near the boundaries with Canada, Mexico, the USSR, the United Kingdom (British Virgin Islands), as well as NPS units of the International Network of Biosphere Reserves. The NPS recently established a coordination office for cooperative program activities, including research, with Mexico. Ongoing international activities include ecological network planning with European biosphere reserves (through the U.S. Man and the Biosphere Program); wildlife population studies in desert ecosystems (Mexico); monitoring of migratory birds (Costa Rica) and coral reefs (Lesser Antilles); and comparable studies in small watersheds (with USSR biosphere reserves).

Bureau of Mines

The Bureau of Mines (BOM) collects data on the production and consumption of over 100 mineral commodities from 160 foreign countries. During FY-1991, BOM successfully concluded with China a Protocol on Nonferrous Metal Mining and Minerals Research, under the U.S.-PRC Science and Technology Cooperation Agreement. BOM continued to support programs under Department of State S&T agreements with Yugoslavia, Poland and Hungary in areas such as coal mine safety and privatization of mining industries.

Bureau of Land Management

The Bureau of Land Management (BLM) exchanges scientific and technical information with other countries at conferences and professional meetings and through direct contacts. Topics covered by such exchanges during FY-1991 included automated land information systems, land use planning and environmental impact assessment methodologies, land and mineral leasing procedures, land parcel recordation and tracking systems, restorations of stressed riparian areas and upland rangelands, climate change monitoring protocols, and mineral land reclamation practices. As an extension of its domestic programs, BLM regularly worked with Canada and Mexico on transboundary management problems and opportunities.

When requested, BLM also provides training and technical assistance to other countries. For example, in FY-1991 BLM provided training to wildlife biologists in Sri Lanka and provided assistance to the Hungarian Government in establishing a minerals management agency.

Bureau of Reclamation

The Bureau of Reclamation participates in cooperative research and technology exchanges with other nations in support of its domestic programs and offers training and assistance in all aspects of water resource development, management and related fields. The Bureau has worked in over 60 countries and has trained over 5,000 resources engineers and scientists from over 80 countries.

Minerals Management Service

The Minerals Management Service (MMS) engages in cooperative research programs with other nations in support of its domestic oil and gas program and to promote environmentally sound offshore operations worldwide. The United Kingdom, Canada and Norway are major participants. Research is conducted in technology development related to oil spill response, pipeline safety and ice force measurement.

Natural Hazards

As noted earlier, USGS and NOAA have important roles in the field of international natural hazards prediction. The National Weather Service (NWS), a part of NOAA, provides marine weather and sea state forecasts for designated high seas areas in accordance with World Meteorological Organization agreements and safety of life at sea conventions. It is one of 15 international centers issuing aviation forecasts and hazard warnings.

NOAA participates in a Pacific Tsunami Warning System (PTWS) comprised of most Pacific Rim states, with an operational center near Honolulu, charged with responsibility for detecting and locating major earthquakes in the Pacific region to determine whether they have generated tsunamis and to provide appropriate warnings.

NOAA's National Environmental Satellite Data and Information Service (NESDIS) centers carry out many activities related to exchange of earth sciences data under various agreements. Among other things, these activities include monitoring solar flares and other solar-terrestrial phenomena that can detrimentally affect human activities such as telecommunications.

USGS continued to operate two global seismographic networks to provide rapid and accurate information of earthquake occurrence worldwide. The World-Wide Standardized Seismographic Network (WWSSN) currently comprises about 100 stations operating in more than 50 countries. USGS also operates the Global Digital Seismographic Network (GDSN), a new satellite-linked seismographic network. The GDSN provides extremely high-quality digital seismic data for seismological research and is a unique international information resource. Working in cooperation with Argentina, Chile, Indonesia, Italy, Morocco, Peru, the Philippines, Thailand and the United Kingdom, USGS also is developing action plans and pilot programs in each of three geographic regions to demonstrate the feasibility and need for uniform global earthquake hazard mapping and risk assessment/management.

Under auspices of USGS' Volcano Hazards Program and the joint Volcano Disaster Assistance Program of USGS and USAID's Office of Foreign Disaster Assistance (OFDA), USGS maintains and keeps ready for volcanic crises caches of specialized equipment and monitoring instrumentation. The June 12-15, 1991 eruption of Mount Pinatubo volcano in the Philippines, 100 kilometers (62 miles) northwest of Manila, was the largest eruption in the past five decades and led to the largest-known evacuation of people due to a volcanic threat. Quick deployment of monitoring instruments and the preparation of volcanic hazards maps by USGS personnel and scientists from the Philippine Institute of Volcanology and Seismology permitted characterization of precursory volcanic activity, and provided the basis for accurate warnings of impending eruptions.

These warnings were widely disseminated and led to the evacuation of more than 58,000 residents near the volcano, including 14,500 U.S. military personnel from Clark Air Base prior to June 12. When the climactic eruption of June 15 occurred, more than 200,000 people had left the area. By the end of FY-1991, more than 23 USGS geologists, seismologists, hydrologists, and electronics and computer specialists had each spent between 3 and 8 weeks at Pinatubo to assist the Philippine Institute and advise American military commanders.

An NOAA polar orbiting satellite has tracked the progression of the ash/aerosol cloud produced by the Mount Pinatubo volcano since June 15, 1991. NOAA provided forecasts of the plume trajectory just after the eruption and subsequently developed a new forecast and visualization technique for forecasting plume trajectory and spread from any volcano in the world.

CHAPTER 3

NARRATIVES ON SELECTED COUNTRIES AND INTERNATIONAL ORGANIZATIONS

ARGENTINA

General

Unlike the U.S. where the private sector has a significant role in conducting scientific research and development, about 95 percent of science and technology research in Argentina is conducted by government institutions and universities. The two major institutions responsible for carrying out government policies in this field are SECYT (the Secretariat of Science and Technology) and its operating arm CONICET (National Council for S&T Research). As a result of a decade or more of virtual economic stagnation and budgetary restrictions, science and technology suffers from a serious brain drain of scientists seeking employment abroad. Scientists continue to be among the lowest paid employees in the country with salaries for researchers ranging from $500 to $1600 per month. In addition, scientists face very limited funds for equipment, books and operating expenses. As a percentage of GNP, Argentina invests less than 0.5 percent in R&D, though efforts are being made to raise this to roughly 1.0 percent in 1992.

Argentina presently has about 20,000 scientists, many of whom have received graduate degrees from abroad, primarily the U.S. and Europe. There are approximately 30 universities offering degrees in science and engineering and 167 research institutes or centers under the direction of CONICET.

Cooperative science and technology research activity between the U.S. and Argentina is based on a 1972 bilateral umbrella agreement which has been periodically revised and updated. The agreement next expires in August 1992 but is expected to be renewed prior to that date. NSF supported approximately $200,000 in direct R&D grants for Argentina in FY-91 and about $3 million through indirect activities. During the 1991 visit of Vice President Quayle, the two governments signed two major space agreements. The first was a framework agreement with a focus on civil space cooperation, while the second provided for NASA to launch an Argentine solar research satellite, the SAC-B, sometime in the mid-1990's. In September of 1991, a Peace Corps agreement was signed with Argentina. The programs to be developed will focus primarily on environmental and natural resource related issues.

Basic Science

Within its limited financial resources, Argentina has been quite active in basic science research, hosting international scientific conferences, and working with other countries on scientific and technological projects. Recent examples include:

Global climate change

Argentina is undertaking a new global climate change research initiative to focus on possible future change in the biosphere. The proposal includes studies of current environmental conditions, such as atmospheric and stratospheric ozone, measurement of gases with greenhouse effects, desertification and changes in ocean levels.

The studies will be conducted at six research centers located in Argentina, as well as at universities and other institutes. Argentina plans to spend $20 million in 1991 on this project.

Computer data network

SECYT is also organizing a national computer data base called RECYT (Scientific and Technological Network), which will facilitate the integration of the national S&T system, as well as communication with specialized foreign entities.

Astronomy

In late July 1991, the Argentine Astronomical Association hosted the International Astronomical Union's General Assembly in Buenos Aires. More than 1200 astronomers from around the world participated, including approximately 400 U.S. scientists with research support from NSF and NASA.

In a joint effort with the Cambridge Center of Astrophysics (Harvard University), a new radio receptor was installed on one of the radio telescopes at the university of La Plata's Radio Astronomy Institute (IAR). The receptor mirrors a similar device at Harvard university to search for extraterrestrial life.

Space

SECYT, in conjunction with Argentina's newly created space commission, CONAE, signed an MOU with NASA to help develop and launch a solar research satellite, SAC-B, as noted above. SAC-B will carry out solar burst research, as well as provide background x-ray and gamma-ray observations. The University of Buenos Aires Institute for Astrophysics and Space Physics (IAFE) is developing the satellite platform and various instrument packages, in cooperation with Goddard Space Flight Center and the University of Pennsylvania. The SAC-B platform is expected to form the basis for future Argentine research satellite designs and experiments.

Health and Life Sciences

A number of infectious diseases are of major concern in Argentina, including the following:

Hemorrhagic fever

This is a disease found only in Argentina and Korea, and has a mortality rate of about 10 percent. It affects mostly the rural areas of the provinces of Buenos Aires, Santa Fe, Cordoba and La Pampa. From January to September 1991, a number of deaths were reported among the 700 confirmed cases. Over a twelve year period, a vaccine known as Candid I was developed in the U.S. by an Argentine scientist, Dr. Julio Barrera Oro, and was tested on human volunteers in the U.S. and Argentina. It was found to be 97% effective. As part of a special U.S.-Argentine cooperative effort, in August 1991 the U.S. provided Argentina with the first 50,000 of an eventual 200,000 doses of the vaccine. Argentina hopes to produce the vaccine on its own within five years.

AIDS

The Argentine government announced a national AIDS program in July, 1991. $2 million will be spent over 18 months for treatment, condoms, training and research. The government is also trying to use mass media to increase public awareness of the dangers of AIDS. Currently there are 1,234 reported cases of AIDS in Argentina, although it is estimated that 20,000 to 40,000 people are HIV-positive. The Catholic church has recently issued a document calling on Argentines to combat AIDS through education.

Measles

Measles experienced a resurgence in Argentina in 1991. From January to September, over 9000 cases of measles, resulting in 41 deaths, were reported. In September the Ministry of Health (MOH), anticipating a rise in the number of people affected through the end of the year, declared a measles epidemic. The government has belatedly initiated a national inoculation program. A total of 230,000 doses of vaccine have been donated by France, Chile, Brazil and Spain. A further 500,000 doses were purchased from France. PAHO and the World Health Organization (WHO) have also been called in to assist.

Chagas disease

Chagas, a cardiovascular disease which manifests itself 20 to 30 years after initial infection, is by far the most widespread illness in Argentina. A large part of the country, mostly poor areas, is infested with the insect that carries the disease. According to official estimates, about 2.5 million people are infected (out of a population of 33 million), of which 10-20% have suffered irreparable and incapacitating damage from the disease.

Cholera

Unlike neighboring countries, Argentina has so far reported no cases of cholera. The Ministry of Health, however, fears its eventual arrival is inevitable. The government is encouraging people to take the usual precautions against cholera such as washing hands, boiling water, and peeling vegetables, but the general sanitary conditions in rural Argentina are poor and deteriorating. The press reports that out of the total 33 million population, 11 million are without potable water and 21 million have no sewage system in their homes. Besides making the public aware of the dangers of cholera, the government has also increased waste treatment and water chlorination throughout the country. Argentina, Brazil, Paraguay, Uruguay, Bolivia and Chile are attempting to coordinate their anti-cholera programs.

Energy, Environment and Economics

A mysterious oil spill off the Argentine coast near the province of Chubut reminded Argentines of energy/environment interactions. In September 1991, thousands of Magellan penguins arrived for their annual breeding season covered with oil from a yet undetermined source. Volunteers started cleaning and feeding the penguins. Nearly 18,000 penguins out of a total of about 650,000 were affected by the oil. The Argentine government requested the U.S. to help determine, from space, the origin and extent of the oil spill. As of the end of FY-91 the source of the oil spill remained unknown.

Environmental protection in Argentina is mainly the responsibility of the federal Ministry of Health and Social Action. A National Commission of Environmental Policies (CONAPA) was created in 1989 but has to date been relatively ineffective. In June 1991, President Menem announced the creation of a new, cabinet-level secretariat for the environment, though actual implementation of this agency is not expected until early 1992. In November, 1991 President Menem appointed a new Secretary for the Environment who apparently will report directly to the President's office. Some provinces also have local environmental offices.

Environment, however, has not been a high priority in Argentina, and coordination between federal and provincial authorities remains minimal. Limited funding in a stagnant economy is another factor. The government is trying to redress the situation in view of the air and water pollution problems throughout the country. Other serious problems are lack of adequate long-term disposal of hazardous and nuclear waste, desertification, soil erosion, urban and rural floods, and urban noise pollution. Non-governmental organizations such as Argentine Greenpeace and the World Wildlife Federation are beginning to gain more political clout at grassroots levels.

President Bush's Enterprise for the Americas Initiative (EAI) was strongly endorsed by the government of Argentina. The debt for environment provision was specifically highlighted by the scientific community as a means of providing continuous funding of programs for research in global climate change and other environmental areas.

The U.S. Ambassador and the Governor of Buenos Aires recently signed a technical development program (TDP) agreement for the study of hazardous wastes and environmental protection in the province of Buenos Aires. A U.S. contribution of $500,000 included support for a feasibility study on the treatment of hazardous wastes.

While not directly relevant to E^3, another major environmental event struck Argentina during FY-1991 in the form of a major eruption in August of the Mount Hudson Volcano, close to the Chilean-Argentine border, which spewed ash over an area of 100,000 square kilometers in the southern province of Santa Cruz. Argentina requested U.S. help to evaluate the health and environmental effects of the ash. The USG responded with immediate disaster assistance for the populace as well as providing experts to help analyze this natural disaster.

Emerging Technologies

Biotechnology

SECYT has developed a national program for biotechnology as part of its national science and technology plan. Priority areas include development of productive biotech processes, fermentation processes, production of recombinant proteins, cell cultivations, production of vaccines, antigens, biopharmics, diagnostic reagents and biomolecules.

Semiconductors

As part of the national program of computer networking and electronics, Argentine researchers produced their first Very Large Scale Integrated (VLSI) chips. Using CMOS technology and "sincronised chronogram of multiuser projects," a chip equivalent to 5,000 transistors was manufactured. Some seventeen researchers and eight different institutions were involved in this project.

Agriculture and Natural Resources

Desertification caused by overgrazing seriously affects about one-third of the Patagonia region, the main sheep-raising area of Argentina. If the process continues, the country may suffer severe economic as well as ecological consequences. Desertification is considered to be the main ecological-agricultural problem in the Patagonia and has caused serious vegetation loss and irreversible soil erosion in many areas. INTA, the National Institute for Agricultural Technology, and other federal, provincial and private institutions are presently promoting a 5-year project to prevent and/or control desertification in Patagonia. The German government has granted Argentina US$2.9 million for a 4-year project to fight desertification in Patagonia.

In the Salta province of northern Argentina the uncontrolled cutting of trees and the lack of adequate environmental protection policies have accelerated the process of desertification. Argentina is presently working with a number of Italian companies on a forestry project to transform the country into a producer and exporter of wood and thereby reverse the process of desertification. The provincial government of Cordoba together with the national government is seeking International Development Bank loans to plant 40 million trees over the next 5 years.

BRAZIL

General

Brazil has often been referred to as the "country of the future." Ranking fifth in land area and sixth in population among the world's nations, Brazil is one of the richest in natural resources, with extensive land areas suitable for agriculture, some 20% of the world's fresh surface water, the world's largest tropical forest, the world's largest wetlands, and vast mineral reserves. Brazil also has the largest industrial plant in Latin America and the greatest number of scientists and technicians in the region, with over 500 research institutes and over 100 organizations involved in notable science and technology-related activities.

The U.S. has had a formal S&T agreement with Brazil since 1971. A six-month extension in May 1991 allowed time to complete negotiations on an annex on intellectual property rights. The S&T agreement was renewed in November 1991.

Basic Science

There are numerous professional science organizations in Brazil. For three decades, the most prominent has been the Brazilian Society for the Promotion of Science (comparable to the AAAS), which still attracts over 5,000 participants to its annual meetings. Its activities in the past were often political, entailing a continuous struggle against the military dictatorship for greater freedom and democratic government. That goal having been achieved, the Society's influence has now largely given way to that of over two dozen specialist professional scientific societies which promote research in their areas.

The Government of Brazil (GOB) spent 0.6% of 1989 GNP on S&T and supported about 70% of the R&D work done in the country. However, fiscal austerity measures in 1990 took a heavy toll on all sectors of the budget, including S&T. 1991 saw additional tightening. An inquiry by the Brazilian congress showed that the science sector's infrastructure had become obsolete as the result of a ten-year dearth of investment. Funding institutions reported that, as ability to maintain adequate laboratories became more impaired, applications for grants were increasingly for basic equipment and facilities rather than research.

During 1991, the science sector showed not only strain but the beginnings of cracks, with unheard-of strikes by scientists, boycotts of council meetings of the National Council for Research (equivalent of the U.S. National Science Foundation), and the start of a brain drain as some of the better talent began looking for a more stable work atmosphere. The economic and financial problems caused reduction in government science programs and in morale. A shift of government funding to technology programs underlined this trend, but has also resulted in some adaptive changes, such as creation of technologically-oriented and/or industrially-linked programs.

One bright spot during FY-1991 was ability of the various funding institutions to maintain, and even increase, the number of scholarships for university students, thus continuing to build a solid human resource base. Brazil retains a significant foundation in the basic sciences, the traditional focus of the universities and an area in which a high percentage of scholarships for study abroad are given.

Brazil has traditionally cooperated with U.S. institutions in basic science. Among the most long-lasting relationships has been that between NSF and Brazil's National Research Council (CNPQ). A outgrowth of that cooperation, the program in high-energy physics between Fermilab and the National Physics Laboratory of Brazil, has long been regarded as especially beneficial to the two partners. More recent collaboration between Argonne National Laboratory and the Institute for Physics at the University of Sao Paulo is also proving valuable.

Health and Life Sciences

Brazil's tropical location and its strong group of biological scientists has made it an important country for research in tropical diseases such as malaria, leishmaniosis, chagas and schistosomiasis. Brazilian scientists are working closely with the National Institutes of Health (NIH) in research in these and in other areas, such as AIDS, where Brazil has one of the highest number of reported cases in the world.

Brazilian scientists have accomplished health research breakthroughs in the past. However, their ability to continue to do so is now almost completely dependent on collaboration with, and support from, international partners. Ministry of Health resources have, by necessity, become focused on more basic problems, such as a massive, successful, education program against cholera, and large-scale vaccination campaigns against common childhood diseases.

Energy, Environment and Economics

At the time of the first oil-price shock in 1973, Brazil took a number of innovative policy decisions which included exploration for domestic oil reserves, development of ethanol-fueled cars and support of a nuclear energy program. Brazil today has a fleet of four million cars fueled by ethanol. Brazil is an exporter of gasoline and a leader in deep-water drilling techniques.

The sugar cane based fuel ethanol was never economically competitive with gasoline and, in 1990, a shortage of ethanol forced a reevaluation of the program. Pressure to retain an emphasis on ethanol stemmed not least because of environmental concerns. The two megalopolises of Rio de Janeiro (some 9 million people) and Sao Paulo (about 15 million) would face totally unacceptable air pollution levels if ethanol-fueled cars gave way to gasoline powered vehicles. The Persian Gulf war in early 1991 gave further impetus to continuation of work on alternative fuels and creation of pricing structures which would promote cleaner fuels. The latest innovations in 1991 included introduction in several urban centers of fleets of busses using natural gas .

Hydropower remains the main source of electric power generation in Brazil. The world's largest hydroelectric dam is on the Brazil-Paraguay border.

Environmental concerns are slowing development of thermal plants dependent on Brazilian coal, which has a high ash content. Imported metallurgical coal and charcoal have been the primary fuels for steel plants. While there are no plans to change this, insistence on reforestation programs to make charcoal a truly "sustainable" fuel source has grown in recent years. There are also changes in the energy pricing structure to try to reflect all the costs of production and utilization, including those of environmental protection.

With only one nuclear power plant in operation, Brazil's nuclear program has had little success as an energy source. Another plant is partially complete, but at enormous financial cost. An autonomous, unsafeguarded nuclear program has focussed on mastering the fuel cycle and developing small reactors. International proliferation concerns were eased by the signing of a bilateral safeguards agreement between Brazil and Argentina in July 1991, and by the start of negotiations for a full-scope IAEA safeguards agreement.

USG agencies are cooperating with Brazil in a number of areas related to environmental concerns. These include EPA programs on agricultural chemicals with the Ministry of Agriculture; a new U.S. Forest Service program begun in August 1991 on fire management; funding from USAID for a variety of sustainable development demonstration projects in the Amazon region, being carried out by non-governmental organizations; climatology studies by NOAA with Brazil's Space Institute (INPE); and atmospheric studies with INPE by NASA.

Emerging Technologies

Brazil's list of "critical technologies" includes new materials, biotechnology, aerospace technology, information and communications, and energy. However, traditional closed-market policies and lack of adequate intellectual property rights protection in some key areas have prevented significant international cooperation. Attempts by the GOB to open the Brazilian market may change this in the near future.

In the meantime, there is little practical cooperation taking place beyond some areas of basic research where France and Germany are the leading partners. China has recently signed a contract with Brazil to develop two remote-sensing satellites, and the Soviet Union has expressed strong interest in the computer science sector.

Agriculture and Natural Resources

Brazil maintains a wide range of technical cooperation ventures in agriculture with several countries as well as a number of key international agencies, mainly the Food and Agriculture Organization (FAO), the Interamerican Institute of Cooperation for Agriculture (IICA), the World Bank, and the Interamerican Development Bank

(IDB). Bilateral cooperation agreements with the United States are primarily between U.S. Universities and EMBRAPA, the research institute for the Brazilian Department of Agriculture. At the end of 1990, about 30 cooperation projects were in force with 20 U.S. universities, involving research on crops, biological controls (in which EMBRAPA has made a number of breakthrough discoveries), dairy cattle, pastures, soil conservation, and germplasm.

Brazil also provides technical assistance in agriculture to some 20 countries in Latin America and Africa in the areas of basic foodstuffs, pasture improvement programs, rural administration, and plant genetics.

CANADA

General

Sharing more than 4,800 kilometers of border with the United States, Canada is a staunch ally and our largest trading partner. A dense web of science and technology cooperation involving both private industry and not-for-profit laboratories has developed between the two countries.

Private and official environment, science and technology linkages are key factors in the U.S.-Canadian relationship. This has been nowhere more evident than in the area of acid precipitation. The 1990 passage of the U.S. Clean Air Act and the March 1991 signing of the Air Quality Agreement by President Bush and Prime Minister Mulroney signalled the resolution of this issue, which had been an irritant to bilateral relations for more than a decade.

Official bilateral S&T cooperation spans the spectrum of disciplines. Canada is a major collaborator in Space Station Freedom and a Canadian payload specialist is scheduled to fly on shuttle flight 42 in early 1992. In the field of energy, cooperative efforts are as varied as research on improved batteries, nuclear safety, and nuclear fusion energy. Canadian health researchers have very close ties with their American colleagues and compete successfully for grant support from the National Institutes of Health. In all, cooperative activities involve a dozen U.S. agencies and their Canadian counterparts.

As of the end of FY-1991 the government's newest constitutional proposals for shaping Canada's future, tabled September 24, were being deeply debated nationwide. This debate addresses what kind of a Canada is to be in the future, and its outcome may well have a significant influence over the future of both domestic and international Canadian S&T.

Basic Science

During FY-1991, science and technology in Canada saw low-growth budgets and an increased emphasis on the diffusion of S&T in an effort to improve the competitive position of Canadian industry. The government's commitment to diffusion was evidenced by its decision to name the Minister of Industry, Science and Technology concurrently as Minister of International Trade.

Despite budgetary constraints, Canada remains actively involved in building the Mobile Servicing System (MSS) for Space Station Freedom. Having invested several hundred million dollars in the MSS, Canada followed closely the debate in Washington over the future of the Space Station and expressed deep concern over the possible unilateral termination of the program. As a result of these perceived uncertainties, the Canadian Space Agency (CSA) began to consider broadening the scope of its future international collaboration to include projects managed by the European and/or Japanese space agencies.

The government also bucked the low budget trend in sub-atomic physics in announcing its willingness to provide C$236 million to support construction of the KAON accelerator at the Tri-Universities Meson Facility (TRIUMF) in British Columbia. However, the commitment is dependent on the Government of British Columbia's providing or securing the remaining construction costs (an estimated additional C$500 million) as well as significant out-year operating costs. U.S. officials have indicated a willingness to provide some $75 million to support KAON construction. In another area of sub-atomic physics, President Bush, in a letter to Prime Minister Mulroney, formally invited Canada to participate in the Superconducting Super Collider (SSC) project. While noting budgetary difficulties, Canadian officials are actively reviewing SSC requirements with a view toward identifying areas of potential scientific and industrial interest.

Health and Life Sciences

Bilateral cooperation between the U.S. and Canada may be closer in the life sciences than in any other S&T field. U.S. and Canadian researchers and public health officials routinely participate in myriad conferences and symposia on both sides of the border. Both governments fund researchers in the other country and a senior Canadian public health officer serves on the board of the U.S. Centers for Disease Control. Periodic meetings are held to discuss public health issues, including disease prevention, health statistics and health promotion.

Pacific yew bark, available only in the northwest United States and in British Columbia (BC), is the source for taxol, an experimental drug for the treatment of ovarian cancer. There is an urgent need for taxol for clinical trials under auspices of the U.S. and Canadian National Cancer Institutes. While the BC Government has authorized the export to the U.S. of 158,000 kilograms of yew bark, individuals and groups on both sides of the border have raised questions about the potential environmental impact of large-scale harvesting of yew stocks.

Energy, Environment and Economics

As noted above, the passage of the U.S. Clean Air Act and the March 13, 1991 signing of the U.S.-Canada Air Quality Agreement removed a major irritant to bilateral relations. Under the Agreement, both sides agreed to limit emissions of sulfur dioxide and nitrogen oxide and to implement measures that will prevent air quality deterioration and protect visibility. A bilateral air quality committee, established under the agreement, will review progress being made and issue regular public reports.

Energy, environment and economics are central to the debate over the Great Whale hydroelectric project in northern Quebec. The project would produce 3,200 megawatts of electricity and include the planned sale of 1,000 megawatts to the state of New York over a period of 15 years. The nature of the environmental impacts and the reviews required are in litigation as parties attempt to determine

where jurisdiction lies and which law or agreement applies. Hydro Quebec and The New York Power Authority have established a November 1992 deadline for agreeing on a firm contract.

Great Lakes water quality was the subject of close bilateral cooperation during FY-1991, with both government adopting pollution prevention plans.

In a move with major policy and practical impacts, the Canadian Government adopted an environmental Green Plan in December 1990. The plan calls for the expenditure of some C$3 billion in support of environmental programs during the next six years and requires that, in the development of policy, all government agencies take environmental issues into account.

Emerging Technologies

Several Canadian firms and research facilities are very interested in high speed rail transport and have begun efforts to establish a center for excellence in the field. Championed by Bombardier Inc. and the Ecole Polytechnique, both of Montreal, the center would involve a consortium of Canadian universities. At least two U.S. universities have been invited to participate in the effort. Bombardier estimates that there is a North American market ultimately worth some $200 billion for high speed train transport.

Agriculture and Natural Resources

U.S.-Canadian ties in agricultural R&D are very intense. There are 112 bilateral cooperative projects in areas ranging from animal health to environmental protection to water quality. The Ministry of Agriculture estimates that half of Canada's agricultural research scientists interact with American counterparts on a day to day basis. American students and researchers are common in Canada's superb network of agricultural research facilities, which operate under both university and Ministry of Agriculture auspices. The broad lines of agricultural research programs in the U.S., Canada, U.K. and France are the subject of annual quadripartite meetings.

CHILE

General

Although a relatively small and developing country, Chile has considerable scientific and technological infrastructure. Chile devotes about 0.5% of its GNP to scientific research and development of technology. This amounted to $90 million in 1988, which was twice the level of a decade earlier. Currently there are some 5,000 scientists working in Chile, more than 1,500 of whom hold Ph. D.'s. Science related issues are becoming part of the nation's public policy debate. Research is coordinated by a central government body and carried out at universities and technical institutions throughout the country.

The Government of Chile (GOC) has identified the principal aims of its science policy to be improving the domestic and export markets for Chilean science and technology products, and providing state support for projects which will result in major social benefits such as employment and economic development. The principal science policy body in Chile is the National Commission on Science and Technology (CONICYT). CONICYT's action plan for 1992-95 includes the administration of four funds oriented respectively toward S&T development (basic sciences); R&D development (applied sciences); "young scientists"; and "high performing scientists."

Research is carried out in about 400 research units located in different universities throughout the country. In the ten years that private (non-state, non-church affiliated) universities have been allowed to exist, Chile's system of higher education has expanded in both size and scope. Currently there are 23 traditional universities, 38 new private universities and 82 professional institutes (community college-equivalent). The four or five largest universities capture 60 percent of available funds yearly and account for more than 75 percent of all S&T publications.

R&D activities are carried out both by institutes that belong to government ministries and by private sector institutions. There are over 50 research institutes under either ministerial guidance or within public enterprises or private companies. These R&D institutes work largely on applied research covering areas such as agriculture, marine resources, forestry, copper mining, nuclear energy, geology, hydraulics, air pollution and antarctic science.

Chile has important international science and technology relations, including formal agreements with the U.K., France and Germany. Despite the absence of formal agreements, Chile also has significant scientific interactions with the United States, Italy, France and Japan. In December 1990, the USG proposed to the GOC establishment of an umbrella S&T agreement. As of the end of FY-1991 Chile was studying a U.S.-provided draft text for an agreement.

Basic Science

Chile's most developed fields of basic scientific research are medicine, biology, astronomy, mathematics and physics. Almost all Chilean scientists (M.S. and Ph.D.

level) working in these areas have had training abroad. The most rapidly expanding disciplines are biotechnology and computer science. The opening of a U.S. Agency for International Development (USAID) Advanced Developing Country Program office in Chile three years ago brought new resources to Chilean basic science. Through its Program on Science and Technology Cooperation, USAID has provided $1.4 million in funding for eleven basic science projects in areas such as biodiversity, biotechnology and life sciences.

Chile has maintained some activity in space science through its relationships with the U.S. and other spacefaring nations. In 1989, NASA transferred all of its Peldehue tracking station assets, including some $15 million worth of machinery and equipment, to the Space Studies Committee (CEE), a branch of the engineering faculty of the University of Chile. CEE has continued operating the satellite tracking facility, offering services both to NASA -- which still needs it for satellites using bands not otherwise covered -- and to other users located in Chile or in third countries.

NASA has maintained its contract for CEE's services in tracking certain satellites and has permitted CEE to continue pulling down signal information generated by remote sensors installed aboard NASA, NOAA and other U.S. satellites. More recently, as a result of a joint venture between the GOC and the German government, CEE is pulling down meteorological and geophysical information collected by the German ERS satellite.

Chile is strongly committed to maintaining a presence in the Antarctic, over a portion of which it maintains a territorial claim. Chile is a founding member and active participant in the Antarctic Treaty System. It maintains its own Antarctic bases and has a vital role in logistics for Antarctic activities. There is important interaction on Antarctic issues between the U.S. National Science Foundation's Division of Polar Programs (NSF/DPP) and Chilean government researchers. Permanent contact between NSF/DPP and its counterpart, the Chilean Antarctic Institute, takes place under the framework of a memorandum of understanding for joint cooperation. The Chilean Air Force provides ongoing support for U.S. Antarctic Program operations, including air access to Antarctica via semiannual NSF/DPP sponsored flights.

Through a bilateral cooperative effort, the National Oceanic and Atmospheric Administration and the Chilean Navy have jointly established three global sea level observing stations at strategic sites in Chile. These monitoring stations are a critical component of international efforts to understand global climate change, particularly sea level rise. The data are used to support international scientific research programs such as the Tropical Ocean and Global Atmosphere Program and the World Ocean Circulation Experiment, and also have immediate practical applications for both countries (navigation, weather prediction, etc.).

Health and Life Sciences

Chile faces a number of key challenges in the health area; AIDS, cholera and drug addiction have particularly come to the forefront. The health and life sciences play a crucial role in Chilean scientific and technological activity. Chilean life scientists have strong ties with the U.S. National Institutes of Health (NIH), either directly through USG support or through the World or Pan American Health Organizations.

Chile has access to U.S. health (and other) scientists through the academic Bitnet computer network. Most of the spectacular growth experienced in the usage of Bitnet in Chile (from 500 to more than 4000 users in four years) is due to the interconnection, through Bitnet, to Medline, NIH's on-line medical library. Currently, any authorized user can access the NIH library from almost any medical facility in Chile. This research resource provides on a continuing basis information to medical doctors and other Chilean bioscientists.

Chile also has ties with other nations which have strong life and health science sectors and research programs relevant to Chilean concerns. For example, both Chile and Japan have a high incidence of gastric cancer, and most Chilean researchers in this field now receive their training in Japan.

Several health related issues have recently acquired new prominence in Chile's public policy agenda.

AIDS

As of the end of FY-1991 there were some 250-300 AIDS patients in Chile. Unofficial statistics indicate that there are probably more than ten times as many who are HIV carriers. Chilean health authorities have implemented all basic tests applied in the U.S. to detect the virus and to try to prevent the disease from spreading beyond those already infected. The GOC has prepared and shows an educational program on AIDS during prime time television.

Drug Abuse

The GOC has become concerned about the spread of cocaine use in Chile, particularly among youths in the northern cities of Arica and Iquique, which are relatively close to producing areas in Bolivia and Peru. Marijuana use is also growing. As a result, there has been increased research into the prevention and treatment of drug abuse.

Epidemiology

Chile suffered an outbreak of cholera in late 1990. The steps taken by the GOC to track the outbreak and to take legal and educational measures to contain it demonstrated a high level of sophistication in public health administration. In addition to cholera, other diseases which may have significant human and or

economic impact are closely monitored by Chilean scientists. Afthosa (foot and mouth disease), for example, has been eradicated in Chile.

Energy, Environment and Economics

Issues of energy, environment and economics have also become key as Chile tries to balance development with improving quality of life. Having gone through a process of free-market oriented economic reforms, the Chilean economy has grown significantly in recent years with attendant increase in the demand for energy. With much of its power generation industry now privatized, Chile has experienced a period of vigorous expansion in construction of generating capacity. Interest has been particularly great in harnessing Chile's very great hydroelectric potential. The GOC, which is in the process of drawing up a national energy strategy, has also indicated its interest in revitalizing Chile's coal industry. In this regard, the U.S. Department of Energy has provided Chile technical assistance on clean coal technology.

Metals mining and prospecting remain a key but environmentally problematical economic sector. Newer mines built by foreign investors respect international environmental protection standards, but older state-owned facilities have major environmental drawbacks. This is particularly the case with smelters, which emit significant amounts of sulfur dioxide. A decree on sulfur dioxide emissions was recently issued.

Economic growth has had significant environmental consequences in Santiago, Chile's capital and major urban center, which suffers from one of the worst air pollution problems in Latin America. There are now restrictions on driving downtown, and older, highly polluting buses are being withdrawn from service. Starting in 1992, all new automobiles sold in Chile will be required to have catalytic converters to use unleaded gasoline.

Environmental quality has become an important public issue and relevant research is taking place. Because of limited national resources, foreign assistance has been crucial to Chile's understanding of environmental phenomena. With help from USAID funding, a group of researchers at the Catholic University in Santiago has prepared a detailed survey of Chilean environmental problems. The Italian government has established an environmental research center on the Biobio River in south-central Chile.

At the end of FY-1991 the National Environmental Commission, an interagency GOC body, was in the process of drawing up new legislation and regulations on the environment.

Emerging Technologies

Chile is not a big player on key, cutting edge "emerging technologies," although some interesting work is going on. Nevertheless, with a significant pool of scientific and technical talent, and a highly entrepreneurial business community, Chile has been able to make some contributions. For example:

• Chilean researchers are seeking new uses for copper, a major Chilean natural resource. An effort is being made to develop a copper battery which could compete with environmentally problematic lead batteries.

• Chile has a very active computer software industry which produces and exports programs used in the banking, medical and forestry industries.

• Enaer, the aircraft firm owned by the Chilean air force, has produced the "Pillan" trainer and the "Nancu" light aircraft featuring a composite body.

Agriculture and Natural Resources

Agricultural and natural resources products are vital to Chile's economy. The production of fruits and vegetables for export has been a major success story in diversifying the economy, as have been the fisheries and forest products industries. Considerable scientific research is done in agriculture through the National Agriculture and Cattle Research Institute, which concentrates on applied areas such as pest eradication. There is also significant international exchange. For example, every year approximately 30-40 U.S. Department of Agriculture and Forest Service scientists visit Chile.

The Chilean National Fisheries Institute has been given new resources and responsibilities under a recently passed fisheries law which aims for integrated, scientific resource management of that sector. The GOC has similarly strengthened its main mining related institutions, the National Geology and Mining Service, which maintains Chile's Geological Survey; and the Center for Research into Metals and Mining, which does research into mining technology under contract from state and private mining firms.

CHINA

General

Two old slogans were resuscitated in 1991 to place new emphasis on the importance of science and technology to China's ten-year plan for economic and social development to the year 2000. The first, "Science and technology are the primary productive forces," which China's senior leader Deng Xiaoping put forth in 1986, became continually highlighted by Chinese media. Premier Li Peng endorsed a second slogan dating from 1982, "Economic development must rely on science and technology while the development of science and technology must be geared to the needs of economic development," in announcing China's eighth five-year plan in March, 1991.

The slogans were substantively reflected by the consolidation of six previous S&T plans into one coherent "Breakthrough Plan." "Breakthrough" refers to China's attempt to "leapfrog" other countries to a level of science and technology that is competitive in international markets with the major industrialized nations. 1991 funding for the "Breakthrough Plan" was around $2.5 billion.

Basic Science

China depends on and invites international science and technology cooperation. Since 1980, China has carried out science and technology cooperation with 108 countries at both governmental and non-governmental levels, and has concluded S&T agreements with no less than 56 countries, including the United States.

China's eighth five-year plan (1991-1995) and the ten-year economic and social development plan (1991-2000) identify key science and technology projects, which entail international cooperation in many instances. Over the next five years, China's basic research in the natural sciences will include research on high critical temperature superconductivity, the structure, performance, numerator design and equipment manufacture of photoelectric functional materials, climatic dynamics and weather forecast theory, the theory and method for large-scale scientific and engineering computation, and modern metrological science and technology based on quantum physics.

Cooperation with the U.S. under the Marine, Fishery and Atmospheric bilateral S&T agreements has figured prominently in China's development in marine and atmospheric sciences. Under these agreements the National Oceanic and Atmospheric Administration, in cooperation with other U.S. Government agencies, academia and private industry, has helped China to become a contributing scientific partner. Under the Marine and Fishery S&T agreement, NOAA's National Ocean Service and National Oceanographic Data Center helped the PRC establish a Chinese National Oceanographic Data Center; a U.S.-PRC team conducted a joint study of sedimentation dynamics in the Yangtze River/East China Sea; and U.S. and Chinese investigators have conducted joint cruises in the western Pacific.

Health and Life Sciences

China's medical and health services goal for the year 2000 is for every citizen to enjoy primary medical and health care, while continuing the nation's commitment to a comprehensive system of preventive medicine. During the eighth five-year plan, China hopes to reduce the nation's infant mortality rate by 10 to 15%; reduce the incidence rate of major infectious diseases by 20%; maintain effective control over snail fever; inoculate the populace in 85% of all townships and cities against the major infectious diseases; make potable water available to 85 percent of the rural population (i.e., over 850 million people); and add 450,000 hospital beds as well as 500,000 more professional health technicians.

Energy, Environment, and Economics

Environmental protection is Chinese "state policy," although the developing countries' Beijing Declaration, issued in June 1991, places responsibility for global environmental protection with developed countries. The eighth five year plan calls for China to maintain an acceptable level of environmental protection that does not curb economic development.

Coal, usually low grade and high in sulfur, supplies 75 percent of China's energy requirements. China's own air pollution studies recognize that coal is the major contributor to ambient concentrations of particulates and sulfur dioxide which are among the world's highest. Hydroelectric and thermal power are to be given greater priority, including the long-delayed and controversial Three Gorges Dam, which Chinese and foreign critics alike fear will cause massive environmental damage along upper reaches of the Yangtze river. China's decision to develop nuclear energy for commercial use has also triggered some environmental concerns.

Emerging Technologies

China's high-tech research and development program has identified seven key technologies to be developed by the year 2000 and beyond: new materials; biotechnology; and space, information, laser, automation and energy technologies. Amidst financial constraints, biotechnology, space and information have priority. Biotechnology will focus on increasing agricultural output and improving public health; space technology will focus on the development of a manned space vehicle; and information technology will focus on artificial intelligence based on a new generation of computers.

Agriculture and Natural Resources

China stresses international S&T cooperation in agriculture, including post harvest techniques, and fisheries and forestry production. The Ministries of Agriculture, Forestry, Commerce, Light Industries and Water Resources, numerous associated livestock, crop and functional institutes, and commissions and universities have participated in a wide range of international meetings, cooperative research activities and exchanges of technicians and scientists.

Among the principal activities with the United States has been the Ministry of Agriculture's annual agricultural science and technology exchange program with USDA's Office of International Cooperation. In FY-1991, ten Chinese and American teams traveled to each other's countries in groups of three to five people for several weeks each. Studies by the PRC teams ranged from environmental protection to efficient uses of wood fiber, and by the U.S. teams, from a livestock and feed study to research on forage germplasm. Two other important long-term U.S.-China cooperative projects involve a joint biological control laboratory under the auspices of USDA's Agricultural Research Service (ARS) and the Chinese Academy of Agricultural Sciences (CAAS); and an ARS-CAAS germplasm agreement in which the two countries are engaged in cooperation and scientific exchange on plant genetic resources.

The new five-year plan also envisions basic research on the utilization of sterile male hybrid cereal, cotton and oil crops, and research on predicting changes in the environment and on developing policies for coping with them.

CZECHOSLOVAKIA

General

Czechoslovakia has a strong scientific tradition dating from the Middle Ages and a cohort of scientists and researchers with solid basic skills.

The demise of the communist regime in November, 1989 left Czechoslovak science with a 40-year legacy of centralized command and ideological correctness. In the brief period since then, the Czechoslovak scientific community has set out to restructure the organization of science in the country and restore the professionalism and competency of Czechoslovak scientists across the board. Efforts have been concentrated on making those basic policy and institutional changes that will support Czechoslovakia's resumption of its once active role in the world scientific community.

The reform process has included democratization of science institutions, reorganization of government ministries at both federal and republic levels and of academies of science, and outreach to the West, particularly the U.S., in search of partnerships that will accelerate the reform and revitalization process.

After negotiations lasting over a year, Czechoslovakia and the U.S. signed a bilateral Science and Technology Agreement during President Havel's visit to Washington in October 1991. This umbrella agreement provides for cooperation in basic science, environmental protection, medical sciences and health, agriculture, engineering research, energy, natural resources, standardization, science and technology policy and management, and other areas as may be mutually agreed by the two parties. The agreement is jointly funded, with the U.S. contribution coming through the Department of State budget. The agreement will complement and expand joint scientific work already under way between a number of U.S. technical departments and agencies and their Czechoslovak counterparts.

Basic Science

The door is fully open to intellectual exchange with the United States in all fields of basic science. Although Western advances in technology and scientific instrumentation reached Czechoslovak scientists only as a distant echo during the Cold War period, theoretical research continued, stimulated in part by the need for ingenious approaches to scientific problem solving when modern technology was lacking. Development of the soft contact lens by a Czechoslovakian scientist has been the most frequently noted achievement, but good work was also done in such areas as physics, chemistry and materials science.

The Czechoslovak science community recognizes that basic science contributes to the modern technological infrastructure essential for the development of a free market economy. However, with so many urgent national priorities, it is particularly difficult to fund activities with no obvious immediate payoff. Thus, cooperation with other countries is especially important to sustain the existing pool of talent in basic science and build upon it for the future.

In this period of rapid change in Czechoslovakia, the term "basic science" cooperation has also come to encompass the whole process of democratization of the scientific establishment and science policy making. The U.S. National Science Foundation (NSF), National Academy of Sciences (NAS) and the American Association for the Advancement of Science (AAAS) are engaged with Czechoslovakian technical ministries and academies of science in a dialogue geared toward assisting the development of new institutions and a more coherent policymaking process, and better use of scarce human and other resources.

NSF currently has a basic sciences cooperative agreement with the Czechoslovak Academy of Science. NSF, NAS and AAAS are all actively collaborating with Czechoslovakian scientists and scientific organizations.

Health and Life Sciences

The health sector underwent major review during FY-1991 by the Czech and Slovak Republic governments (there is no federal level ministry of health,) and by a World Bank health sector team. As of the end of FY-1991, reforms were under consideration that could affect all aspects of health care policy, organization, services and financing. The Czech Ministry of Health also proposed the establishment of a regional health center that would serve the entire central and east European region.

Life expectancy, particularly for adult males, has since the 1950s stagnated or declined in Czechoslovakia relative to Western Europe. Approximately 80 percent of adult deaths are due to cardiovascular disease, cancers and injuries. The World Bank study attributes the high incidence of cardiovascular disease and cancer to alcohol and tobacco use, a diet high in animal fat and low in fresh vegetables, lack of exercise, obesity and stress. Infant, child and maternal mortality has declined greatly from the early post-World War II period, but the rate of decline since 1975 has lessened compared to neighboring west European countries. Abortion is relied upon heavily as a means of birth control.

There is considerable evidence that environmental pollution also contributes to health problems, but additional research is needed to establish specific relationships between various sources of environmental pollution and health problems. Although data on the health status of the population are extensive and readily available, the World Bank study concludes that epidemiological studies are needed to clarify the relative impacts on health of environmental pollution, social conditions and lifestyles.

Other priority needs include institutional reforms in health care delivery, training (including that of nurses), access to family planning information, and reforms in the health care financing and social insurance areas.