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# National Academy of Sciences: International Development Programs of the Office of the Foreign Secretary

## Summary and Analysis of Activities, 1961-1971

PREPARED FOR THE
BOARD ON SCIENCE AND TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT

HARRISON BROWN
THERESA TELLEZ

NATIONAL ACADEMY OF SCIENCES
Washington, D.C.

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The opinions and conclusions contained therein do not necessarily represent those of AID.

NATIONAL ACADEMY OF SCIENCES
Washington, D.C.

This report has been prepared by the staff of the Office of the Foreign Secretary, National Academy of Sciences, for the Office of Science and Technology, Bureau for Technical Assistance, Agency for International Development, Washington, D.C., under Contract No. AID/csd-2584, T.O. #1.

## INTRODUCTORY NOTE

This report, undertaken for the Academy's Board on Science and Technology for International Development (BOSTID) and for the Agency for International Development, covers efforts of the National Academy of Sciences in countries of Africa, Asia and Latin America during the ten years ending in 1971. Although the major focus is on program activity resulting from science workshops which began in 1964, for historical reasons, the coverage of activity reaches into the years prior to 1961 and into 1972. Because of the many sensitivities involved in Academy relationships with individuals and groups overseas, the analysis in its present form is intended for AID's internal use only. A condensed version of this report will be prepared for wider public dissemination.

The present report, we feel, will be helpful to board and staff members and to AID personnel because of the several different ways by which program effectiveness was examined.

After circulating drafts to BOSTID staff and selected members of BOSTID for comments, we received numerous criticisms and suggestions, for which we are very grateful. To the maximum extent possible, we have incorporated their suggestions. The authors, however, had to use their best judgment in making final decisions, based on information at hand, the overall perspective of the report, and the intended audience. Therefore, the authors assume full responsibility for the views and conclusions drawn from the data in the analysis.

That this is largely a self-analysis should be emphasized, because it was not kept in mind by some readers. In our writing, we made a deliberate effort to minimize our enthusiasm for developments we found exciting and unique. Most of the report consists of a straightforward, factual account of events which in themselves reveal interesting findings that are discussed in the analysis.

We have acknowledged that one of the more important keys to success has been the involvement of high-caliber individuals and, in describing events, we have noted the roles played by many individuals and advisory groups, from

both the United States and abroad. However, because the document focuses mainly on events and results, individual contributions are not highlighted as perhaps they should be, considering their importance.

In the case of staff of the Office of the Foreign Secretary (OFS), we think it prudent to acknowledge staff work in a general way rather than to single out individuals. At the same time, we emphasize that a great deal of credit for the success of some programs belongs to highly dedicated and imaginative staff members--which has been pointed out time and again by board members and colleagues overseas.

Harrison Brown
Foreign Secretary

Theresa Tellez
Professional Associate

National Academy of Sciences
May 1973

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# I

## SUMMARY

During the past 10 years there has been a concentrated attempt by the Office of the Foreign Secretary of the National Academy of Sciences to apply scientific and technological knowledge to the problems associated with underdevelopment. This review and analysis focuses on programs of scientific cooperation with underdeveloped countries during the period ending in 1971. The primary objective of the study is to determine the strengths and weaknesses of past efforts to gain a better perspective for planning and operating future programs.

The principal business of the National Academy of Sciences (NAS) and its constituent bodies is to advise the U.S. government on matters pertaining to science and technology, and to engage in activities that strengthen U.S. science. Nonetheless, the NAS has a long tradition of communication and cooperation with scientific communities in other countries. The principles of science are universal, and the scientific endeavor is worldwide. For centuries, international communication in the scientific community has been essential to scientific progress, and from its founding the National Academy has fostered the flow of scientists and scientific information between the United States and other countries. In retrospect, it seems clear that had U.S. scientists not been able to study and work in European universities during the 19th and early 20th centuries and had European scientists not come to the United States to teach in our universities, U.S. scientific capabilities would have grown more slowly and would not have reached their present level. "Technical assistance" contributed substantially to our national development.

The assumptions underlying the international development programs under review are based on the belief that (1) scientific and technological growth is an essential element of national development; (2) indigenous scientific capability or local problem-solving competence is requisite for a country to lessen its dependence on others; and (3) science can be applied to human betterment in general, and specifically to the problems of poor nations suffering from hunger, disease, and inadequate resources.

The NAS's current interest in underdeveloped countries began in the late 1950's. Before that time, its international endeavors were confined to maintaining cordial working relationships with sister academies in other countries, particularly in Western Europe, and to participating in activities of the International Council of Scientific Unions and its constituent unions. After World War II participation in international scientific endeavors began to expand. With other organizations, the NAS participated in the development of a program of scholarly exchanges made possible by the Fulbright Act of 1946. The NAS also created the Pacific Science Office to sponsor and promote scientific research in the Pacific. A program of scientific exchanges with the Academy of Sciences of the USSR, inaugurated in 1959, eventually led to similar programs with other Eastern European countries. The NAS also played a leading role in organizing multinational cooperative scientific endeavors such as the International Geophysical Year (1957-59), noted in part for the gigantic cooperative research and exploration program in Antarctica; the International Biological Program (1964), and later in the 1960's, the International Indian Ocean Expedition.

In 1958, the U.S. International Cooperation Administration (ICA) asked the NAS to examine the scientific and technological components of U.S. technical assistance programs in Africa south of the Sahara and north of the then Union of South Africa, and, in 1959, to advise on technical assistance programs in Latin America. The NAS's involvement became more substantial after the ICA was reorganized into the U.S. Agency for International Development (AID) and when the Alliance for Progress was created in 1961.

In 1963, one of the first projects undertaken with AID support by the Office of the Foreign Secretary (OFS) was a science book program, designed to make available at low cost U.S. scientific and technical books to institutions in underdeveloped countries. The NAS undertook the subsidized book-purchase program as an experiment in developing a viable mechanism to provide better access to technical books. From 1963 to 1968, technical books were sent to institutions in Brazil, the Central American republics, Korea, Indonesia, Nigeria, Ethiopia, UAR, Ghana, Turkey, and Iran. The NAS phased out its activities when Franklin Book Programs was preparing to undertake an expanded program. Unfortunately, the Franklin organization was unable to carry out the proposed program because of financial problems.

REGIONAL ACTIVITIES

In 1963, the Latin America Science Board (LASB) was created by the NAS to advise on programs under the Alliance for Progress; and in anticipation of similar activity in Africa, a regional advisory board (Africa Science Board, or ASB) was also established. With variation in emphasis and technique, the LASB, the ASB, and the long-established Pacific Science Board (PSB) concentrated on ways and means to strengthen scientific competence in their respective regions. Members of the boards were eminent U.S. scientists and other scholars with special knowledge of the particular geographic areas. The ASB was supported by the Ford Foundation; the LASB by AID; and the PSB by the National Science Foundation, the Office of Naval Research, the Smithsonian Institution, and private sources. The Rockefeller Foundation also contributed substantially to all these efforts. Thus, according to sponsorship, the ASB was relatively independent, but its level of activity was limited; the LASB was tied to the goals of the Alliance for Progress but had greater financial backing; and the PSB engaged in multifarious activities, most of which were oriented to increasing U.S. competence in the scientific exploration of the Pacific area rather than to development.

Although not ignoring individual country needs, the regional approaches, especially in Africa and Latin America, were aimed primarily at multinational efforts to solve common problems, particularly in agriculture, health, and higher education in the sciences. The NAS sought the participation of existing counterpart institutions, and encouraged their establishment where such institutions were lacking. In addition, NAS established contacts with regional organizations such as the Scientific Council for Africa (CSA) and the Commission for Technical Cooperation in Africa South of the Sahara (CCTA).

In Latin America, ties already existed between the Academy and the few national research councils (in Mexico, Brazil, and Argentina) and other scientific bodies, including the Department of Scientific Affairs within the Organization of American States (OAS). The LASB's charge was to identify opportunities for research in U.S. programs sponsored under the Alliance for Progress. In performing this task the LASB made direct contacts with USAID missions in major aid-receiving countries. Although the LASB recommended some programs for specific countries, its main interest lay in developing regional research programs that would involve multinational efforts. That such programs were premature for national governments, and for USAID missions, became evident in the ill fate of an intensive study on research in tropical agriculture conducted by an LASB task

force at the request of AID. As matters turned out, significant support of science in Latin America did not come about until the Punta del Este Summit Meeting in 1967.

The Africa Science Board was not as successful as the LASB in obtaining AID support for its early activities. Nevertheless, in the early 1960's the board members established contacts during visits to several African countries which led to the development of substantial programs. Subsequently, AID began to support several agricultural studies, including a large one on rinderpest disease. Continued interest in tropical agriculture led to a pan-African conference in 1968. This conference in turn led to the creation of the Association for the Advancement of Agricultural Sciences in Africa (AAASA), the first pan-African scientific society, and to other meetings and studies. Subsequently, a study on African agricultural priorities was requested by AID and is currently a collaborative task of the OFS and the NAS Agricultural Research Board, with African and European scientists participating. Other major studies sponsored by the ASB, funded by AID and Rockefeller Foundation funds, dealt with water resources and the biological-sociological problems engendered by the construction of the Kainji Dam in Nigeria.

The early experiences of the LASB and ASB in attempting to garner support for regional programs provided valuable lessons. All too often, regional programs in Latin America were regarded by potential participating nations as undertakings that would expend valuable human and capital resources with little return. Seldom were they viewed as concerted attacks on common problems that would conserve resources and avoid duplication. In both Latin America and Africa, weak organizational structures and lack of trained personnel contributed to a general lack of enthusiasm by national governments, and by AID. As a result, the two NAS boards looked for possible constructive programs in specific countries showing a potential for improving their scientific and technological capabilities. This move from the regional to a more focused approach on the national level paralleled the emerging bilateral activity in Taiwan under the auspices of the PSB.

BILATERAL PROGRAMS

In Asia, the initiative for a Sino-American meeting on science and technology came from the Academia Sinica of the Republic of China (Taiwan) in 1963. The first meeting, a workshop, held in Taipei in 1964, led to a bilateral cooperative program between the NAS and the Academia Sinica in several areas of science and technology. As the program began, the country had reached a point of economic sufficiency at which AID was phasing out its assistance; the program was privately funded with major support from the Asia Foundation.

Bilateral programs in Africa and Latin America began with the more explicit goal of viewing national priorities in terms of applying science and technology to problems of economic and social development. Initially these programs emphasized the role universities could play in training manpower for the development and management of natural resources and the organization of research. AID provided financial support. The countries selected were those believed to have potential for generating support for science from both internal and external sources. Exploratory workshops held with Nigerians in 1965 and with Brazilians and Peruvians in 1966 led to further bilateral activity and encouraged the initiation of similar workshops in other countries.

As bilateral programs have evolved in several countries, some changes have occurred in the structure of relationships, program activity, and mode of operation. Within AID, the establishment of an Office of Science and Technology within the Technical Assistance Bureau centralized the interest in NAS science cooperation programs. To be effective, bilateral programs also needed closer relationships with AID missions abroad. Within NAS, the regional boards were eventually superseded in 1969 by the Board on Science and Technology for International Development (BOSTID)*, which has used increasing numbers of panels and ad hoc groups for various projects and studies. To examine national priorities in a more systematic and comprehensive manner, OFS strengthened links with foreign counterpart institutions, in the belief that national research councils, science ministries, or similar bodies could serve as focal points for marshalling internal and external resources.

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*Preceded by the Science Organization Development Board, created in 1966.

At first, workshops were conceived as weathervanes to explore the feasibility of NAS cooperative programs in certain countries; however, the workshops have developed into a continuing activity with a wide spectrum of functions, such as developing, overseeing, and evaluating programs in science and technology considered necessary to national development.

In countries where the NAS - counterpart relationship is particularly strong, and is constantly reinforced through personal contact between representatives of the two participating institutions, numerous constructive developments have taken place. Joining forces brings together matching and complementing expertise, and this collaborative, institutional arrangement has no doubt helped to persuade many a planning ministry of the good intentions of participating parties and of the potential benefits for the country.

The bilateral programs have not been uniformly successful, nor have they been free of major difficulties. Political relations between governments and internal political upheavals have often disrupted institutions, personnel, and finances. Since these programs began, military coups or wars in Nigeria, Ghana, Argentina, Peru, and Bangladesh*, have directly or indirectly affected bilateral activities, usually by delaying action. In Nigeria, two military coups in 1966 and prolonged civil strife thereafter prevented the development of a bilateral program, although the NAS stayed in touch with Nigerian scientists--partly through the participation of the universities of Ibadan and Ife in ecological studies of the Kainji Lake Basin, sponsored by the Water Resources subcommittee of the Africa Science Board.

In all countries, the NAS has strived to maintain its relationships with the scientific communities even under the most difficult circumstances. In some dire situations such contacts have proved to be of critical importance. For example, serious concern was aroused by the mistreatment of the academic communities in Argentina and Brazil in the mid-1960's, attributed in both cases to military and political heavy-handedness. Colleagues in both countries asked for moral support, and in the case of Argentina, high-level scientists pleaded with the NAS to beseech President Onganía to intervene on behalf of scientists. Also, scientists who chose to leave their countries asked for professional placement in many countries, including the United States.

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*Disrupted the program in India.

During this period, some scientists in Argentina, Brazil, and the United States expressed the view that the NAS should sever all relations in these countries, thereby denouncing the regimes. NAS policy, however, has been to avoid either endorsing or censuring governments and, instead, to work closely with the local scientific communities.

The case of the Argentine graduate science students who were left stranded by the precipitous departure of their professors was considered an emergency situation; the NAS helped to place some students in U.S. universities. Most, however, chose to complete their work in Latin America.

The Argentine disruption in the universities caused a delay in the first bilateral workshop of at least 2 years.

By the end of 1971, 26 bilateral workshops had been held in 12 countries: 1 each in Ghana, Nigeria, Zaïre (the Congo), Argentina, Chile, and Colombia; 2 each in India, Indonesia, and Peru; 4 alternating between the Philippines and the United States; 4 between Brazil and the United States; and 6 between Taiwan and the United States.

Most workshops have dealt with the general theme of science and technology in economic and social development and have focused on priorities of research. Specialized workshops dealing with a particular topic have so far been held only in Asia. Industrial research has been the subject of workshops in India, Indonesia, the Philippines, and Taiwan. Food, ocean resources, fisheries, and oceanography have been discussed at workshops in Indonesia, Taiwan, and the Philippines. In India, the last workshop focused on water resources and associated problems of environmental pollution. Two regional workshops held in Central America and Southeast Asia focused on problems of environmental pollution and development.

The topical orientation of workshops is shown on Chart 1, "Bilateral Workshops: Major Topics by Country, 1964 - 1971" (see p. 12). The principal categories of interest have been national science policy and organization; sectoral R&D (e.g., agriculture, industry, health); science education; and multidisciplinary problems such as food-nutrition, environmental pollution, and marine resources.

Workshop topics and the number of countries in which they have been studied are listed below:

| | |
|---|---|
| Science Policy and Organization | 12 |
| Natural Resources | 11 |
| Manpower and Education | 10 |
| Industrial R&D and Management | 10 |
| Agriculture | 9 |
| Medical Sciences, Public Health, and Demography | 8 |
| Scientific and Technical Information, Computers, and Communication | 7 |
| Marine Sciences and Fisheries | 6 |
| Food and Nutrition | 5 |
| Social Sciences and Humanities | 4 |
| Transportation | 1 |
| Urbanization and Unemployment | 1 |

Aside from the predominant interest in science policy and organization inherent in all the workshops, the main focus has been on four topics: Manpower and Education; Agriculture (including Food and Nutrition); Natural Resources; and Industrial R&D and Management. Follow-up activity, however, is more concentrated in science education and research, as reflected by the 10 study groups in Chart 1 concerned with various disciplines. The next area of concentration is in the agricultural sciences for which 5 study groups have been organized. Although industrial research shows but 2 study groups, follow-up activity has been largely at the local level; and if the BOSTID studies and panels dealing with various aspects of industrial research are included, the interest in this area is quite extensive. In contrast, natural resources and medical sciences have had little follow-up. Except for the study groups in Zaire, established in early 1972, programs dealing with demography and biosocial aspects of population are noticeably absent. Problems of rapid population growth have been discussed at many workshops, but this topic remains in low profile in bilateral programs.

Workshop meetings have generated a total of 21 joint study groups, most established to examine education and research needs in basic science and in areas related to agriculture and industry. The regional workshops on environmental aspects of development were the direct result of an AID inquiry overseas.

In addition to study groups, the workshops have stimulated several other cooperative bilateral endeavors: specialized seminars and conferences, short-course seminars, science

policy missions, provision of staff personnel for short-term assignments, and a major project to develop graduate education and research in chemistry. The two-way flow of persons attending meetings, conducting studies, or visiting institutions has resulted in the establishment of many institutional ties among universities, professional societies, research institutes, and technical assistance agencies. For example, an outgrowth of contacts between BOSTID members and Thomas Odhiambo, University College in Nairobi, was the creation in 1970 of the International Centre of Insect Physiology and Ecology in Nairobi, Kenya. BOSTID members and staff participated in the early planning and development organized by the American Academy of Arts and Sciences and Dr. Odhiambo.*

Parallel to the bilateral workshop activity, a number of studies have been conducted, at AID's request, on aspects of science and technology in development.

A 2-year study undertaken for AID by the Office of the Foreign Secretary, not under BOSTID's auspices, examined the consequences and policy implications of rapid population growth. Under the chairmanship of Roger Revelle, a committee of 11 persons assessed the extent of knowledge on population questions.**

Many problems considered in the BOSTID studies have been identified at workshops; others reflect AID's interest in pursuing additional opportunities for study and action. Important examples are these current studies:

-Development of Research Administration and Technical Managers in Newly Industrializing Countries.

-The Role of U.S. International Firms in Strengthening R,D&E in Developing Countries.

-Appropriate Technologies for Developing Countries.

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*See "East African 'Center of Excellence': The International Centre of Insect Physiology and Ecology." Bulletin of the American Academy of Arts and Sciences. Vol. XXV, No. 6. March 1972. pp. 3-23.

**National Academy of Sciences. Office of the Foreign Secretary. Rapid Population Growth: Consequences and Policy Implications. Vol. 1. Summary and Recommendations. Vol. 2. Research Papers. Baltimore: Johns Hopkins Press, 1971. 690 pp.

A related study on a proposed International Industrialization Institute reflects AID's interest in new approaches to technical assistance in areas of industrialization. Two other studies are worth mentioning: one on post-AID assistance to Korea completed in 1969 and the study now under way on the Role of Science and Technology in Economic Development in the 70's.

Other experimental approaches and techniques are currently under trial. In a joint project, the Brazilian National Research Council (CNPq) and the NAS are working to develop a program of graduate teaching and research in chemistry at two major universities in Brazil. Begun in 1969, the Chemistry Program involves such innovative features as the creation of NAS Overseas Research Fellowships and the commitment of several U.S. universities to assist U.S. fellows and Brazilian faculty and students. Another project seeks to identify appropriate and innovative technologies for underdeveloped countries. This project is guided by an advisory committee and a series of technical panels now looking into such matters as small power sources, ferrocement uses, roofing systems, and food problems.

In summary, the program pattern over the last decade reveals a beginning which was regional and problem-oriented, followed by a bilateral focus, and a present resurgence of interest in problem-oriented studies and regional endeavors. The principal tools used by BOSTID have been bilateral workshops and joint study groups coupled with special advisory missions requested by the host institutions. In addition, BOSTID has sponsored special studies, international conferences, and symposia. A number of studies concerned with problems common to underdeveloped countries are, or have been, conducted by technical panels, some of which are multinational in membership. On an experimental and pilot basis, BOSTID has also undertaken the special projects such as the previously mentioned technological innovation and Brazil chemistry programs.

Although no major attempt has heretofore been made to evaluate the overall performance of NAS programs in underdeveloped countries, continuous reviews and evaluations have been part of BOSTID's functions. Periodic project and contract reviews are held within AID, and in April 1972, a panel convened by AID evaluated NAS programs in Brazil, Ghana, Indonesia, and India.

The data collected for the analysis that follows consists of correspondence, comments, proceedings, and reports of workshops, study groups, panels, communications from AID,

and other pertinent documentation. For descriptive narratives of bilateral programs and other special projects see Appendices A and B. For reports and publications, see Appendix C.

Chart 1. BILATERAL WORKSHOPS: MAJOR TOPICS BY COUNTRY, 1964 - 1971

| | Science Policy & Org. | Manpower, Education | Agriculture (Res., Trng., Exten.) | Food & Nutrition | Medical Sci., Public Health, Demography | Natural Resources (Forestry, Water, etc.) | Marine Sciences, Fisheries | S&T Info., Computers, Communication | Indus. R&D, Management | Soc. Sci. Humanities | Environ'l Probs. | Transport | Urbanization, Unempl. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ghana | x | x | S-Agr. Res. | | x | x | x | | x | | | | |
| Nigeria | x | | x | | x | x | x | | | | | | x |
| Zaïre | x | S-Earth Sci. | x | S | S-Demography<br>S-Primates | x | | | | | | | |
| India | x | | | | | x | | x | x | | | | |
| Indonesia | x | x | x | x | | | | x | x | | | | |
| Philippines | x | x | x | x | x | x | x | x | x | x | | | |
| Taiwan | x | x | | | x | x | x | x | x | xx | | | |
| Argentina | x | x | x | S-Food Tech. | | S-Hydrology | | S-Sci. Info. | x | | | | |
| Brazil | x | S-Earth Sci.<br>S-Steroid Chem.<br>S-Chemistry | S-Agr. Res.<br>S-Agr. Econ. | | x | x | | S-Computers | S-Indus.<br>S-Norms, etc. | | | S-Transp. | |
| Chile | x | x | | x | | x | x | | | | | | |
| Colombia | x | S-Chemistry<br>S-Math S-Biol.<br>S-Engr-Phys-Geol | x | | | x | | | x | | | | |
| Peru | x | x | x | | x | x | x | x | x | x | | | |
| Totals | 12 | 10 | 8 | 5 | 8 | 11 | 6 | 7 | 10 | 4 | | 1 | 1 |
| REGIONAL WORKSHOPS<br>Central America | | | | | x | | | | | | x | | |
| SE Asia (Singapore - 1972) | | | | | | x | | | | | | | |

S=Study Group (21 total)
x=Topic at a Workshop

## II

## ANALYSIS

Examining the experiences of the past decade raises many questions. Has the National Academy contributed significantly to the solution of some of the pressing problems facing underdeveloped countries? Have we been able to help build indigenous scientific and technological capabilities? What have we accomplished in the short run? What is likely in the long run?

Although this analysis is a self-evaluation, many judgments and opinions and most of the information were provided by our counterparts, consultants, and colleagues from other institutions--AID, private foundations, and industry. A principal source of information has been the progress reports made at workshops by representatives of overseas counterpart institutions.

A primary objective of the evaluation was to look for patterns of change resulting from program activity. A major action taken in response to bilateral recommendations was considered an important indicator of program effectiveness. Some actions or indicators were then examined country by country for an overall pattern. Another objective was to quantify the actions taken toward implementing bilateral recommendations. Patterns of change were also viewed as short-term or long-term developments.

The evaluators have tried to identify the principal factors that influence program effectiveness and those that determine basically whether anything will happen to improve the state of science and technology in a country, regardless of how well-conceived and highly motivated a given bilateral program might be. Factors considered include political relationships, local political stability, attitudes of AID in Washington and the USAID missions, the quality and influence of the local program leadership, the availability of financing, and the quality of U.S. inputs.

Program effectiveness has been viewed in three stages at which the different types of action are needed, and

thus involving different institutional relationships: (1) NAS - AID/Washington and USAID missions; (2) NAS - counterpart; and (3) any combination of the four, plus any others concerned with implementation. (See Charts 2 and 3, pp. 29-35.) In making recommendations, the relationships between the NAS and AID/Washington and USAID missions on the one hand and counterpart institutions abroad on the other have been critical. Implementing recommendations involves a third set of relationships that may or may not involve the NAS directly.

However diffuse the NAS role may be at the implementation stage, the origin, timing, or character of many significant developments can be traced to NAS bilateral activities. An attempt was made, therefore, to look for indications of relationships to NAS programs at all stages of local program development.

The results reflected at the implementation stage are among the most important indicators of overall effectiveness because they reflect the attainment, by all parties concerned, of major objectives and often guide future programs.

## INSTITUTIONAL RELATIONSHIPS

### Between NAS and AID/Washington and USAID Missions

The significant increase in the number of bilateral programs and other projects requested of the NAS by AID in recent years could in itself be interpreted as a reflection of NAS success. To avoid oversimplification, however, other variables are examined and developments and accomplishments discussed that reflect the trend of NAS-AID relationships.

Over the past decade, the NAS has advised AID's regional bureaus for Latin America, Africa, and the Far East; the Bureau for Technical Assistance; and the field missions. Initially, when little attention was given to science and technology (S&T) as such, the scientific and technical components of AID programs were situated entirely within regional or country programs. Initial contracts with the NAS for advice were with regional bureaus, although USAID overseas missions were primarily responsible for implementing programs. Thus, the NAS had to surmount two major problems: getting AID programs involved with S&T and working simultaneously with several offices of AID because of the jurisdictional programs within that organization.

At present, the NAS is under contract to the Office of Science and Technology, established within the Bureau of Technical Assistance in 1969. In addition, many USAID missions

contract with the NAS directly for specific aspects of the bilateral programs. There is still some confusion about responsibilities and jurisdictional boundaries among the AID entities and about whether some projects fall within the "development" framework, currently a major consideration within AID. Nevertheless, there is no doubt that AID itself has recently been showing more and more attention to S&T in foreign assistance programs, as manifested by the creation of the Bureau for Technical Assistance. Within the bureau the Office of Science and Technology, in particular, has actively promoted NAS workshop activities among its foreign programs, and more recently it has increasingly used the NAS to conduct specialized studies of problems with substantial technological components that affect underdeveloped countries. The bureau, of course, uses and contracts for the services of many institutions, but the NAS contract is the only one of its kind--with the objective of strengthening the capabilities of underdeveloped countries in S&T in general. No other U.S. institution, to our knowledge, has undertaken such extensive programs in science relating to economic and social development.

Approximately 38 publications of workshop proceedings and auxilliary reports, together with some 45 technical reports by joint study groups and consultants have resulted from the bilateral programs. In addition, some 20 special studies have been undertaken, many in the last 2 years, including 5 now under way that deal with appropriate technologies for underdeveloped countries. Because these studies are not country-specific, dealing rather with problems of developing countries in general, they have been undertaken within the NAS with the participation of specialists from developing countries. All publications and reports are submitted to AID and, when appropriate, made available to counterpart institutions and other groups and individuals interested in development problems.

The recommendations that have emerged from workshops and related activities have determined much of the emphasis of NAS programs, provided AID a framework for evaluating the state of science in a number of countries, and established priorities that reflect the views of the local scientific communities. Where AID representatives have been involved in the programs from an early stage, responses to recommendations have usually been positive, subject of course to the availability of funds. Interaction between the NAS and its counterparts on the one hand, and between the NAS and AID on the other, has in most cases resulted in coordination of effort and better ordering of priorities.

Some USAID missions have increasingly relied on NAS advice for major programs in science and technology, as in Brazil, which was until recently the recipient of the second largest U.S. foreign assistance effort. AID has also sought NAS advice on countries such as Korea, which in the near future will no longer receive major AID support, on ways to make U.S. technical expertise and assistance continue to be available, once AID phases out. In this way, some adverse effects of sudden termination of programs, such as Taiwan experienced when U.S. aid was withdrawn, can be avoided.

Perhaps more than any other single mechanism, the NAS sponsorship of bilateral programs has provided AID a wide opportunity for tapping the U.S. scientific and engineering community. NAS programs have attracted high-caliber experts from an extensive pool of talents. A large part of the U.S. S&T community is deeply concerned about the problem of world poverty; the bilateral programs provide a mechanism that enables many of them to become seriously involved in development problems.

Since the beginning of the bilateral programs in 1964, nearly 500 U.S. scientists and engineers have participated in workshops, conferences, and studies. Over half worked directly with programs abroad, and many have made large commitments in time and effort to joint studies or other activities generated by the programs. Another 200 specialists have been involved in BOSTID studies, ranging from 1-day meetings to studies lasting longer than 2 years. In the NAS tradition, nearly all participants volunteer their time and are reimbursed only for per diem and travel expenses. A few paid consultants were involved in cases requiring services and time beyond the usual 10 - 15 days generally required for workshops and overseas visits by study groups. The increased number of technical studies requested by AID in the last 2 years has made it necessary to hire some highly specialized employees on a short-term basis. For the most part, however, the technical and professional services of scientists and engineers provided by the NAS to AID has been a contribution of volunteer participants, and the cost to NAS has been primarily for staff support, in addition to the travel and per diem expenses of experts attending meetings.

## Between NAS and Counterpart Institutions

The choice of a counterpart institution and effecting good working relationships with it are key elements of

a successful bilateral program. The major responsibility for enhancing science and technology within a country, and for applying them to the solution of development problems, rests with local institutions. Therefore, as many of these institutions as possible should be involved in the bilateral program from its earliest stages. The counterpart institution, usually a national research council or the equivalent, must have motivation, influence, and qualities of national leadership to mobilize local institutions for the achievement of common goals.

The single most significant characteristic of NAS relationships with counterpart institutions has been the concept of partnership. The importance of partnership cannot be overemphasized in dealings between countries stigmatized by the labels "underdeveloped" and "developed"--often interpreted as "inferior" and "superior." Joint decision making with counterparts has been beneficial to both sides at the personal, as well as the institutional, levels.

Joint effort was deemed essential for several reasons, both philosophical and pragmatic. Too many "experts" have prescribed remedies for ills they knew little or nothing about. Because advisors are expected to advise (interpret, "to come up with solutions"), usually within a limited time, the listening-learning-solving process has too often lacked substance and sensitivity. To avoid this, the learning and solving process should be synergistic, combining the talents of experts from both countries. A more pragmatic consideration is that because any effective or lasting social or cultural change depends primarily on local institutions, local input at all levels of problem solving is indispensable.

Ideally, there will be a joint sharing in the total endeavor, including planning, decision making, participation in meetings, projects, selection of participants, hosting, financing, reviewing, and evaluating. Most of these ideals have been met in NAS programs, in some more completely than in others.

One difficulty has been cost sharing in countries where S&T have had low priority in national budgets. For instance, it was not possible to secure local funding for workshops in Peru or Nigeria, countries with no NAS-NRC counterpart at the time of the workshops. Reciprocal meetings in the United States have also been difficult to arrange because of the lack of travel funds which the counterpart must provide. Nevertheless, the idea of cost

sharing has appealed to all colleagues overseas, despite some difficulties. Fortunately, some USAID missions have willingly provided funds for initial endeavors until individual projects or programs could be locally funded.

The mutual effort in program development has been highly satisfactory and rewarding from initial planning of workshop agenda and selection of participants through joint studies and implementation of recommendations. Alternating meeting sites has proved useful in unforeseen ways for scientists of both countries. Exposure to each other's working environments and institutions has often given better insights into the nature of the problems faced and the facilities needed for their solutions. Seminar-type sessions at workshops held in the United States on research policies in various governmental agencies and on R&D administration in industry have proven sufficiently useful that counterpart institutions have been prompted to hold similar seminars at workshops in their countries.

One of the most useful functions of the NAS in its relationships with counterpart institutions has been its catalytic role. In most underdeveloped countries, before the NAS workshop, there was little interaction among scientific institutions and almost none between the counterpart institution and important parts of the governmental and private sectors. From the first Peruvian workshop to a more recent one in Ghana, the seemingly simple act of bringing scientists together with key planners to discuss an obvious need has brought repeated praise. For example, M. Dowuona, Chairman of the Council for Scientific and Industrial Research in Ghana, stated,

> The Workshop...was, in many respects, a unique event in the history of scientific development in Ghana. Never before has there been such a gathering in Ghana of Ministers of State, Heads of University and Research Institutions, Deans of Faculties, Directors of Research Institutes, Professors, Lecturers and Research Officers, for the purpose of discussing in real earnestness how science may be developed and scientific research planned and organized so as to have the requisite impact on the economic and social development of the country. The importance of the occasion was enhanced by the participation of a strong team of scientists from the U.S.A., covering a wide range of disciplines, and having behind them considerable knowledge and experience of the status and role of science not only in their own country but in several countries of both the developed and the developing world. Their contribution helped on several occasions in guiding the discussion and

> in clarifying some fundamental issues involved in a number of controversial matters. Also where local efforts were halting because uncertain, they were able to bring their wider knowledge and experience to bear in reinforcing or in questioning wavering convictions equally, as seemed appropriate to them, they did not hesitate in criticising assumptions underlying on-going, full-fledged programmes.*

Interaction among diverse but select groups of participants has often resulted in the formulation of recommendations of programs that are more workable and more politically feasible than they might otherwise have been. Moreover, NAS representatives have often been asked to accompany local scientists to meetings with planning ministries or other fund-granting institutions. Although at times this may be mainly a symbolic gesture, increasing care has been given to the formulation of programs that require joint endorsement. The idea of joint endorsement by the NAS and the local scientific institution has likewise led to more careful planning and implementation.

The NAS's relationships with counterpart institutions have grown from an initial stage of curiosity and caution to the present era of, for the most part, friendliness and openness. The relationship is, of course, greatly influenced by the nature of the local institution; therefore, the NAS has strived to maintain enough flexibility to permit it to deal with embryonic research councils, as well as the more mature and rigid institutions. In avoiding over-enthusiasm and, related to it, the danger of falling into a parent-child relationship, the NAS is often reminded of the friendly but frank advice given by a colleague at one of the early workshops: an "NAS push would be necessary periodically--only don't push too hard." This advice has encouraged new, more flexible approaches at times when little appeared to be happening with recommended projects.

One of the best examples of NAS technical assistance at the counterpart level is reflected in the results of the study on the problem of developing industrial research in Brazil. This exercise involved breaking new ground for the Brazilian National Research Council (CNPq), which was most reluctant to go beyond academic expertise and

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*"Foreword." Scientific Research in Ghana. Part II. Proceedings of the Workshop on Research Priorities and Problems in the Execution of Research in Ghana held in Accra. CSIR and NAS. 1971. p. i.

draw in private and governmental industrial experts for the study. Nevertheless, the leaders of the CNPq were eventually persuaded of the need and were helped to choose appropriate representatives. Once formed, the joint study group itself had several hurdles to overcome, but in its deliberations it, too, managed eventually to transcend a number of important but sensitive issues. The Brazilian component of the joint study group became so intensely interested in the problem that it met some 30 times over an 18-month period. Since the report was issued in 1968, several recommendations of major import have been implemented. NAS assistance to the CNPq at an early stage and at subsequent critical junctures contributed substantially to the success of this effort. In the years since the publication of the study, the CNPq has continued to exert influence by sponsoring national and regional meetings and forming specialized panels to consider various aspects of Brazil's industrial research needs. Other parallel, joint efforts of the NAS and the CNPq have reinforced the gains in industrial research--for example, the study on Norms, Standards, and Testing, and the Chemistry Program, which is concerned directly with university graduate research.

The NAS - counterpart relationship, best exemplified by the Brazilian case, has been duplicated in other countries such as Indonesia and India. In other countries of Asia, South America, and Africa, the dyadic relation is more often than not on firm ground, but the effectiveness of implementation ranges from teetering to promising, for it depends also on the financial strength, political influence, leadership, and flexibility of the counterpart institution.

Bilateral programs, which always involve personal interaction, have not been without strains. The strains in relationships that have occurred have been mainly at the study-group level, where the interaction is more intense and both staff and experts labor to produce recommendations acceptable to all parties. These problems have generally been surmounted, except for the U.S. - Brazil transportation study group which had difficulty in getting under way because of the conflicting viewpoints of some of its members. This particular study has not been resumed beyond the preliminary consultations because CNPq subsequently gave it a low priority, and funds have not been made available for its resumption. In similar cases with mismatching of study group members and personnel, the programs have been resurrected by changing some of the people on both sides.

Slightly different problems arose in the more recent Colombian study group activity (originated late 1971 - early 1972). In this case, the NAS is collaborating with two

counterpart institutions: the Colombian Fund for Scientific Research and Special Projects "Francisco José de Caldas" (COLCIENCIAS), a newly created institution, and the more established Colombian Institute for the Development of Higher Education (ICFES), whose main purview is university education. In addition, Planeación, the government agency charged with coordinating planning efforts, had a major voice in determining the magnitude and nature of technical assistance programs. Aside from the bureaucratic complications of dealing with three organizations, prolonged university strikes helped delay the studies. Colombian counterparts have had, on the one hand, to appease students by playing down foreign collaboration and, on the other hand, to satisfy requirements for higher standards of technical advice requested by international and other foreign fund-granting organizations. One measure of the effectiveness of this collaboration is the extent to which the groups have been able to function under difficult circumstances. It is too early to determine the effectiveness of the implementation stage, but developments so far indicate that a determination of priorities for follow-up activity will soon be made.

By the end of 1971, all bilateral study groups had functioned in Latin America. Since the beginning of 1972, one study group has functioned in Ghana, and four in Zaïre. It is too early to expect much implementation, but the prognosis is promising.

If the NAS - counterpart relationship is unique and the concept of joint effort has proven to be worthwhile, it is important to inquire further about the nature of the relationship. In a general sense, the NAS and counterpart roles can be easily distinguished. The NAS presents the image of a prestigious, independent, nongovernmental, and nonoperational organization devoted to the advancement of knowledge and the welfare of mankind. In bilateral programs, the NAS has stimulated or initiated projects, acted as a catalyst or a mediator, and formed a partnership with its counterparts in a number of undertakings. As a purveyor of technical advice for well over a century, its advisory resources have long included government, academia, and industry; it recruits experts for studies ranging from the highly particularistic to the broad and multidisciplinary. It can offer high-quality technical advice, traditional or avant-garde ideas. In its partnership role, it has used many approaches with counterparts for the first time, thereby making the experience one of reciprocal learning and teaching.

On the counterpart side, the foreign institution is challenged to muster the best talent available and encourage the participation of government at the highest levels in efforts to upgrade the nation's science and technology. Although these two tasks have benefited from outside assistance, the results have been most successful where local counterpart institutions have pursued these objectives as a matter of policy. A major advantage of the local institution and one of the principal contributions it brings to the partnership are its intrinsic knowledge of the country's resources, problems, and cultural imperatives that must be taken into account in developing research priorities and policies.

Most counterparts are relatively young, have limited resources, and are dependent on some branch of government. Given the local limitations, the institution often needs a great deal of skill to maintain local standing in the community and to use foreign assistance in an optimal way. Most colleagues recognize the need for external assistance but must also respond to local concerns and protests about foreign influence, usually expressed most sharply by students. The mutual head-scratching and problem-solving relationship has also been accepted by counterparts as a learning-teaching experience--an acceptance made easier because of the relative independence of the NAS and its acceptability as a highly respected scientific institution.

Aside from the counterpart's contributions to the partnership exercise itself, the counterpart must be ultimately responsible for the greater outlays of time, effort, and resources if it is to succeed in strengthening local scientific and technological competence. This major responsibility is not incumbent upon outside help but can nevertheless profit from external assistance. As with any scientific endeavor, intellectual interaction and joint generation of ideas can lead to productive results.

It is by no means easy to completely distinguish the roles the NAS and its counterpart must play every step of the way. However, it is clear that combined intellectualizing, debating, and persuasion have proven mutually fruitful and gratifying.

### During Implementation Stage

In general, the recommendations generated by NAS bilateral programs must eventually be implemented by institutions of government, industry, or universities within the host country. Many of the proposed actions fall within the interests of regional organizations, the United Nations and its specialized agencies, and other international organizations. However, the initial steps necessary to bring a program into being must be taken by the counterpart institution, often with NAS assistance: bringing the appropriate persons together, finding the required funds, or formulating a policy that might necessitate legislation for the creation of a new governmental entity.

It is impossible to demonstrate in all cases a positive relationship between the bilateral programs and subsequent developments; nevertheless, the workshops help create a climate of trust between individuals and the appreciation for technology that permit things to happen that might not occur otherwise. Examples of recommendations that have been acted upon are shown in Chart 2 at the end of this chapter (see pp. 29-33). The formulation of policies, which have been incorporated into national development plans; the creation of new institutions; the increase of financial support for, and the development of, specific projects in science, engineering, and related fields are representative of some of the principal developments.

## SHORT-TERM AND LONG-TERM DEVELOPMENTS

### Short-Term

The general pattern of developments resulting from bilateral programs in shown in quantitative and qualitative terms in Chart 3 (see pp. 34-35). The same information was examined to determine the time between submitting and implementing recommendations. Surprisingly, a significant number of developments occurred within a few weeks to 18 months. In view of this, the results of the bilateral programs are divided into short-term (within 18 months) and long-term (more than 18 months).

In more than half the bilateral programs (Ghana, India, Philippines, Taiwan, Brazil, Chile, and Colombia) recommendations made at workshops were incorporated into national development plans or discussed as subjects of legislation to be drafted on specific topics: e.g., water pollution bill in India; Philippine bill introduced to appropriate

1 percent of the gross national product (GNP) for science and technology; in Indonesia, formulation of a national nutrition policy based on recommendations of a food and nutrition workshop.

A number of institutions that were recommended at workshops have been created. In some cases, plans were under discussion before the workshops, but the joint deliberations served to strengthen the case. In the Philippines, regional offices of the National Science Development Board (NSDB) were established to help disseminate technical information and create institutes for research on coconuts and textiles. National nutrition offices were created in Zaïre and Chile a few months after they were recommended at workshops.

In Colombia, following the recommendations of the first workshop and a subsequent UNESCO science policy mission, a national policy council for S&T and a national office for S&T (COLCIENCIAS) were created. Peruvian workshop participants created an Association for the Advancement of Science while awaiting the establishment of a national research council, recommended at the first workshop.

In Taiwan, following the first workshop in 1964 and the subsequent visit by the NAS science policy mission, the Chinese created five graduate centers: in biology, chemistry, mathematics, engineering, and physics. An outgrowth of the second joint meeting was a parallel program in the humanities and social sciences, which has resulted in the creation of a Sino-American Institute for the Humanities and Social Sciences.

In most countries, inventories and other similar studies recommended at workshops have been undertaken soon thereafter by appropriate national insitutions. For example, several surveys in higher education have been undertaken in Peru, Colombia, Brazil, the Philippines, and Taiwan. Joint study groups have conducted, or prompted the undertaking of, surveys of graduate education facilities, training programs; made natural resources inventories; and initiated reviews and compilations of basic data deemed necessary for the attainment of national objectives. Most joint study groups were organized and functioning soon after they were recommended at a workshop.

Generally, study groups have functioned over 12 - 18 months and by the end of the period have usually recommended specific actions. Two study groups--one on agricultural research and the other on agricultural economics in Brazil--were active over a longer time, but they were unusual.

Most of the 21 bilateral study groups have dealt with university education and research in the sciences, e.g., earth sciences, agricultural sciences, chemistry, biology, mathematics, food technology, hydrology, and computer sciences. In Brazil, one group focused on industrial research and one on norms, standards, and testing; in Argentina, another provided guidance for the telex network on science information. Early in 1972, the first joint study groups with African counterparts were formed. One will deal with agricultural research in Ghana and four different groups in Zaïre will examine earth sciences, demography, food and nutrition, and socio-medical aspects of primates.

Science policy missions, organized in response to counterpart requests, were undertaken in Colombia and Taiwan. The NAS prepared a registry of Chinese scientists in the United States to help identify scholars available for teaching at graduate centers in Taiwan. To attract scholars, the Chinese established special chairs for senior lecturers and researchers.

Several committees have also been established within a short period after the workshops, most of them for follow-up on recommendations or policy formulation in areas given priority. In Taiwan, the National Science Council and the Executive Yuan formed a committee to pursue the numerous recommendations of the industrial research workshop. Additional subcommittees were set up for specific purposes, for example, the Promotion Committee for Hsinchu Industrial Park and the Committee on Marketing Research and Management. Similar planning committees were formed in the Philippines (1969) and India (1970) after workshops on industrial research. In Chile, a National Protein Committee was created concomitant with the establishment of a national nutrition office following the first workshop in 1971. The Government of Chile also considered the recommendations dealing with marine sciences, computers, and mathematics. In Argentina, a national chapter of the Institute of Food Technologists was created after the first workshop in 1969.

Other actions to implement recommendations include a study sponsored by the Philippine NSDB aimed at expanding the documentation facilities of the National Institute of Science and Technology (NIST). Seminars on the organization and management of R&D for agricultural and industrial research institutions have taken place as a result of workshops in Brazil, Colombia, Indonesia, and India.

Long-Term

Several countries have made successful attempts at improving program inputs and increasing appropriations for S&T projects in national development plans. In the Philippines, the government created in 1968 a special Science Fund expected to provide P40 million annually for 5 years. In Taiwan, 2 percent of the GNP has been allocated to research and education and technological development. In Peru and Colombia, appropriations were allocated for newly established NRCs. Brazilian NRC appropriations have increased each year, and overall support in 1970 for R&D than 400 percent over the previous 2-year period, a substantial increase even during an inflationary period. New Brazilian legislation in late 1971 reflects continued efforts to implement recommendations of the joint U.S. - Brazil industrial research study group.

Major institutional changes continued to take place in Taiwan, Peru, and Brazil. In 1967, Taiwan created a National Science Council together with a Committee for Scientific Development, the latter established within the National Security Council. In Peru, a National Research Council came into being in 1968 after difficult and persistent efforts by Peruvians following the first workshop in 1966. Although the bilateral program in Nigeria was interrupted by military coups, the civil war, and subsequent internal strife, the Nigerians created a National Council on Science and Technology in the early 1970's, an objective of the first bilateral workshop.

In pursuit of goals to improve graduate education and research in Taiwan, an Institute of Oceanography was established in 1968 and soon followed by a Science Documentation and Instrumentation Center and a Union Library.

In Brazil, the establishment of an Institute of Patents in the Ministry of Industry and Commerce, and a Pharmaceutical Foundation, created by industry, were two additional developments resulting from bilateral recommendations made by the industrial-research study group.

Establishment of a science information telex network between the Argentine CONICET, Argentine libraries, and the John Crerar Library in Chicago required a number of actions before it began to operate. In addition to numerous consultations between CONICET and NAS representatives, Monica Allmand, the Argentine manager of the system, visited installations in Canada and the United States, where she undertook a training course. Since the system has been under way,

the Argentines have developed a procedures manual, which they have now made available to other Latin American countries. It is expected that the system will be expanded.

Since the industrial-research report was issued by the NAS and the CNPq in 1968, Brazilian counterparts have taken several actions to develop programs suggested by the bilateral group. Between 1969 and 1971, the CNPq convened working groups to study needs and possibilities in food technology, ceramics, steel, cellulose and paper. It also convened the first major conference to gather representatives from industry and governmental agencies. As already mentioned, new institutes have been created; moreover, existing institutes in Brazil have modified their organizational and administrative structures, taking into account the suggestions of NAS consultant, Lawrence Bass. Since Dr. Bass's visit to Brazil, the Brazilians have translated his book, The Management of Technical Programs, into Portuguese. A related development, also arising from bilateral discussions, is the initiation in 1970 of the Brazilian Journal of Technology.

In 1972, the USAID mission in Brazil reported that a loan from the Brazilian Development Bank had been authorized to finance projects recommended at workshops and that the Brazilian Government was considering new employment and pay scales for researchers and the establishment of regional graduate centers in five or six universities.

The cooperative project in chemistry sponsored by the NAS and CNPq has the objective of developing graduate education and research at two Brazilian universities. Implementation of this operational project, the only one of its kind in the bilateral programs, has involved an initial investment of US$700,000 by the CNPq and US$475,000 by the NAS over a 5-year period beginning in 1969. (See Appendix A for a more detailed description of actions undertaken to implement the project.) Thus far, nine NAS Overseas Research Fellows have been conducting research and teaching at the Federal University of Rio de Janeiro and the University of São Paulo. Several Brazilian students who require graduate courses not offered in Brazil have been in the United States preparing for futher work in the program. By the end of 1971, 5 masters degrees had been granted; another 29 were in progress, along with 3 doctorates. Almost a dozen technical papers on research conducted under this project have been published.

The graduate research centers in Taiwan, established shortly after the bilateral program began, have also awarded their first masters and doctorate degrees. This program

and the Chemistry Project in Brazil have promoted curriculum revision in science education and increased the exchange of information. Support for graduate fellowships in the sciences has increased in many areas of study covered by the bilateral programs. While graduate teaching and research facilities in Taiwan and Brazil are improving, changes in other areas--such as increased faculty salaries and establishment of university chairs for visiting professors--are improving the academic environment. In the first 2 years of the exchange-of-scientists program with the National Science Council of Taiwan, the U.S. National Science Foundation supported 30 short-term visits to Taiwan for consultation, teaching, and research. The Asia Foundation has supported a Special Visitor Program, which by mid-1971 covered visits of 14 U.S. specialists in science and engineering education, oceanographic and marine resources, patent laws and practices, and systems analysis.

In the conduct of the oceanographic program in Taiwan, two U.S. members of the Sino-American Cooperation Committee spent 3 months in Taiwan in early 1966. Following the establishment of the Oceanographic Institute in 1968, the U.S. research ship, Geronimo, was leased to the Chinese for training and research. The ship's captain was trained in the United States, and a U.S. scientist was assigned to the ship. Other agencies, especially the U.S. Department of the Interior and the U.S. Navy, took major responsibility for this aspect of the program.

Visits to U.S. institutions by individuals or teams of colleagues have been an integral part of bilateral programs. Other activities playing a part in successful implementation of programs include lectures, seminars, and consultations by U.S. scientists and engineers when they are abroad, and by counterpart scientists visiting the United States.

Some factors contributing to the accomplishments of bilateral programs can be identified easily: positive attitudes toward science and technology; the availability of physical, financial, and trained human resources; and political stability. Without more thorough analysis, it is difficult to determine the right combination of these factors for a particular country. NAS experience thus far provides empirical evidence that given a critical mass of highly motivated scientists and policy makers within a country, both internal and external assistance can be mobilized for programs to improve indigenous competence in science and technology. No model has yet been devised for planning successful bilateral programs a priori, principally because of the diversity of conditions within each country, and in part because of gaps in our own knowledge.

Chart 2. WORKSHOPS, PROJECTS, AND INDICATORS OF RESULTS BY COUNTRY, 1964 - 1971

| Country | Workshops and Joint Study Groups | Implementation of Recommendations and Other Activities Related to S&T |
|---|---|---|
| (Although it is impossible to measure the full effects of bilateral programs, most activities were cited by host-country officials or AID missions as direct or indirect results. It is recognized that many others contributed to these developments.) | | |
| **AFRICA** | | |
| Ghana | Jan 1971: Research Priorities and Problems in the Execution of Research<br>Agricultural Research and Extension, Oct 1971 | Ghanaian Conference on Agricultural Research, July 1971.<br>Plan for Economic Development (3-5 yrs) drafted on basis of workshop and conference. |
| Nigeria | Aug 1965: Science and Nigerian Development<br>no study groups | Rockefeller Fdn. grant to NAS for ecological studies in Nigeria, Ghana, and Zambia, 1967-69<br>Nigerian Council on S&T (NCST) created in 1971 (?).<br>NCST Chairman Victor Oyenuga participant in NAS study on African agricultural research capabilities. |
| Zaïre | June 1971: Science & Technology in the Economic Development of the Congo in the '70s<br>To meet in 1972:<br>Food and Nutrition<br>Demography<br>Earth Sciences<br>Primates | Food and nutrition center (CERENA) established within 4 mos. after workshop.<br>Preliminary visit by U.S. member of Food and Nutrition panel, Dec 1971; experts to visit center periodically; telex link to U.S. institution planned.<br>Chairmen of U.S. panels on Demography and Earth Sciences visited Kinshasa in Dec 1971 for preliminary plans of study groups. |
| **ASIA** | | |
| India | Mar 1970: Management and Organization of Industrial Research<br>no study groups<br>Sept 1971: Water in Man's Life in India<br>no study groups | Indian Planning Committee formed to establish society for promotion of better management of applied research laboratories.<br>A science and technology department was created under Min. Subramanian to coordinate planning.<br>CSIR laboratories planning production-oriented research projects. |
| Indonesia | May 1968: Workshop on Food<br>no study groups | National nutrition policy formulated.<br>Workshop recommendations incorporated in first government 5-yr plan.<br>Agricultural study recommended undertaken by AID.<br>R&D organization and management training program instituted in Indonesia; Indonesians visited 5 U.S. institutions.<br>Scientific information and documentation systems given priority by government.<br>Standardization, measurement, and quality control being given more attention by government. |

| Country | Workshops and Joint Study Groups | Implementation of Recommendations and Other Activities Related to S&T |
|---|---|---|
| Philippines | Nov 1965: Scientific and Technical Cooperation and Development<br>no study groups | 4-yr plan for applied R&D incorporated workshop recommendations<br>Legislation introduced to increase support of S&T to 1% of GNP.<br>NIST documentation division expanded. |
| | Nov 1966: Scientific and Technical Cooperation and Development<br>no study groups | Inventors Commission established.<br>Coconut Research Institute established.<br>Textile Research Institute established.<br>NSDB planned summer institutes for science teachers.<br>NSDB planned studies on rat control and agricultural pests. |
| | Dec 1967: Fisheries and Oceanography<br>no study groups | Study undertaken on Philippines-U.S. Cooperation in Fisheries and Oceanography, June 1967.<br>Special Science Fund established, 1968. |
| | Feb 1969: Industrial Research | National Advisory Commission on Industrial Research established. |
| Republic of China (Taiwan) | Apr 1964: Sino-American Science Cooperation<br>no study groups | Platt science policy mission, 1964<br>Chinese inventory of 40 research institutes and manpower<br>NAS registry of Chinese scientists in the U.S. |
| | Feb 1965: Sino-American Science Cooperation<br>no study groups | 5 graduate centers established in biology, chemistry, physics, mathematics, and engineering.<br>Chinese visits to U.S. institutions to establish cooperative arrangements<br>AID support, $10,000, to Argonne Nat'l Leboratory and Tsing Hua Nuclear Research<br>Oceanography study by E. Wallen and H. B. Steinbach, 1966<br>Academia Sinica establishes program in social sciences and humanities with SSRC and the ACLS, 1966.<br>Joint chairs for senior researchers and lecturers established in Chinese universities.<br>Union Library established. |
| | Apr 1967: Sino-American Science Cooperation<br>no study groups | Vice-President-Premier C.K. Yen visits U.S. to promote relations.<br>Conference on the Economic Development of Taiwan, Academia Sinica, SSRC and ACLS, June 1967<br>Visit to Taiwan by Donald Hornig, President's Science Adviser, 1967<br>Creation of National Science Council, 1967<br>Creation of Committee for Scientific development, Nat'l Security Council, 1967<br>Ivan Bennett medical team visit to Taiwan, 1968 |
| | Aug 1968: Industrial Development of Taiwan: Science, Technology, and Management<br>no study groups | Committee created by the NSC and the Executive Yuan to implement industrial research recommendations.<br>Chinese actions on industrial research cover: marketing research and management, graduate education, textbooks, transfer of technology to small and medium industries, building Hsinchu industrial park |

| Country | Workshops and Joint Study Groups | Implementation of Recommendations and Other Activities Related to S&T |
|---|---|---|
| Republic of China (Taiwan) | | Bruce Billings appointed Special Assistant for Science and Technology to the U.S. Ambassador in Taipei.<br>Oceanographic Institute established, 1968.<br>U.S. loan of oceanographic research ship, 1969<br>Training in U.S. for captain of research ship<br>Thomas Hilde assigned to ship for 2 years to direct research.<br>NSC signs agreement with U.S. NSF for scientific exchanges, Jan 1969. |
| | Oct 1969: Sino-American Science Cooperation | Pan Hsueh-Chang appointed Science Counselor at Embassy in U.S., 1970. |
| | no study groups | Science Documentation and Instrumentation Center established (reported in 1970).<br>Center for American Studies being built for social sciences and humanities. |
| | May 1971: Sino-American Colloquium on Ocean Resources | Graduate science centers have recruited faculty from abroad; several hundred masters degrees and a few doctorates have been awarded.<br>Platt visit and report on graduate science and engineering centers |
| LATIN AMERICA | | |
| Argentina | July 1969: Science and Technology in Economic Development | 3-week training course in the U.S. and Canada provided for Argentine manager of Argentine telex network, 1971. |
| | Science Information, Aug 1970 | Telex network between CONICET and John Crerar Library established, May 1971. |
| | Hydrology, Sept 1970, and Sept 1972<br>Food Technology, July 1971 | Manual on procedures for telex use produced by Argentines. |
| Brazil | Apr 1966: Science and Brazilian Development | Workshop recommendations incorporated in 5-yr plan for 1968-72.<br>Increased support for CNPq from Cr$43 million in 1967 to Cr$1,470 for 1970-73<br>Brazilian government increase of support for R&D up 400 percent in 1970 over 1968. |
| | Steroid Chemistry, Apr 1966 | Sisal research program undertaken in NE Brazil; Mexican firm, Syntex, collaborated in early stages. |
| | Feb 1968: Science and Brazilian Development | Two seminars on agricultural-research administration have been conducted by joint study group, 1969, 1970. |
| | Agricultural Research, 1968, 1969, 1970 | AID sponsored visits of Brazilian agricultural economists to U.S. institutions, 1969 |
| | Agricultural Economics, 1968, 1969, 1970 | CNPq created working groups on food technology, ceramics, steel, cellulose, and paper which met between 1969-71. |
| | Industrial Research, 1967, 1968 | |

| Country | Workshops and Joint Study Groups | Implementation of Recommendations and Other Activities Related to S&T |
|---|---|---|
| Brazil | | CNPq sponsored conference attended by representatives of 4 industrial research institutes and 31 agencies, 1971. |
| | | Seminars on R&D organization and administration conducted by NAS consultant Dr. Lawrence Bass; his suggestions have been adopted by ITAL, IPT, INT, and the Technological Research Institute of Pernambuco. |
| | | Dr. Bass's book, The Management of Technical Programs has been translated into Portuguese. |
| | | An institute of patents has been created in the Ministry of Industry and Commerce; patent legislation being studied. |
| | | The Brazilian pharmaceutical industry has created a foundation along the model recommended by the joint industrial research study group. |
| | | CNPq has increased fellowships for technological research. |
| | | Revista Brasileira de Tecnología begun, 1970. |
| | | New Brazilian legislation reflects recommendations of study group, 1971. |
| | Norms, Standards and Testing, 1967, 1968 | UNDP is studying program in norms, weights, and measures, 1972. |
| | Mineral Resources and Earth Sciences, 1968, 1969, 1970 | Survey of graduate education made by CNPq; assistance given schools in Pôrto Alegre, São Paulo, Rio for earth sciences. |
| | | AID loan of US$8.4 million to DNPM-USGS basic training program. |
| | Computer Sciences, 1968, 1970, 1971 | Major program being developed for graduate educ. and research in computer sciences at 3 Brazilian universities. |
| | Chemistry, 1968, 1969, 1970, 1971 | Major chemistry project initiated by CNPq and NAS to develop graduate education and research in chemistry at 2 Brazilian institutions in collaboration with Stanford, Caltech, Michigan, and Indiana Universities. As of 1971, CNPq support totaled US$700,000; NAS US$475,000; 9 U.S. postdoctorates were in Brazil; Brazilian students were in U.S.; 5 masters degrees awarded, 29 others in progress; 3 doctorates in progress. |
| | Apr 1969: Science and Brazilian Development | |
| | Transportation, Apr 1970, July 1970 | After two meetings of study group, project postponed. |
| | Nov 1971: Science and Brazilian Development | Science and technology a priority, esp. agriculture, industry, and health, in Ministry of Planning |
| | Agricultural Engineering (to meet in 1972) | USAID mission reported BID loan has been authorized to finance projects recommended at workshops; Brazilian |

| Country | Workshops and Joint Study Groups | Implementation of Recommendations and Other Activities Related to S&T |
|---|---|---|
| Brazil | Cerrado (Savannah) Region (to meet in 1972) | government has followed up recommendations in patent legislation, unemployment, and pay scales for researchers, and the development of regional graduate centers in 5 or 6 universities. |
| Chile | Jan 1971: Contribution of Science and Technology to Development<br>no study groups | National Nutrition Office established, 1971.<br>National Protein Committee established, 1971.<br>Metallurgy courses taught at Univ. of Chile by U.S. workshop participant.<br>Chilean government considering workshop recommendations in marine sciences, computers, mathematics, food and nutrition.<br>National Science Congress scheduled in mid-1972 to discuss national policies. |
| Colombia | Feb 1968: Science and Technology in Development<br>Ad hoc group on graduate education, Mar 1970<br>Engineering, Physics, and Applied Geology (to meet in 1972)<br>Biological Sciences (to meet in 1972)<br>Mathematics, 1971<br>Chemistry, 1971 | UNESCO science policy mission undertaken by NAS Foreign Secretary, Aug 1968.<br>National Council for Science and Technology and the Colombian Fund for Scientific Research and Special Projects, "Francisco José de Caldas," (COLCIENCIAS) created, Dec 1968 (result of workshop and above-cited mission).<br>NAS staff support to COLCIENCIAS, July-Aug 1969<br>Colombian seminar on administration of scientific research; courses given by Dr. Lawrence Bass as NAS consultant, Aug 1969. |
| Peru | Apr 1966: Role of Science and Technology in Economic Development<br>Paracas ad hoc group Sept 1966<br>Nov 1967: Role of Science and Technology in Economic Development<br>no study groups | NRC proposal drafted by Paracas ad hoc group and NAS, Sept 1966.<br>PSAC study of International Technical Cooperation and Assistance (ITCAP), headed by NAS Foreign Secretary, June 1967<br>Survey of education undertaken by Inter-University Council of Peru, Jan 1968.<br>Peruvian Assn. for the Advancement of Science created, Feb 1968.<br>Paracas Group meeting on research needs, Ancón, Peru, Nov 1968<br>Peruvian National Research Council created, Nov 1968. |

**Chart 3. INDICATORS OF PROGRAM PERFORMANCE AND EFFECTIVENESS BY STAGES**

The indicators shown here are products or results of NAS programs at three successive stages of activity that involve three sets of participants: (1) NAS and AID/USAID missions; (2) NAS and counterpart; (3) combinations of NAS, AID, USAID missions, counterparts, and other institutions. Viewing the products at each stage as inputs or outputs, the stages would be (1) input; (2) input and output; (3) output. Since program effectiveness is ultimately judged by the results in the last stage and implementation of program recommendations at the country level begins in stage 2, these two stages are combined.

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RESULTS AT STAGE 1--NAS and AID/USAID MISSIONS*

Quantitative

Projects and Reports:
- Bilateral workshops....26 (38 vols.)
- Regional workshops..... 2
- Study groups.....21 (prog. reports)
- Internat'l meetings.... 2 (Agr. & Protein)
- Panel reports.....18 (sp. studies)
- Consultants.....23 (proj. reports)

Number of U.S. scientists and engineers involved in programs....over 500

Number of bilat. prgms.....12 countries

Special studies involving countries....2 (Korea, Pak.)

Financial support increased by AID/W, six USAID Missions (Asia & L.A.); additional funding by NSF and other institutions, esp. for programs in Brazil & Taiwan.

Total funding and number of programs has grown considerably.

Joint Chemistry Project in Brazil and the Technology Innovation Project are two major experimental projects generated by bilateral programs and BOSTID.

Qualitative

BOSTID provided a focal point for advice to AID on S&T in development.

More comprehensive advice made available to AID on various S&T problems in development context and within specific countries.

Level of NAS experts of consistently high calibre.

Attitudes on S&T much improved within AID and embassies.

Communications improved. Info. on S&T in development increased.

Linkages: NAS - AID relationship improved and expanded.

AID interest and support of NAS programs has brought more awareness of S&T in foreign assistance programs.

NAS programs have generated projects involving other U.S. institutions, universities, and international organizations.

Quantity and Quality

Better quality and quantity of S&T data available on countries.

Better planning and programming.

Quality and number of development-oriented personnel expanded.

Accumulated data provide better indicators for program planning.

As a result of increased awareness and interest in S&T in development, BOSTID prgms. have grown in number and scope. Current studies focus on timely issues and pressing problems such as the Role of S&T in the '70's; appropriate technologies for underdeveloped countries and the role of multinational corporations.

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*In Taiwan, where AID phased out, relationship with U.S. Embassy.

## RESULTS AT STAGES 2 AND 3 (AT COUNTRY IMPLEMENTATION LEVEL)

### Quantitative

| | Workshops | Joint Study Groups |
|---|---|---|
| Africa: | 3 | 5 |
| Asia: | 14<br>1 regional | 0 |
| L.Am.: | 9<br>1 regional | 16 |

Number of U.S. scientists and engineers in workshops and study groups: nearly 300

Other activities generated:

R&D seminars in Brazil, Colombia, India, Indonesia

Surveys and inventories in several countries

U.S.-Argentine telex system on S&T Information

U.S.-Brazil Chemistry Project

New institutions created: NRCs in Peru, Colombia; national committees or offices on various aspects of S&T in several other countries; professional societies (Argentina, Peru) and Association for the Advancement of Agricultural Sciences in Africa.

Funds for R&D have been increased substantially in several countries, especially Brazil and Taiwan. Matching contributions by governments for projects.

### Qualitative

Joint undertakings with counterparts in study, analysis, and planning have been effective in problem solving and have resulted in a mushrooming of activity. Bilateral programs have been instrumental in the following changes:

-formulation of national science policies, esp. where none existed, and contrib. to development of policies in specific areas (disciplines, sectors, etc., depending upon priority established).

-increased awareness of S&T role in socio-economic development (changed attitudes in general toward S&T).

-better understanding of opportunities and obstacles to development of S&T.

-better communication and linkages established among research institutes, universities, industry, and government.

-transfer of some techniques characteristic of U.S. science have broadened scope of NRCs (coupling expertise from different sectors; use of public-spirited, unpaid consultants).

### Quantity and Quality

Increased collaboration and scope: in nearly all countries, bilat. programs have generated meetings and studies among local community, and additional studies and science policy missions undertaken by the NAS, other institutions, and international organizations.

Increase in constituency:Workshops & study groups engendered visits to U.S. institutions of high-level persons from the scientific community, government, and industry interested in S&T and economic development.

Increased channels of communication: via visits, exchange of information, & joint projects, etc., have helped countries keep abreast of latest sci. information and advances.

After 28 workshops and 20 study groups, it has been possible to foresee key areas of interest and need with more assurance.

Many NAS participants have advised overseas colleagues, beyond official duties without remuneration.

## SOME FACTORS THAT INFLUENCE PROGRAM EFFECTIVENESS

The results of bilateral programs in the 12 countries in which workshops have been held show a broad spectrum of relative accomplishment. At one end, our counterpart organizations in Brazil and Taiwan have made substantial efforts to analyze their research and development needs and have made numerous important recommendations to their governments, many of which have been translated into action. At the opposite end, programs in Chile, Nigeria, the Philippines, and Peru are now in limbo and have resulted in fewer actions.

Many factors combine to affect the success of a program. Among the more obvious ones are the following:

### 1. Political Relationships of the Host Country with the United States

If the political relations are good to excellent, as they have been with Brazil and Taiwan throughout the bilateral programs, the chances for success are obviously increased. If the relationships are strained, as they have been with Peru since 1969, with Chile since 1971, or with India since early 1972, the chances for success are considerably lessened.

### 2. Political Stability within the Host Country

Almost every internal political upheaval postpones workshop program activities or lessens in other ways the effectiveness of the programs. In Nigeria, two military coups and a civil war halted the embryonic program. In Ghana, the recent coup has slowed the program there. In Argentina, Chile, Colombia, and the Philippines political uncertainties have had adverse effects on virtually all bilateral efforts in those countries.

### 3. Attitudes of AID/Washington and USAID Missions

From AID, enthusiastic support at best, or a neutral attitude at worst, is essential to the success of an AID-funded workshop program. This includes AID offices in Washington, as well as the missions, since the concurrence of both is required. A large part of the credit for the success of the program in Brazil belongs to the USAID mission in Rio de Janeiro, which has sponsored it enthusiastically from an early stage of program development. The failure of the AID mission in Manila to become actively interested

at an early stage in the development of the Philippine program undoubtedly contributed to the lack of progress in bilateral efforts.

4. Quality of Local Leadership

A bilateral program is doomed to failure from the start in the absence of highly qualified and motivated local leaders and staff who personally appreciate the importance of S&T to national development and are determined to take the actions necessary to strengthen and apply it. The qualities of leadership in Brazil, Taiwan, India, and Ghana have been good to excellent; those in Colombia and the Philippines have been considerably less than optimal.

5. Influence of Local Leadership

If recommendations emerging from workshops are to be meaningful, they must be implemented. More often than not, implementation requires governmental action. Therefore, the local workshop leadership must be close enough to their government to influence its actions. The leaders of the program in Taiwan were able to exert considerable influence upon their government; indeed, four of them subsequently became ministers. Although somewhat less influential, program leaders in Brazil and Ghana* have been able to secure the active government support for implementations of recommendations. One reason for the slow progress of the program in the Philippines has been the local leadership's lack of influence with its government.

6. Availability of Funding for Workshops and Study Groups

Ideally, workshops and study groups are jointly funded and, in certain programs--for example, those in Brazil and Taiwan--this has been accomplished from the beginning. In other cases--for example, in the Nigerian and Peruvian workshops--only U.S. funding was made available. Sometimes U.S. funding has been available for workshops but not for continuing activities. AID/Washington has often financed the initiation of a workshop program, but turned the responsibility for continuing availability of U.S. funds over to the local USAID mission. If the mission is not interested in the program, funding obviously is not available.

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*Until the coup of Col. I. K. Acheampong, January, 1972.

7. Availability of Funding for Implementation

The greater share of the financial responsibility for implementing recommendations from workshops and study groups must be borne by the host country. Often, however, U.S. support has contributed substantially to initial program development until funds were made available by the host country. In Taiwan, the host government has paid virtually all costs of implementation. In Brazil, the host government has paid a greater part of the implementation costs, but U.S. contributions have been important. In the Philippines, sufficient implementation funds have not been available from either local or U.S. sources.

8. Quality of U.S. Input

Understandably, the quality of NAS inputs to workshop programs has varied. U.S. participants, who are appointed by the President of the NAS on the recommendation of the Foreign Secretary, and are asked to serve without compensation, have not been of uniformly high professional competence or of equal cultural and political sensitivity. Nevertheless, considering the large numbers of natural and social scientists and engineers involved, the average overall quality has been surprisingly high, and the deviation from the average has been surprisingly low. Of those involved, only a small proportion would not be invited to participate again because of their inadequacies.

The high quality of the U.S. participation is attributable only in part to screening procedures. In substantial measure, the quality stems from the motivation of the U.S. scientific-technological community to become involved in such activities. A large reservoir of highly motivated, highly qualified candidates is available. Refusals to serve are few, and volunteers are numerous.

The situation with respect to the inputs of the NAS staff is similar. Although the staff varies in quality, the overall competence has been high. Some programs have undoubtedly been accelerated by imaginative staff inputs, and some have undoubtedly suffered from lack of adequate staff effort. Sometimes these differences have resulted from variations in the qualities of individuals; more often they have resulted from inadequate staffing necessitated by budgetary constraints. Again, the range in quality separating the best from the worst is small compared with the range in the first seven factors.

9. Communications

One of the most difficult problems in the development, operation, and implementation of a workshop program is communication. Experience has shown that it is not possible to develop a program with colleagues in developing countries by mail. A great deal of personal contact is essential, and in its absence programs tend to either stagnate or disintegrate.

Communication with the numerous facets of the AID bureaucracy is often even more difficult than with colleagues in developing countries. Not infrequently, a program will necessitate simultaneous approval by the Technical Assistance Bureau, the Regional Bureau, and the country USAID mission. Rapid personnel turnover is a constant problem. Inadequate communication with AID, particularly when coupled with bureau provincialism, jealousies, and personality problems, has often placed tremendous strains on the NAS staff. In the process, programs have been delayed, weakened, and even cancelled.

If an AID-sponsored program in Country X is to be successful, it is essential that one or more members of the NAS staff travel frequently to Country X and develop close working relationships with appropriate individuals in the scientific-technological-governmental community there, as well as with appropriate individuals in the local USAID mission. It is also essential for the same staff members to develop adequate working relationships with key persons in the AID Regional and Technical Assistance Bureaus in Washington.

These communication demands consume a large proportion of staff time, and communication failures have not been infrequent. More often than not, lack of progress in a workshop program can be traced directly or indirectly to inadequate personal contact either in Washington or in the field.

## ANALYSIS OF PROGRAMS BY COUNTRY

In assessing the effectiveness of the workshop programs country by country several questions have been asked:

1. Has the program affected the policy-making structure for science and technology? Has it stimulated the development of executive-level machinery for planning, coordinating, and financing scientific and technological research oriented to the country's economic and social needs and objectives?

2. Has the program affected the research infrastructure? Has it stimulated the development of research infrastructure, supporting services, and related policy framework in broad sectoral and multidisciplinary areas--such as agriculture, food and nutrition, industry, marine resources, the environment--and their effective orientation to the needs of the respective user communities?

3. Has the program affected advanced training and research? Has it stimulated the development of particular scientific or technical disciplinary capabilities--in both teaching and research--in fields pertinent to the country's resource base and development potential, such as earth sciences, agricultural economics, polymer chemistry, and computer sciences?

4. Has the program resulted in an overall improvement in the attitudes of the local government toward science and technology? Has it resulted in increased financing of advanced training and research? Has it resulted in actions by government leaders at the ministerial level aimed at the better utilization of research for the solution of sectoral problems?

5. Has the program led to a genuine strengthening of the local scientific-technological community? Has it increased the cohesiveness of the community and improved relationships and communications between its disparate parts?

6. Has the program given rise to important inputs to national planning efforts and programs? Have recommendations been incorporated into national plans? Have one or more ministries made use of workshop recommendations? Has the program led to other projects, locally funded, without any NAS involvement?

In only a few cases could one expect the answers to all these questions to be an unqualified "yes," for the objectives of most programs have been relevant to only one or two of these indicators.

The evaluators believe that a strong positive response to any one of the five questions would indicate an effective program.

When the results of the bilateral programs resulting from workshops in 12 countries are studied the degrees of effectiveness might be categorized subjectively six ways.

Very effective: Brazil, Taiwan

Effective: Indonesia

Potentially effective: Ghana, Zaïre, India

Effective with qualifications: Argentina, Colombia, Peru, Philippines

Indeterminate: Chile, Nigeria

Failures: We know of no program that can be categorically classified as a failure.

The programs will be discussed in the following country-by-country analysis.

## Very Effective Programs

### BRAZIL

The answers to the six questions concerning the effect tiveness of workshop programs are all positive.

Policy-Making Structure For Science and Technology. The CNPq is a well-conceived organization attached directly to the office of the President of the Republic. The bilateral program has helped strengthen the organization administratively and has improved its credibility in the eyes of several ministries. Although the program has not stimulated the creation of anything new in policy-making structure, it has resulted in a substantial increase in the influence of the CNPq in policy matters involving science and technology. The CNPq has grown dramatically since the program was conceived. Appropriations to the CNPq for science and technology for the period 1970 - 1973 average about Cr$500 million per year compared with Cr$43 million in 1967. The initiatives the CNPq has undertaken in coordinating applied research efforts have increased its own capacity to identify national priorities and develop policies and programs.

Research Infrastructure. Numerous developments have resulted from recommendations made by the workshop and working groups on research infrastructure. For example, the CNPq sponsored seminars on R&D organization and administration in industry and agriculture; and created internal working groups in food technology, ceramics, steel, cellulose and paper. The creation of a model industrial research institute is under serious consideration. Recommendations concerning the organization of research made by the joint

working group on industrial research have been adopted by several major research institutes. An institute has been created in the Ministry of Industry and Commerce to study patent legislation and collect information on foreign patents. The Brazilian pharmaceutical industry has established a foundation to support a newly created research institute fashioned on the model outlined by the joint working group on industrial research. The CNPq has provided increased support for research on national technological problems, has increased substantially the number of postgraduate scholarships in engineering and supporting areas, and initiated the publication of Revista Brasileira de Tecnología.

A study on the problem of developing standards and testing procedures for Brazilian industry has been widely circulated, and its recommendations, which include the establishment of a research laboratory in standards, will probably be implemented as soon as certain internal political problems are resolved.

Two symposia have been held on the administration of agricultural research and have brought together representatives from state and federal agricultural research institutes. These seminars have contributed to the coordination of research-and-training programs and to the administration of agricultural research in the nation as a whole.

Advanced Training and Research. The most significant development in advanced training and research has been the experimental project aimed at developing Brazilian graduate education and research in chemistry at the highest level in the Universities of Rio de Janeiro and São Paulo. Eight U.S. professors of chemistry, selected by the Brazilians, agreed to establish cooperative research programs with designated counterparts. Each agreed further to sponsor one or more postdoctoral students from the United States to undertake research, conduct seminars, and teach at a Brazilian institution for a minimum of 2 years. The postdoctoral fellows were given the title "National Academy of Sciences Overseas Research Fellow."

Under the program, the U.S. professors visit the Brazilian laboratories twice each year, and the Brazilians spend whatever time is appropriate at their U.S. colleagues' laboratories. Brazilian students who require courses unavailable in Brazil are allowed up to 1 year of study in the United States in order to participate in the research program.

The program is jointly funded: Brazil pays for all equipment, supplies, and travel of Brazilians; the United States pays for the stipends of the fellows and all travel of the U.S. participants. The Brazilians have also increased the salaries of the participating Brazilian professors significantly.

Since the program began, the number of graduate students at the University of São Paulo has risen from 25 in 1969 to 116 in 1971. At the end of 1971, 5 students earned masters degrees; 29 others have masters degrees in progress; and 3 are working on doctorates. Eleven technical papers have been published, and ten more have been submitted for publication.

In terms of developing graduate research and education in chemistry in Brazil, the Chemistry Project promises to be one of the most successful undertakings. However, a far more important aspect of the success of the program is the potential application of its principles to other fields of science and to other nations. The Chemistry Project has pioneered an important new approach to technical assistance which obviously has broad applicability.

In addition to chemistry, the Brazilians have shown a keen interest in developing graduate research and training in the earth sciences. A joint study group has been created and has outlined a cooperative training program to include five Brazilian universities. Once there are enough trained Brazilian earth scientists, it is intended to initiate a cooperative program of graduate research and training similar to the CNPq-NAS Chemistry Project.

A joint study group in agricultural economics has formulated a proposal designed to strengthen research in agricultural economics in Brazilian agricultural research stations. Another joint study group in computer sciences has formulated recommendations for strengthening graduate programs at three Brazilian universities and for improving computer-science teaching in the universities with computers and service departments.

Attitudes of Local Government. The program has definitely contributed to an overall improvement in the attitudes of the local government toward science and technology. Heads of the Ministry of Planning, the National Bank of Economic Development, the National Department of Mineral Production, and the Ministry of Agriculture have indicated strong support for the development of an effective Brazilian establishment for research and development. President

Médici has expressed personal interest and concern. In part as a result of these attitudes, investments in science and technology have increased at a rate far in excess of the rate of inflation.

Local Scientific-Technological Community. The CNPq has made a deliberate effort to involve in its activities scientists and engineers who represent a variety of institutions, geographical regions, and fields of specialization. This has resulted in a new cohesiveness and a strengthened dedication to join in the task of applying science and technology to the solution of Brazil's development problems.

Inputs to National Planning Efforts and Programs. At present, scientific and technological research holds top priority in the Ministry of Planning's "Program for Aims and Bases of Government Activities," primarily in health, agriculture, industry, and an overall strengthening of S&T capabilities. The CNPq's initiatives in industrial research have influenced programs in both the Ministry of Planning and the National Bank of Economic Development.

Some Factors That Have Influenced Program Effectiveness. In large part, the success and continuity of the program in Brazil can be attributed to the enthusiasm of Antonio Couceiro, president of the CNPq until 1971, and to his energetic deputy, Manoel da Frota Moreira. From the first mention of a workshop in 1965, they were interested in the possibility of a joint program with the NAS, and as their concern diminished that the program might become "U.S.-dominated," their interest rose. Also interested at an early stage of the program were government leaders such as Roberto Campos, the Minister of Economic Planning. Attached directly to the office of the President of the Republic, the CNPq has access at high level to most ministries.

Moreover, the Brazilian side in general has from the start shown interest and dedication to the concepts of the program. Sometimes, administrative problems have arisen, occasionally because of inadequate staffing on one or both sides, and occasionally because of the bureaucratic setting--in the Brazilian government or in AID.

Although Lincoln Gordon, the U.S. Ambassador to Brazil, expressed interest in a bilateral program when it was suggested in 1965, the then Director of the USAID mission in Rio de Janeiro was far from enthusiastic, and many of his staff shared his suspicions. Nevertheless, the first workshop was held, and subsequent developments led to a softening of attitudes in the USAID mission. The enthusiastic support

of William Ellis, mission director since 1967, has without doubt contributed significantly to the success of the program.

The U.S. - Brazil program has been helped greatly by a good political relationships between the two countries throughout the period and enough political stability to permit the program to move ahead without interruption.

TAIWAN

The answers to the six questions on the effectiveness of workshop programs are all positive.

Policy-Making Structure for Science and Technology. As a result of the early bilateral discussions and studies begun in 1964, the Chinese restructured their scientific establishment in 1967 by creating a National Science Council and, in addition, a Committee for Science Development within the National Security Council. From that time to the present, Wu Ta-You, Professor of Physics at the State University of New York at Buffalo, has served as chairman of both bodies and as science advisor to the President. As a result of a workshop held in 1968 to consider the problems of building up an industrial research complex in Taiwan, the Chinese established a committee under the cabinet to oversee implementation of the recommendations. A workshop on ocean resources, held in May, 1971, called for the creation of a National Commission on Marine Sciences to take responsibility for national policy and to coordinate activities in this field. In part as a result of the evolution of the policy-making structure for S&T, the central government's allocations for science R&D increased several-fold from 1964 to the present level of about 2 percent of GNP.

Research Infrastructure. An inventory of scientists and research institutions in Taiwan has been undertaken, and a register of Chinese scientists in the United States has been prepared, which has facilitated the recruitment of interested scholars. Many institutional ties have been established between Chinese and U.S. universities and institutes, in both private and public sectors.

One of the first priorities assigned by the Chinese concerned Taiwan's manpower needs and the "brain drain" which siphoned off about 95 percent of the 2,000 college graduates who were sent abroad each year for postgraduate technical training. Recognizing that one important approach to this problem is first-class postgraduate education at home, the Chinese established seven major centers (noted in next section) for graduate research and education in

the sciences and engineering. They also took definite steps to implement recommendations of a joint workshop dealing with the R&D aspects of food technology, textiles. chemicals and plastics, electronics, metals, and energy.

Advanced Training and Research. As a result of the bilateral discussions, five graduate research centers were created in 1965 under a consortium of Chinese universities--one each in chemistry, physics, biology, mathematics, and engineering. Later, institutes were created for marine sciences and agriculture. Many of the graduate center faculty have been recruited from abroad. Some excellent research and teaching facilities have been established. Thus far, several hundred masters degrees and several doctorates have been granted in physics, chemistry, and engineering.

Attitudes of Local Government. From the beginning of the bilateral relationships, the highest levels of government have shown personal interest in the program. The President pledged strong support for science and technology. Within 2 years after the first meeting in Taipei, two members of the Chinese committee were appointed, respectively, Minister of Education and Minister of Economic Affairs. Other members of the Chinese committee have subsequently been appointed to cabinet rank.

Local Scientific-Technological Community. The bilateral program has almost certainly helped to bridge a communications gap between the older, aristocratic scientific community of the Academia Sinica (Taipei) and the younger, more pragmatic scientists who are more interested in applying science to economic and social development than in pursuing science for science's sake. The original arrangement for bilateral discussions was made between the two academies, but a number of the Chinese recognized that broadening the Chinese group to include younger scientists close to the government and industry would be essential if the results were to contribute significantly to national development.

Inputs to National Planning Efforts and Programs. With a Minister of Education and Minister of Economic Affairs initially on the Chinese committee, the workshops' inputs to national planning efforts and programs have clearly been substantial. Undoubtedly, the efforts of the ministers were a major stimulus to the greatly increased allocations for science research and development.

Some Factors That Have Influenced Program Effectiveness. The success of the program in Taiwan can be attributed in large part to the quality and influence of local leadership.

Members of the Chinese committee such as Chen-Hsing Yen and K. T. Li were dedicated to implementing the joint recommendations; they had the combination of influence and political skills to get things done. Paul Hao, secretary of the committee, also contributed greatly to the success of the workshops.

The quality of the U.S. input was also high. Early in the program, Joseph B. Platt spent several weeks in Taiwan on an advisory mission; his observations and discussions were destined to have a profound effect upon the efforts which followed. Two members of the NAS advisory committee, Eugene Wallen and Burr Steinbach, spent several months in Taiwan advising on the development of an oceanographic research-and-training program for which there is now an institute. Also, a U.S. research ship has been loaned to Taiwan. Still another major input by the U.S. members of the joint science cooperation committee was the identification of Bruce H. Billings, who was appointed Special Assistant to the Ambassador for Science and Technology and U.S. Commissioner of the Joint U.S. Commission on Rural Reconstruction. Although Dr. Billings had almost no U.S. funds available, he became an invaluable catalyst who managed to get things done. He also helped to maintain effective communications.

Because the Taiwan - U.S. program was begun as AID was phasing out its assistance, no AID funds were available for the workshops. Fortunately, the Asia Foundation made funds available for both Chinese and U.S. staffing and travel. Had it not been for these modest private funds, the program would not have been possible.

Finally, the entire period of the bilateral program has been marked by excellent political relationships between the two countries (at least until President Nixon's trip to the People's Republic of China in early 1972) and internal political stability.

## Effective Programs

### INDONESIA

Starting in the late 1940's, a cordial working relationship between the NAS and the Council of Sciences for Indonesia (MIPI), continued at low key through the entire period of approximately a decade of strained U.S. - Indonesian relationships. In 1966, the Indonesian Institute of Sciences (LIPI) replaced MIPI as the primary governmental scientific

body. As U.S. - Indonesian relationships improved, AID agreed to support an NAS-LIPI workshop on food, which was held in 1968. Then there followed in early 1971 a workshop on Industrial and Technological Research, and a third workshop on the development of Indonesian national resources was scheduled for September, 1972.

Policy-Making Structure for Science and Technology. After the first bilateral workshop, the senior administrative officer of LIPI came to Washington to serve as an intern with the NAS and the Smithsonian Institution while completing a graduate degree in science policy at George Washington University. He returned to Indonesia in early 1972 to assume responsibility for LIPI's science policy studies.

As a result of the NAS program, the President of LIPI has indicated that he is considering transforming science organization in Indonesia from the present highly centralized model to something more akin to U.S. and Western European systems.

Research Infrastructure. In mid-1969, the USAID mission sponsored the visit of a team of U.S. agricultural research specialists who worked with their Indonesian counterparts on formulating a plan for a national agricultural research system, integrating the universities, field stations, and research institutes.

As a result of the Workshop on Industrial and Technological Research, a program to improve the management and organization of industrial R&D institutes has been initiated. An intensive management-development course was held in Indonesia and, in addition, two senior R&D administrators from Indonesia visited several U.S. research institutes, spending 7 weeks in one institute and 1 week each in four others. This experimental program will form the basis for a more extensive training program for Indonesian R&D managers.

Advanced Training and Research. There are no visible effects thus far.

Attitudes of Local Government. Clearly, the workshops have stimulated recognition at high levels of government that science and technology are important elements in the development process.

Local S&T Community. The bilateral program has brought the local S&T community together to consider a number of critical aspects of Indonesian development

problems, thereby helping to focus the attention of Indonesian scientists on the role that science and technology can play in accelerating development.

Inputs to National Planning Efforts and Programs. After the first workshop, several key recommendations were incorporated in Indonesia's First Five-Year Development Plan. Also, the targets recommended by the workshop for minimum calorie and protein requirements were incorporated in a national nutrition policy.

Some Factors That Have Influenced Program Effectiveness. Although relationships between the S&T communities of Indonesia and the United States have been good to excellent during the past 20 years, political tensions between the two countries, coupled with political instabilities and difficulties within Indonesia, made the task of developing a bilateral program extremely difficult. In 1968, when LIPI informed the NAS of its readiness to move ahead, steps were taken cautiously.

Although the quality of the local leadership is quite high, its influence at the top levels of government is less than optimal. This difficulty has been somewhat mitigated by the USAID mission's strong positive attitude toward the program. Nevertheless, the lack of adequate local funds for implementing workshop recommendations will long remain a serious obstacle.

## Potentially Effective Programs

### GHANA

In 1965, members of the Africa Science Board visited Ghana for the purpose of developing cooperative activities. Shortly thereafter, President Nkrumah was exiled. Protracted political difficulties postponed the initiation of a program until 1970. Early in 1971, a joint workshop on Research Priorities and Problems in the Execution of Research in Ghana was held in Accra under the auspices of the newly created Ghanaian Council for Scientific and Industrial Research, the universities of Ghana, and the NAS.

Policy-Making Structure for Science and Technology. The workshop almost certainly increased the visibility and credibility of the Council for Scientific and Industrial Research (CSIR) and improved the working relationship between the CSIR, the universities, and various research institutes. These improved relationships are likely in turn to increase the effectiveness of the policy-making structure for science and technology.

By decree, the CSIR is to "advise the Government on scientific and technological advances likely to be of importance to national development." The workshop recommended a joint study to draw operational guidelines for this function. Planning for the study was begun in October, 1971, but in January, 1972, a postponement of the study was requested because of a change in the Government of Ghana resulting from a coup.

Research Infrastructure. A direct effect of the workshop was the establishment of a joint study group on agricultural research and extension, which met in June, 1971. The study groups made several recommendations for the establishment of a closer relationship between agricultural research and extension, and in particular the development of a more coordinated system of agricultural-extension training.

Advanced Training and Research. There are no visible effects thus far.

Attitudes of Local Government. The workshop had a substantial effect on the attitudes of the leaders of the government, as it existed in 1971. The attitudes of the government that came to power in January, 1972, are not yet clear.

Local S&T Community. Ghanaian scientists and government officials have stressed that the workshop was of decisive importance insofar as it brought together for the first time many disparate elements of the local S&T community The workshop stimulated the emergence of a sense of common purpose, not only within the S&T community, but also between that community and officials of the universities and government ministries. According to the Ghanaians, the catalytic effect of the workshop is evidenced by developments such as the calling of the All-Ghanaian Conference on the Role of Agricultural Research and Its Relationship to the Development of Agriculture.

Inputs to National Efforts and Programs. The study on agricultural research and extension was formally initiated by a visit to Ghana by the NAS co-chairman and a member of the OFS staff to discuss with their Ghanaian counterparts the terms of reference of the study. By coincidence, meetings were being held at the same time of government-appointed groups charged with drafting sectoral sections of the "Medium-Term Plan" for the economic development of Ghana. As a result, some of the ideas of the U.S. visitors were incorporated in the plan.

Some Factors That Have Influenced Program Effectiveness. Although relationships between the scientific communities of Ghana and the United States have been excellent for many years, relationships between the two governments did not permit serious discussion of a joint program until the Nkrumah regime was overthrown. Even then political uncertainties prevented the initiation of a program until 1970. Although the workshop of 1971 developed the outline of a continuing program that appeared to have excellent prospects, subsequent political changes have prevented the program from progressing rapidly.

The attitudes of the USAID mission toward the development of an NAS program in Ghana have been positive, and prospects for continued local and U.S. financing appear favorable. Although the quality of local leadership has been high, its influence has changed with changes of government. Political uncertainties within Ghana have, more than any other factor, kept the program from expanding as rapidly as the two scientific communities believe desirable.

On the whole, communications between the NAS and the scientific community in Ghana and with the USAID mission in Accra have been fairly good, although an increase in the number of visits in each direction would probably have accelerated the development of the program during the formative months.

ZAIRE (formerly the Congo)

As a result of a visit by a Congolese scientific delegation to the United States in 1968 and several subsequent visits of NAS staff to the Con. in 1970, a joint workshop between the Office Nationale de la Recherche et du Developpement (ONRD) and the NAS was held in June, 1971, on Science and Technology in the Economic Development of the Congo in the Seventies. The workshop recommended a number of bilateral activities.

Policy-Making Structure for Science and Technology. The workshop, and activities that were generated subsequently, increased the visibility, as well as the credibility, of the ONRD with the government. To this extent, the policy-making structure for science and technology has been strengthened.

Research Infrastructure. The workshop and the subsequent joint study groups appear to be leading to the evolution of broad policy frameworks in food and nutrition and earth sciences. Four months after the workshop, the ONRD established a center for research on food and nutrition (CERENA).

Under consideration is assistance to the new center through periodic visits by a committee of food and nutrition research specialists and through a telex connection between CERENA and a leading U.S. research institution to permit prompt communication of technical information.

Advanced Training and Research. In addition to the creation of the new center for research on food and nutrition, joint study groups have recommended programs for the development of training and research in demography and the earth sciences. A study is also being made of the feasibility of establishing a primate center for the breeding and study of pygmy chimpanzees for biomedical research purposes.

Attitudes of Local Government. That the workshop was held indicates an interest on the part of the Government of Zaïre in the potential role of science and technology in economic development. There is no indication that this interest has either increased or decreased during the intervening period.

Local S&T Community. There are some indications that the program has improved relationships and communications between the disparate parts of the local S&T community.

Inputs to National Planning Efforts and Programs. As noted already, the ONRD established a center for research on food and nutrition and is developing a policy in this area.

Some Factors That Have Influenced Program Effectiveness. A major weakness in the program in Zaïre is that, traditionally, most scientists in the area have been European. Only in recent years have appreciable numbers of Africans been trained as scientists, so the African scientific community is still very weak compared with the European one. The shortage of Zaïrois scientists creates a serious dearth of local leadership, in both quantity and quality. This situation impedes the effective implementation of recommendations.

The problem of the quality and influence of the local leadership is perhaps the most noteworthy obstacle to the development of a successful program. Political relationships between Zaïre and the United States, the attitudes of the local USAID mission, internal political stability, and the availability of funding for study groups have, on the whole, been favorable. The program appears to have potential.

INDIA

Although NAS relationships with the Indian scientific community have been excellent for many years, a working relationship with the Indian National Science Academy was not established until 1968. The first workshop was held in early 1970 on The Management and Organization of Industrial Research, the second in late 1971 on Water in Man's Life in India. A workshop on the organization, operations, and management of a working academy was to be held in Washington in early 1972, but the political tensions between India and the United States resulting from the war in East Pakistan (now Bangladesh) caused an indefinite postponement of bilateral efforts. Although the brief time involved makes difficult any assessment of the program's effectiveness, there are nevertheless some promising indications:

Policy-Making Structure for Science and Technology. The Government of India has established a Department of Science and Technology under the Planning Commission to coordinate planning efforts in research and development. There is some indication that the climate created by the bilateral programs accelerated the creation of the new organization.

Research Infrastructure. The workshop on The Management and Organization of Industrial Research has led to the creation of an Indian Planning Committee to form a society to promote better management of applied research laboratories. In addition, the exercise of organizing workshops on Indian development problems strengthens the capabilities of the Indian National Science Academy to advise the Government of India.

Advanced Training and Research. Although this has not been a priority area, a development has come to our attention: influenced by the workshop, an Indian participant with Hindustan Lever reorganized his laboratory, following a U.S. industrial model.*

Attitudes of Local Government. Traditionally, the Government of India has strongly supported science, as evidenced by the total scientific production of the country and the number of laboratories, such as those under the Council for Scientific and Industrial Research, which receive truly substantial government support. In science, as distinct

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*Confirmed by Lever headquarters in London.

from applications, India leads all developing countries and many industrialized countries. Unfortunately, India has not been particularly successful in applying science to solve many problems of development, particularly those of industry. Somehow, in spite of the strong support given applied research, a communications failure exists between government laboratories and private industry.

A number of leaders of industry, as well as the government scientific establishment, recognize this problem; indeed, that the workshop on The Management and Organization of Industrial Research was held was, in no small measure, the result of concerns expressed within the private industrial sector.

Local S&T Community. The two workshops brought together diverse elements of the S&T community, which could not otherwise have been brought together so constructively. The workshop on management and organization of industrial research brought together the largest group of Indian research administrators ever assembled to consider this particular topic.

Inputs to National Planning Efforts and Programs. The workshop on Water and Man's Life in India brought together some 90 specialists and government officials, including the Minister for Power and Irrigation and the Minister for Planning. The workshop appears to have contributed to the Indian input at the U.N. Conference on the Human Environment at Stockholm, 1972.

Some Factors That Have Influenced Program Effectiveness. Until the tensions between India and the United States arose as a result of the war in East Pakistan, the bilateral workshop program gave every indication of being successful: the USAID mission was enthusiastic and made adequate funds available; the Indian leadership was of high quality and influential; the quality of the U.S. input was excellent.

## Effective Programs with Qualifications

### ARGENTINA

On the positive side, the modest success of the program in Argentina can be attributed to the enthusiasm of the late Bernardo Houssay and his associates--and of the then Director of the small USAID office, which from the outset of the workshop program was rapidly phasing out its activities. From the beginning, however, the bilateral program suffered from difficulties primarily of political origin, such as

the upheaval and university unrest in 1966. Frequent changes in the ministries have produced continuing uncertainty about the organization of science in Argentina at the policy level and about its financing.

Although discussions with the Argentine Academy of Exact, Physical, and Natural Sciences and the National Council of Scientific and Technical Research began in 1966, the workshop did not take place until 1969 because of difficulties experienced by the Argentine scientific community. The workshop focused attention on topics designated by the Argentines: food technology, groundwater hydrology, scientific information, and agricultural research and training.

Policy-Making Structure for Science and Technology. The program has had no visible effect in this area.

Research Infrastructure. The Argentines gave priority to scientific information, and to the extent that the bilateral program in this area has been successful, the research infrastructure has been strengthened. A Telex network for scientific libraries and documentation centers in Argentina is being developed; on May 1, 1971, it was linked to the John Crerar Library in Chicago, which filled Argentine requests for photocopy services. The manager of the network completed a 3-week training program in the United States and Canada, and the Argentines have prepared a manual on procedures. The Argentines are now making plans to develop a computer-based literature information service, initially in the chemical sciences.

The bilateral program in scientific information, like the Brazil Chemistry Program, is an important experiment and may well become a prototype for scientific information networks in developing countries.

Advanced Training and Research. A joint study group on underground hydrology has recommended a research program in the dry pampas; not yet implemented, it nevertheless shows promise. A joint study group on food technology has recommended several research projects on protein concentrates and on the processing of dairy products and fish for human consumption.

Attitudes of Local Government. The program thus far does not appear to have affected the attitudes of the Government of Argentina.

Local Scientific Community. The workshop and the study groups have brought together a number of disparate elements of the Argentine scientific community.

Inputs to National Planning Efforts and Programs. There have been few, if any.

Some Factors That Have Influenced Program Effectiveness. Two Nobel prizes in science, the only ones given to South Americans, testify to the competence of the Argentine research community in the basic sciences. But somehow it has been difficult to transfer that competence to the applied areas that are essential to development. In substantial measure, this difficulty results from tradition; in part from the philosophy and attitudes of the few older scientists who have dominated the Argentine scientific scene for several decades.

Perhaps these difficulties on the Argentine side could have been lessened had a larger program with heavy emphasis on applied research been started at an earlier date, with better provision on the U.S. side for help, both financial and technical, in implementing recommendations. Because AID was phasing out its efforts in Argentina, these measures were not possible.

A second difficulty on the Argentine side was that the local leadership, although of high quality, had limited influence with the military government. For several years, the government viewed the scientific community, and particularly its younger and more liberal elements, with suspicion. Under the circumstances, local funds for implementing recommendations and for other follow-up activities were not readily available.

A third difficulty was the lack of clarity in the respective roles of CONICET and the National Council on Science and Technology (CONACYT). CONACYT was created in 1969 as a policy council and, as such, diminished the influence of CONICET.

## COLOMBIA

The first workshop with the NAS was convened in March, 1968, by the then Colombian Minister of Education. This workshop formulated recommendations in education, industry, agriculture and natural resources, and science policy.

Policy-Making Structure for Science and Technology. After the workshop, the Colombians gave priority to the establishment of a top-level Council for Science and Technology to deal with policy questions and a funding agency within the government to promote science and technology. In December, 1968, directly as a result of the workshop, President Lleras Restrepo decreed the establishment of a cabinet-level Colombian National Council for Science to deal with policy questions. Simultaneously, he created the Colombian Fund for Scientific Research and Special Projects "Francisco José de Caldas" (COLCIENCIAS) as a semi-autonomous agency within the Ministry of Education. COLCIENCIAS was given legal status and a budget for the support of scientific research, manpower training, and special studies.

Research Infrastructure. The attention focused at the first workshop (1968) on problems of industrial research resulted in a meeting of industrial leaders, followed by a seminar on the administration of industrial research jointly sponsored by COLCIENCIAS and the Colombian Institute of Cultural Integration. During the seminar, an NAS consultant conducted a course on the administration of research. In 1969, the NAS also loaned a member of its staff to COLCIENCIAS to assist in administrative and organizational aspects of the new agency.

Advanced Training and Research. Early in 1970, representatives of the NAS, COLCIENCIAS, the Colombian National Planning Office, and the Colombian Institute for the Development of Higher Education (ICFES) agreed to conduct a series of jointly sponsored studies of graduate education and research potential in chemistry, biology, mathematics, physics, earth sciences, and engineering. The several joint panels which were created have submitted a series of recommendations to COLCIENCIAS and ICFES on the development of graduate research and education in the fields selected.

Attitudes of Local Government. The attitudes of government leaders toward the development of a strong scientific and technological base in Colombia was initially enthusiastic. The Minister of Education personally participated in the first workshop, and President Lleras Restrepo invited the participants to the Presidential Palace to report their findings to his cabinet. Since that time, a succession of Ministers of Education have been appointed, and the Presidency has changed hands. There has been a noticeable dwindling of interest at the top levels of government in this kind of endeavor.

Local S&T Community. The Colombian scientific community lacks cohesiveness and is not particularly research-minded because the economic and administrative conditions in the universities make the conduct of research virtually impossible. Whatever effective research is done is conducted in certain specialized institutes created for the purpose, notably in the field of agriculture.

The workshop helped establish a number of lines of communication within the scientific community, and the creation of COLCIENCIAS gave rise to some cohesiveness. The subsequent ineffective performance of COLCIENCIAS, coupled with continuing unrest in the universities and recurrent student strikes, have brought the scientific community back to its original state, characterized in part by a feeling of powerlessness and in part by apathy.

Inputs to National Planning Efforts and Progress. Except for the creation of two entities, the Colombian National Council for Science and Technology and COLCIENCIAS, and the recommendations made by joint study groups on the development of graduate education and research in science, there have been no significant inputs.

Some Factors That Have Influenced Program Effectiveness. Throughout the program, political relations between Colombia and the United States have been excellent, and the attitude of the local USAID mission toward the program has been favorable. The major difficulties with the program have stemmed from the complex political situation within Colombia and from the quality and influence of the local leadership. Related to these factors are a vast array of institutional jealousies that have often prevented action.

On the political side, the program has suffered from a change of Presidents, a succession of Ministers of Education and a growing anti-U.S. activity within the universities. Competition with ICFES was not anticipated when COLCIENCIAS was created, but it has turned out to be a major difficulty. COLCIENCIAS failed to recognize the important role of the Colombian National Planning Office in all questions relating to strenghtening science and technology within the Colombian development plan. Changes in the leadership and attitudes of the Colombian National Planning Office have also created problems.

From the beginning, the leadership of COLCIENCIAS was enthusiastic, but not as effective as one might wish, in terms of administration and influence within the government. Efforts were too scattered to be effective. Above all,

the spirit of true collaboration disappeared once COLCIENCIAS was created. From that time, the Colombian leadership failed to make effective use of U.S. and other national and international inputs.

The bilateral Colombian - U.S. experience is a landmark with respect to the dispatch with which a high-level, policy-making structure for science and technology was created. Unfortunately, the effectiveness of the structure was severely limited by the political and institutional environment.

PERU

In 1966, an ad hoc group of Peruvian scientists participated with the NAS in the organization of the first U.S. - Peru workshop on The Role of Science and Technology in Peruvian Economic Development. The workshop considered ways to improve scientific and technological research and emerged with a number of recommendations. A second workshop was held in 1967.

Policy-Making Structure for Science and Technology. At the first workshop, the Peruvians gave priority to their own recommendation calling for the creation of a national research council. Eventually, a proposed charter was drafted by a bilateral group and introduced by the Peruvians to their Congress. Political difficulties in the Peruvian legislature delayed the creation of the new organization until January, 1969, when the Government of President Juan Velasco decreed the establishment of the Peruvian National Research Council (NRC).

In the meantime, the Peruvian Academy of Sciences joined in sponsoring the second workshop in 1967. At this meeting, the Peruvian Association for the Advancement of Science (APAC) was founded. However, both the Peruvian NRC and APAC have suffered from insufficient funding. Moreover, by 1972, both institutions were in disrepute with the scientists who helped bring them into being because of the political uses allegedly made by the executive staff in office at that particular time.

Research Infrastructure. There are no visible effects.

Advanced Training and Research. There are no visible effects.

Attitudes of Local Government. In 1966, President Fernando Belaúnde Terry showed no particular interest in the development of a strong Peruvian scientific-technological

base. The administration of President Juan Velasco showed more interest and founded the NRC. Unfortunately, the funding of the NRC has so far been grossly inadequate. The Peruvian government has recently decreed that industry provide a share of its profits for the support of research. Initiatives to provide guidance in this endeavor are being taken by the Minister of Industry and Commerce. The present minister was formerly head of the Peruvian Office of Naval Research and an active participant in the NAS bilateral program.

Local S&T Community. The most important single effect of the bilateral program thus far has been the evolution of a cohesiveness within the Peruvian scientific community. When the first workshop was being planned, several of the scientists involved either had not known each other at all or did not know each other well. The first workshop created channels of communication which have persisted over the years. The Peruvian Association for the Advancement of Science further strengthened the bonds within the Peruvian scientific community.

Inputs to National Planning Efforts and Progress. There have been virtually none.

Some Factors That Have Influenced Program Effectiveness. The program in Peru would not have been possible without the enthusiastic support of Robert Culbertson, Director of the local USAID mission. Unfortunately, by the time of the first workshop he had been transferred, and none of his successors has shown any particular interest in S&T as a legitimate area of concern with respect to development. Except for the initial planning stage, support of the program by the local USAID mission has been minimal.

The Peruvian scientific community has shown much enthusiasm for the program, but for understandable reasons adequate leadership has not been forthcoming. In large part, this lack has stemmed from a multiplicity of local political uncertainties.

During the beginning stages of the program, relationships between the government of Peru and the U.S. were excellent. In recent years difficulties about fishing rights and the nationalization of industries have created a situation in which bilateral programs are extremely difficult to maintain, particularly if they are government funded.

Peruvian S&T leadership in competent, but apparently now has little influence with the government.

Communications between the NAS and the Peruvian scientific community range from fair to good at present.

THE REPUBLIC OF THE PHILIPPINES

In 1965, the first joint workshop between the Philippine Science Development Board (NSDB) and the NAS focused on the potential for science and technology in the Philippines, scientific manpower needs, requirements for applied and basic science facilities, and mechanisms for increasing scientific cooperation between the Philippines and other countries. In 1966, a second workshop recommended that four specific problem areas be the subject of further cooperative activity: industrial research, oceanography and fisheries, food and nutrition, and demography. In 1967, a third workshop addressed the problem of fisheries and oceanography. In 1969, a fourth workshop addressed the problem of industrial research.

Policy-Making Structure for Science and Technology. There is no obvious effect so far.

Research Infrastructure. The first two workshops alerted the NSDB and the Philippine Government to the inadequacy of support for science and technology and to the disproportion between resources allocated for basic research and for applied research related to the country's needs. As a result of those workshop discussions, new revenue-producing legislation was passed, and in 1968 a Special Science Fund was established. In principle, this increased the NSDB's grant-making resources, but in fact the results were less spectacular than the legislation might indicate. Each year the Philippine Congress authorizes the expenditure of considerably more funds than are available. The executive branch of government then distributes the actual available funds as it chooses. The NSDB receives considerably less money each year than the congress intended.

The Workshop on Industrial Research led to the establishment of a National Advisory Commission on Industrial Research with participation from the NSDB, Council for Economic Development, National Institute of Science and Technology (NIST), and private industry.

Advanced Training and Research. The NSDB re-examined its allocations for research with the view of obtaining a ratio between basic and applied research activity more in conformity with the experience of more industrially advanced countries. Other developments resulting from the workshops include the creation of an institute for

coconut research, an institute for textile research, and the expansion of documentation services within the NIST.

Attitudes of Local Government. Various individuals in both executive and legislative branches of government have stressed the importance of science and technology to Philippine development, and the workshop program appears to have accelerated this trend. In 1966, the program received unusual recognition in the joint communique of Presidents Johnson and Marcos on the conclusion of the latter's official visit to the United States. The communique commended the program and expressed hope for its continuation and expansion. In spite of such expressed attitudes, however, effective positive actions have been slow and few in number.

Local Scientific-Technological Community. For many years the NSDB has been run by a group of elderly scientists who made little effort to involve younger members of the scientific community or to obtain a broader institutional and disciplinary base. Unfortunately, the workshops had little effect on this situation.

Inputs into National Planning Efforts and Programs. After the first workshop, a 4-year plan was drafted, calling for several studies largely in applied research fields. At subsequent workshops, it was recommended that NAS-NSDB study groups pursue these studies; however, lack of funding prevented any action. Following the fourth workshop, the National Advisory Commission on Industrial Research was created; however, there has been no visible effect. Secretary Alejandro Melchor, special adviser to the President of the Philippines and former workshop participant, has advised that workshop discussions have contributed to planning for the "new society" program in the Philippines.

Some Factors That Have Influenced Program Effectiveness. Although political relationships between the Philippines and the United States were good during the entire period of workshop activity, the local USAID mission was totally uninterested in the program during the early years. This was unfortunate, for had the mission enabled the NSDB to implement a few carefully selected workshop recommendations, it might have given the program sufficient momentum to achieve more objectives. This in turn might have influenced the government attitudes and led to a strengthening of the NSDB.

The second difficulty in the Philippine program involved the quality and influence of the local leadership. As

has been mentioned, the NSDB was controlled by an elderly elite with little influence at appropriate levels of the government.

Although funding has been available to conduct workshops, no funding has been available for implementing joint workshop recommendations. The reasons are complex but stem largely from the matters just discussed.

## Programs of Indeterminate Effectiveness

### CHILE

In early 1971, the Chilean National Commission for Scientific and Technological Research (CONICYT) and the National Academy of Sciences held a workshop to review several research areas of concern to the Chilean scientific-technological community. The workshop formulated joint recommendations on national science policy, nutrition and food technology, marine sciences, computer sciences and applied mathematics, and research and development in copper technology. The plans for the workshop were made in 1970 before the elections, but the meeting was not held until January, 1971, shortly after Salvador Allende assumed the Presidency of Chile.

Immediately after the workshop, the Allende government reorganized the administration of CONICYT, which disrupted plans for program extension and implementation. In spite of this, a number of activities have resulted from the workshop.

Policy-Making Structure for Science and Technology. There is no apparent effect.

Research Infrastructure. The workshop recommended that a national nutrition office be established and that a national nutrition policy be formulated using governmental, industrial, and university expertise. By July, 1971, CONICYT had established the new office.

The working group in marine sciences examined a wide range of topics on the exploitation of marine resources and recommended the development of institutional coordination of all activities in the marine sciences. In May, 1971, CONICYT accepted the working group's entire report.

Advanced Training and Research. Chilean interest in copper technology led one U.S. participant to develop several short courses in this field.

Attitudes of Local Government. President Allende expressed personal interest in the workshop, but it is by no means clear that his government will support research and development at a level appreciably higher than that given by the previous one. However, in spite of the strained relationship, between the United States and Chile and the uncertainty of CONICYT during the time of the workshop, the meeting was allowed to take place.

Local S&T Community. Chilean participants approached the workshop enthusiastically and brought together important members of the scientific community. Subsequent political events, however, make it difficult to assess the effects of the workshop, which at best appear very modest.

Inputs to National Planning Efforts and Programs. There appear to have been modest inputs in the area of food and nutrition.

Some Factors That Have Influenced Program Effectiveness. Although there was good reason in 1970 to believe that a successful program could be developed between CONICYT and the NAS, subsequent political changes have made it impossible to undertake significant follow-up activity. Since the reorganization of CONICYT, communications have been difficult. The deteriorated political relationships between Chile and the United States have made AID funding unavailable.

NIGERIA

In 1965, the NAS Africa Science Board and an ad hoc group of Nigerian scientists, university heads, and economic planners held a workshop to consider the organization of scientific research and science policy for Nigeria that would bear on the country's economic development. Subsequently, two military coups and a prolonged civil war made it difficult to proceed with a program.

Policy-Making Structure for Science and Technology. The bilateral workshop stimulated the Nigerian group, including the Permanent Secretary of the Ministry of Economic Planning, to plan concrete steps to develop a policy-making structure for science and technology. After the civil war, the Nigerian Government requested help from UNESCO in planning a Council on Science and Technology. UNESCO supplied an advisor, and the council has since been created.

It is not possible to estimate with reasonable certainty the effects of the workshop on other elements of Nigerian science, such as research infrastructure and advanced training and research, because the large, disruptive effects of the civil war split the local scientific community.

Some Factors That Have Influenced Program Effectiveness. Before the series of internal disruptions, the prognosis for an effective program appeared good. Although internal instabilities were evident, the political relationship between Nigeria and the United States was good, and the local leadership was of high quality. Prospects for financing a joint effort were likewise promising.

Good working relationships are now being established with the Chairman of the Council on Science and Technology, and it is hoped that an effective bilateral program can be re-established in the near future.

## III

## CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations embody the general principles that have guided the OFS in the conduct of international programs and some lessons learned from a decade of involvement with overseas colleagues. The material is organized under these topics:

A. The Conduct of Programs
B. The Importance of Continuity
C. Follow-up and Implementation
D. Selection of Countries
E. AID/Washington and USAID Missions
F. Evaluation and Program Development
G. NAS Role

### A. THE CONDUCT OF PROGRAMS

The programs that have thus far been most effective have demonstrated that the workshop techniques developed permit goals to be reached bilaterally if certain basic operating conditions are fulfilled:

1. A viable counterpart institution is selected, preferably a national research council, an academy of science, or an executive-level office or ministry dealing with science and technology.

2. Open, joint discussion of objectives takes place.

3. Following the discussion, participants from the host country decide what the actual objectives are going to be, taking into account limitations on both sides of money, manpower, and time. The form, content, and emphasis of the program is fitted to the local situation, perhaps utilizing such techniques as a series of workshops, standing policy committees (as in Taiwan and Brazil), study groups (as in Colombia), or specific project assistance (as in Argentina).

4. From this point until the implementation stage, the program is completely cooperative--

(a) All major recommendations on steps to be taken are joint ones, reached only after adequate discussion.

(b) The bilateral programs are financed by contributions, ideally about equal, from both sides. Private funds are available to supplement governmental support, whenever feasible, to permit adequate flexibility.

(c) To maximize the spirit of "cooperative problem solving," in contrast to onesided "giving of advice," each joint group--a workshop, a study group, or task group charged with implementing a recommendation--includes approximately equal efforts from each country.

5. Recommendations are implemented unilaterally (by the host country), or bilaterally, or by the host country in collaboration with international agencies. In bilateral implementation, the basic decisions remain the sole responsibility of the host country, but they are made only after adequate discussion by joint groups of experts.

6. Great care is taken by both sides in selecting members of joint groups. Personalities, including the ways that individuals interact with counterpart and colleagues, can be crucial. U.S. participants should be sensitive to the local political climate, and it is important that some of them speak the local language. Showing respect for an individual's knowledge or influence can also be important. Candidates for bilateral programs should be acceptable to counterparts.

7. Workshop recommendations are primarily based on the importance of the problems considered to the development of the host country and on the feasibility of proposed solutions in terms of available technology and resources.

8. All reasonable efforts are made to minimize politics in bilateral group deliberations. Indeed, this consideration makes it desirable, where possible, for the study of problems and the formulation of recommendations to be undertaken by nongovernmental organizations.

9. Bilateral professional staff of high quality helps each joint group. Effective programs enjoy daily conduct by staff with initiative, diplomacy, creativity, continuity, and, often, language ability. Furthermore, a substantial amount of advance staff preparation is required for workshops

and study groups. Essential to success, also, is selection by counterpart organizations of a staff that can work well together, particularly because they should frequently be in personal touch with one another.

10. When the not infrequent difficulties arise from the anti-U.S. expressions of student groups, newspapers, or individual government officials, the situation is helped by a deliberate effort to broaden the program participation to include representatives from academies or equivalent institutions in other technologically advanced countries. It is attempted on a scale large enough to dilute the visibility of the U.S. presence, but not large enough to raise serious organizational and administrative problems. Ideally, the other participating organizations are willing to share program costs.

11. When host country and U.S. participants agree it might be useful, scientists from other developing countries are asked to participate in workshop programs.

## B. THE IMPORTANCE OF CONTINUITY

Most conspicuous in some less successful programs is a lack of continuity, which has stemmed from several sources:

1. Changes of government. This has delayed programs in Argentina, Chile, Peru, Colombia, Ghana, and Nigeria. Although this situation is completely outside NAS control, some assessment could, and should, be made of a country's political stability before a program is started there.

2. A change of administration in a counterpart organization. This has delayed programs in Argentina, Chile, Brazil, Peru, Colombia, Zaïre, and the Philippines. This situation is also outside NAS control; nevertheless, proper provision for travel by staff and appropriate committee members could minimize many of these difficulties.

3. A sudden change in political relations between the United States and the host country. This can delay programs, sometimes indefinitely, as in Chile, Peru, and India. Although it is not easy to predict such difficulties, they can be ameliorated to some extent by U.S. staff support adequate to maintain communications during the troubled period.

4. Failure of the local government to support a bilateral program adequately. One of the more frequent reasons for lack of success, this difficulty could be partly eased by carefully selected U.S.-financed incentives.

5. Extremely thin spread of highly trained technological manpower in most developing countries. Often, the individuals responsible for science and technology programs have so many other responsibilities they cannot operate effectively. The possibility of asking carefully selected individuals from more technologically advanced societies to assume, temporarily, some local administrative responsibilities merits serious consideration.

6. Indifference of local USAID missions to science and technology. An important reason behind the only minimal success of some NAS programs, this situation would be greatly improved if all workshops and directly related activities were financed by AID/Washington with the consent, of course, of local missions. Concrete implementation programs would still be financed by local missions, collaborating with local governments.

7. Rapid turnover of AID personnel and consequent inadequacy of "memory" within the organization. One way of coping with this difficulty is to ensure adequate continuity and memory within the NAS staff and to develop and maintain good communications between NAS staff and local USAID missions.

8. Lack of adequate follow-up by NAS staff. This important element in the lack of program continuity has stemmed in part from inadequate numbers of staff, which is related to inadequate funding.

## C. FOLLOW-UP AND IMPLEMENTATION

If a program is to be called successful, it must have substantial follow-up; that is, plans are made to implement recommendations, which necessitates close communications between the NAS and its counterpart organizations. Formation of study groups or similar bilateral activities should take place soon after they are recommended because of the amount of preparation necessary for their work. Beyond the joint evaluative stage, implementing programs within countries is the responsibility of the counterpart or other institutions within the country. Even at this stage, however, the NAS should continue to lend scientific and technical

expertise to help countries identify the necessary technical and human resources, particularly if they must be obtained from sources outside the country.

1. It is essential to make arrangements for continuing discussions between NAS staff and committee members and their counterparts in developing countries.

2. Recommendations that are implemented should be financed with either local funds alone or local funds supplemented by international or U.S. funds. Implementation programs should not be financed solely with U.S. funds.

3. In jointly financed programs arising from workshop programs, such as the Chemistry Project in Brazil, joint staffing and joint direction are essential.

4. In countries with workshop programs in progress, general workshops should be held at least every 2 years to review progress and develop future plans.

5. The limitations placed on the expenditure of government funds make limited but definite private funds highly desirable for the development and implementation of programs.

## D. SELECTION OF COUNTRIES

The criteria for selecting a country and a program should include the factors that indicate a reasonable promise of success. Several questions should be asked:

1. How stable is the government? How likely is a change in government policy that would make it impossible to implement workshop recommendations?

2. Does the climate of local government promise support of programs? Given all good will, what are the chances that a set of recommendations will be implemented by the government?

3. Is there an institution such as a research council with which the NAS can work effectively? If not, what is the likelihood that a suitable and viable organization can be created?

4. Is there a critical mass of trained technical personnel in the country to generate the necessary action?

5. Is the local scientific community eager to develop indigenous capabilities for their country's development of science and technology?

## E. AID/WASHINGTON AND USAID MISSIONS

1. It would be extremely useful if the greater part of U.S. expenses in connection with workshops, working groups, and study groups were provided by AID/Washington, with local mission funds reserved for selected cost-shared implementation programs. Naturally, the local mission would still be consulted from the beginning of program planning, and it would, it is hoped, provide a reasonable level of logistic support.

2. Where the local mission pays for a proportion of implementation costs, it should also pay for NAS efforts involved with the implementation. Should implementation be financed primarily by the host country, NAS inputs should wherever possible be funded by AID/Washington.

3. Present contractual arrangements between the NAS and AID, along with the established operating procedure, do not provide for enough flexibility to permit effective follow-up and to enable the Board on Science and Technology for International Development (BOSTID) and staff to take advantage of new opportunities.

## F. EVALUATION AND PROGRAM DEVELOPMENT

Systematic efforts should be made to measure the results of all projects and programs. Accurate records and accounts of program results should be obtained from the counterpart institution, AID, and other participating parties.

1. A major comparative study might be undertaken of the largest bilateral programs, in Brazil and Taiwan, to determine the full impact of the programs and to explore new directions and opportunities.

2. Major projects, such as the Chemistry Project in Brazil, should be evaluated at the end of NAS involvement and within 10 years of their inception.

3. The content of bilateral programs has been determined largely by colleagues in the host country; this practice should continue. In most countries, periodic workshops have served to take stock of results and to point to new

directions as programs evolved. In countries where periodic workshops have not taken place, bilateral groups should determine whether follow-through or project termination is indicated.

4. To review the special studies conducted for AID in the last 5 years, evaluation and program-development functions, similar to those of bilateral programs, should be undertaken by BOSTID ad hoc panels.

5. In examining program potential, evaluators should investigate major areas of interest that were discussed at workshops but had little or no follow-up, as, for example, natural resources development.

6. Case studies should be made of the development and application of science and technology in selected countries such as Mexico in which NAS has not been active. Comparing developments in these countries with those in countries in which workshop programs have been successful would be useful.

## G. NAS ROLE

As an institution engaged in furthering science and its applications for human welfare, the NAS has traditionally shared its intellectual resources and partaken from its colleagues abroad. In an age of increased technological and societal complexities, the need to engage in intellectual discourse with other societies is apparent. This is true of technological equals as well as those desiring to achieve material sufficiency or some other form of change. In the last decade, the NAS has given increased attention to assistance in the development of scientific and technological resources in underdeveloped countries. More recently, its new associate, the National Academy of Engineering, has joined in these efforts, and it is expected that the Institute of Medicine will also contribute.

1. The NAS should continue to cooperate with its colleagues in underdeveloped countries in bringing science and technology to bear in seeking solutions to major national problems, such as eliminating hunger, controlling disease, and making use of undeveloped resources.

2. The NAS's principal role should continue to be advisory, and in this process to provide technical advice to AID and NAS counterparts and to combine talents with colleagues abroad. Although this role allows the NAS to

stimulate and initiate action, it should be primarily catalytic; whereas the implementation of programs is largely the responsibility of its counterparts abroad. Exceptions to this should be taken only infrequently, and then primarily on an experimental basis.

3. The NAS should encourage other U.S. entities and regional and international organizations to support development projects arising from NAS bilateral programs.

4. To ensure optimal effectiveness and flexibility, private funds should be sought to supplement the central funding provided by AID.

5. NAS efforts should not be spread too thin. Programs would be more effective were they concentrated in a few countries in which there is vigorous follow-up, rather than in many countries on a sporadic basis. Again, this emphasizes the importance of carefully selecting countries and programs.

6. An advisory board, such as BOSTID, should continue to guide the overall program. Board members should be well informed and, without exception, should participate actively in BOSTID programs.

7. The selection of highly qualified U.S. scientists and engineers is a key factor in all programs; therefore, the criteria for "highly qualified" and "appropriate" must in each case be based on the requirements of the task at hand and not on a preconceived, prescriptive notion of expertise.

8. Although maximum participation of outstanding individuals should be encouraged, care should be exercised not to rely too heavily on a few individuals. The pool of talent should be expanded to include new individuals, particularly younger scientists, women, and members of minorities.

9. A concerted effort should be made to include more social scientists in policy-making decisions, particularly those affecting major developmental programs that might alter the social and physical environment. The health of peoples must be taken into full account, including the requisite social and cultural integration to sustain it. Major problems related to rapid population growth, migration, and unemployment should receive foremost attention in development programs.

10. The use of consultants, lecturers, and short-term training programs should be explored more fully to see how bilateral programs can use these services to the fullest extent possible as either innovative or supplementary features.

11. BOSTID panels, such as those advising on the Technology Innovation Project, should be cognizant of the concerns of both underdeveloped countries and aid-lending agencies (some panels already have multinational membership and representation from multilateral organizations). In the selection of panel members, the experience already gained by individuals through NAS bilateral programs should, wherever possible, be taken into account.

12. A staff adequate in both quantity and quality is vital to NAS programs, particularly because the daily conduct of programs must rely on staff initiative, diplomacy, creativity, and memory.

# APPENDIX A

## BILATERAL PROGRAMS, 1964 - 1971

Board on Science and Technology for International Development
Office of the Foreign Secretary
National Academy of Sciences
Washington, D.C. 20418

# APPENDIX A: BILATERAL PROGRAMS, 1964 - 1971

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## INTRODUCTION

Interest in international cooperation has been traditional with the National Academy of Sciences (NAS), and the concentration in the last decade on countries of Africa, Asia, and Latin America is an extension of this interest. Most countries in these regions have seen the need to develop their own scientific and technological capabilities, and the NAS has responded, largely through AID's foreign technical assistance programs, by mobilizing U.S. scientists, engineers, and other experts to fulfill what is regarded as a mutually desirable objective.

At the end of 1971, bilateral programs* sponsored by the Board on Science and Technology for International Development (BOSTID) of the NAS were under way in Ghana, Nigeria, Zaïre (Congo), India, Indonesia, the Philippines, Taiwan, Argentina, Brazil, Chile, Colombia, and Peru. Most programs were co-sponsored by the NAS and a counterpart institution, such as an academy of science, a national research council, or an executive-level office of science and technology. Most bilateral programs have relied on workshop meetings for inspirational guidance and planning mechanisms for a variety of activities.

Workshops, usually undertaken in a series 1 - 2 years apart, are 1-week, intensive meetings devoted to general or specific aspects of science policy and organization, or to priorities of research, training, and related topics. Workshops, sometimes held alternately in the United States and abroad, are generally confined to a selected group of approximately 10 experts from the visiting country and a slightly larger number from the host country, including governmental planners and representatives from the private sector. Guidance for workshops is often provided by a formal or de facto bilateral committee under the joint auspices of the two co-sponsors.

Study groups, composed of equal numbers of NAS and counterpart experts, follow through on workshops by studying

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*Regional activities and special projects are described in Appendix B, "Special Studies and Projects."

specified areas more intensively and making recommendations for action programs.

The following summaries of bilateral programs describe the general character of each program by indicating some of the persons and institutions involved, types of studies conducted, and some of the results. See Appendix C, Part I, for reports and publications listed by country.

# AFRICA

## GHANA

In February, 1965, members of the Africa Science Board visited several African countries to explore possibilities for cooperative activities. Discussions with representatives of the Ghana Academy of Science and the University of Ghana laid the basis for a program. Because of protracted political difficulties in Ghana and the reorganization of the science establishment after the exile of President Nkrumah, a program was not begun until 1970, when the Ghanaians were better able to resume an active relationship with the NAS.

A joint workshop on Research Priorities and Problems in the Execution of Research in Ghana was held in Accra in January, 1971. Convened under the auspices of the NAS, the newly created Ghanaian Council for Scientific and Industrial Research (CSIR),* and the universities of Ghana, the workshop brought together 12 U.S. scientists and over 60 Ghanaian scientists, cabinet ministers, and university and research institute administrators. At this meeting two areas of critical importance were identified for further study by a joint group: (1) agricultural research and extension and (2) research priorities in relation to Ghanaian development.

Ghanaian scientists and government officials have asserted that the workshop was of decisive importance in that it brought together for the first time many disparate elements of the scientific community. This catalytic effect can also be seen in later developments: in addition to the projected joint studies, the All-Ghanaian Conference on the Role of Agricultural Research and its Relationship to the Development of Agriculture convened in July, 1971; and the dissemination of a crops-research handbook to personnel in the agricultural ministry, in agricultural extension work, and in other fields.

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*Created in 1968.

Study Group on Agricultural Research and Extension

An analysis of the Ghanaian agricultural research situation pointed to the need for greater attention to the relationship between agricultural research and extension and, in particular, to the development of a more coordinated system of agricultural extension training and implementation. The study was formally begun with a planning visit in June, 1971, by the NAS co-chairman, Donald Barton, and an NAS staff member. This visit had three main objectives: to arrive at mutually acceptable terms of reference for the study; to discover and meet the people who have the power to implement agricultural programs; and to determine the best timing for the study in terms of political, economic, and social conditions in Ghana.

The planning meeting came at a fortunate time, because the Government of Ghana had recently formed a committee to draft the Medium-Term (3 - 5 years) Plan for the economic development of Ghana. This committee was charged with the formation of subcommittees on sectors of the economy and the presentation of its final plan by October 15, 1971. The agricultural research and extension study was scheduled so that the NAS visitors and members of the key subgroups of the Ghanaian Medium-Term Plan Committee could exchange ideas. As a result, some of the U.S. visitors' ideas were incorporated in the Medium-Term Plan, and, in turn, ideas contributed by the Ghanaian Medium-Term Plan Committee were incorporated into the planning for the joint study.

The primary recommendations emanating from the study were (1) the establishment of a "National Agricultural Service" administration within the Agricultural Ministry, which would consist of basic extension services and related activities; (2) the separation of the ministry's Information and Publications Unit into two distinct entities, one to be retained by the ministry as a public information dissemination unit, and the other--an agricultural information extension unit--to be located within the CSIR; and (3) the establishment of a mechanism for evaluating through internal and external systems the effectiveness of agricultural extension in Ghana.

Study Group on Science Policy and Research Priorities

The decree establishing the CSIR in 1968 states that one function of the council shall be "to advise the Government on scientific and technological advances likely to be of importance to national development and in particular to advise the Government or other agencies of Government on scientific

and technological matters affecting the utilization and conservation of the natural resources of Ghana and on how best scientific research may be coordinated and employed in the interests of such utilization and conservation of the natural resources of Ghana and on how best scientific research may be coordinated and employed in the interests of such utilization and conservation." The workshop recommended that a joint study be made to draw the operational guidelines for this function of the CSIR.

Planning for the study was initiated in October, 1971, during the visit in Ghana of the NAS co-chairman and an NAS staff member. Discussions were held with representatives of the CSIR; the Universities of Ghana, Kumasi, and Cape Coast; and many other individuals concerned with science policy and research priorities. From these discussions the study was scheduled for March, 1972, in Accra.

In January, 1972, the chairman of the CSIR requested a postponement of the study because of a change in the Government of Ghana. The study may be rescheduled during the summer of 1972.

NIGERIA

In February, 1965, members of the Africa Science Board visited several African countries to establish closer ties with African colleagues. Discussions in Nigeria concerned science organization and policy matters in view of impending legislation before the Nigerian Parliament calling for the creation of a National Research Council and an Academy of Sciences. Nigerian scientists were especially interested in the NAS experience with government, industry, and academic institutions. Further meetings on these questions were proposed.

Following the visit to Nigeria, the Africa Science Board and staff encouraged Nigerian participation in such programs as the Upper Mantle Project and the International Biological Program, sponsored a panel discussion on "Science Research Opportunities in Nigeria" at the meeting of the African Studies Association; and attempted to recruit a science policy advisor for Nigeria under UNESCO auspices. The board also arranged for preliminary studies of ecological changes and resettlement resulting from construction of the Kainji Dam.

The first U.S. - Nigerian science workshop was held in August, 1965, at the conference center of the Rockefeller Foundation in Bellagio, Italy. The Africa Science Board and an ad hoc group of Nigerian scientists, university heads, and economic planners met to consider which elements of a science policy for Nigeria would bear on the country's economic development; and the organization of scientific and technological research by the proposed Research Council and Academy of Sciences. Discussions centered around the following topics: (1) training of scientific personnel, (2) division of labor between universities and applied research institutes, (3) public health aspects of economic development, (4) natural resources, (5) economic planning and the use of data from agricultural research, (6) priorities and international cooperation, and (7) contributions of academies and research councils to economic development.

Subsequently, two military coups and a prolonged civil war made it difficult to proceed with a program. The OFS has maintained contact through correspondence and periodic visits with members of the Nigerian scientific community and the USAID Mission in Lagos.

In late 1971, Victor Oyenuga, the Chairman of the newly created Nigerian Council on Science and Technology, visited the NAS and showed strong interest in developing a closer relationship with the NAS, but indicated the NCST must first take care of its basic organizational matters.

## ZAIRE*

In late 1968, a scientific delegation from the Congo visiting the NAS on a mission to study U.S. science policy organization invited cooperative relations with the NAS. The NAS was unable to take action until January, 1970, when an OFS staff officer visited Kinshasa. Several staff visits followed in the course of 1970, leading to agreement in January, 1971, with the Office Nationale de la Recherche et du Developpement (ONRD) for a joint workshop, which took place in Kinshasa in June, 1971.

The workshop on Science and Technology in the Economic Development of the Congo in the Seventies, examined science policy and economic development, natural resources, human resources, agriculture, and food and nutrition. Bilateral activities recommended by the workshop included joint study groups on (1) agricultural economics, (2) demography, (3) earth sciences, (4) a primate center in the Congo for the breeding and study of dwarf chimpanzees, and (5) food and nutrition.

Four months after the workshop the ONRD established under its auspices a center for research on food and nutrition. In December, Ansley Coale, chairman of the prospective NAS panel for a joint study group on demography; John Maxwell, earth sciences chairman; and Ray Pariser, the workshop member particularly concerned with the nutrition recommendations, visited Kinshasa to make arrangements and formulate the terms of reference for future activity in these three areas. The Joint Study Group on Demography was scheduled to convene in Kinshasa for 1 week in late January, 1972; the Joint Study Group on Earth Sciences for 2 weeks in late July. In nutrition, Dr. Pariser is formulating a program designed to assist the new Zaïre research center partly through periodic visits of an advisory group, partly through a telex connection with his department at the Massachusetts Institute of Technology (MIT) which will permit prompt communication of information on technical questions. A panel of specialists in primatology and related fields will visit Zaïre in mid-April to pursue discussions leading to the establishment of a pilot breeding colony of dwarf chimpanzees.

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*The name of the Democratic Republic of the Congo was officially changed to Zaïre late in 1971.

The NAS is not taking further action on agricultural economics because negotiations are now in progress between Michigan State University, AID, and the Government of Zaïre for a project to establish an economic research unit in the Zaïre Ministry of Agriculture and a training program within the National University of Zaïre.

## ASIA

### INDIA

Although NAS's informal contacts with the Indian scientific community began in the 1950's, it did not establish a relationship with its principal scientific society, the Indian National Science Academy* (INSA), until 1968. Independent solicitation from Indian sources for the intiation of NAS workshop activity in India similar to that in other cooperating countries, particularly on industrial research, resulted in the first workshop, held in Baroda in March, 1970, on The Management and Organization of Industrial Research. The workshop brought together an NAS panel of 10, under the chairmanship of National Academy of Engineering (NAE) Foreign Secretary Bruce Old, and some 40 Indians, all senior research administrators of private or public industries and national laboratories. NAS panelists were all R&D vice-presidents of major industries and contract-research organizations. The workshop stimulated Indian participants to recommend the formation of an Indian association for industrial research patterned on the Industrial Research Institute (N.Y.) and the regular, informal meetings of industrial research-management leaders, patterned on the National Conference on Industrial Research. This recommendation has led to the creation of an Indian Planning Committee to form a society to promote better management of applied research laboratories.

The second workshop, Water in Man's Life in India, in New Delhi, September, 1971, considered the interrelationship of water resources and environmental factors. NAS Deputy Foreign Secretaries Thomas Malone and Roger Revelle made separate visits to arrange for this workshop. Dr. Revelle chaired the NAS panel of 12 specialists in water-resources planning, sanitary and environmental engineering, hydrology, and ecology. The following discussion topics were included:

-Quality of water resources in urban and rural settlements

-Economic aspects of clean water supply

-Sewage-disposal problems

-Disposal of industrial effluents

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*Formerly the National Institute of Science of India (NISI).

-Use of fertilizers and pesticides and their bearing on water pollution

-Estuarine pollution and its effect on marine life

-Problems of siltation

Indian interest in the workshop, due in part to their preparations for participation in the forthcoming U.S. Conference on the Human Environment (Stockholm, 1972) and in part to the intrinsic importance of the subject matter, was shown by the participation of over 90 specialists and government officials, including the Minister for Power and Irrigation and the Minister for Planning.

Other bilateral activities projected with INSA included a workshop on National Technology Policy, and an exercise to be held in Washington in March, 1972, to familiarize the leadership of the Indian Academy with the organization, operations, and advisory relationships of the NAS-NAE-NRC with the federal government and its agencies, as a means of assisting INSA to strengthen its own capabilities to perform similar tasks for the Government of India. These events were postponed indefinitely as a result of the strife in East Pakistan (now Bangladesh) and the resultant political tensions between India and the United States.

INDONESIA

In 1946, the NAS Pacific Science Board established relations with the Council of Sciences for Indonesia (MIPI). In 1960, at the request of MIPI, one of its staff officers served as an intern in science administration in the NAS Office of International Relations. Relationships were maintained with MIPI and Indonesian scientists during the latter years of the Sukarno regime when other U.S. relationships with Indonesia were largely suspended. The NAS-AID book program, for example, operated without interruption during the entire period of U.S. - Indonesian difficulties.

In 1966, the Indonesian Institute of Sciences (LIPI) replaced MIPI as the primary governmental scientific body. In early 1968, as U.S. - Indonesian relations improved, AID agreed to support NAS participation in a joint workshop with LIPI on food, which was held May, 1968. Following the workshop several key recommendations were incorporated in Indonesia's First Five-Year Economic Development Plan. Also, the targets recommended by the workshop for minimum calorie and protein requirements were incorporated in a national nutrition policy. Further, a recommendation for a study by a joint U.S. - Indonesian team of agricultural scientists to formulate a plan for a national agricultural research system, integrating the universities, field stations, and research institutes, was implemented. The AID Mission sponsored the visit of a team of U.S. agricultural research specialists in mid-1969.

In 1969, the senior LIPI administrative officer came to Washington to serve as an intern with the NAS/OFS and Smithsonian Institution while completing a graduate degree in science policy at George Washington University. He plans to return in early 1972 to assume responsibility for LIPI's science policy studies.

In January, 1971, the NAS and LIPI held a workshop in Djakarta on Industrial and Technological Research, which produced recommendations dealing with research organization and management, technical information, standardization, fiscal incentives, patents, small-industry extension services, as well as recommendations dealing with major industrial sectors, such as chemicals, pharmaceuticals, food, textiles, and pulp and paper. As a result of the workshop, the Indonesians have initiated a program to improve the management and organization of industrial R&D institutes. They held an intensive management-development course in Indonesia, and two senior R&D administrators visited R&D institutes in the United States, spending 7 weeks in one institute and 1 week each in

four others. This experimental program will form the basis for a more extensive training program for Indonesian R&D managers.

The NAS and LIPI have tentatively agreed to hold a third workshop in the fall of 1972, addressed to the role of science and technology in the development of Indonesia's natural resources.

Representatives from LIPI will participate in an NAS regional workshop on Use and Protection of Water Resources in Southeast Asia in Singapore in March, 1972.

## THE REPUBLIC OF THE PHILIPPINES

In October, 1964, the Chairman of the Philippine National Science Development Board (NSDB) requested the AID Mission in Manila to ask the NAS to sponsor a joint workshop dealing with problems of Philippine science development. The NAS agreed and through its Pacific Science Board coordinated preparations for the workshop.

The first Philippines - U.S. Workshop on Scientific and Technological Cooperation and Development, held in Manila in November, 1965, was deliberately broad and exploratory, focusing on the challenges and potential for science and technology in the Philippines, scientific manpower needs, requirements for applied and basic science facilities, and mechanisms for increasing scientific cooperation between the Philippines and other countries.

In November, 1966, a second joint workshop, at Asilomar, California, recommended that four specific problem areas be the subject of further cooperative activity: industrial research, oceanography and fisheries, food and nutrition, and demography. In December, 1967, a third joint workshop in Manila addressed itself to the problem of fisheries and oceanography. In January, 1969, a fourth joint workshop in Manila addressed itself to the problem of industrial research.

The first two workshops alerted the NSDB and the Philippine Government to two major problems: (1) the inadequacy of support for science and technology for both education and research, and (2) the disproportionate allocation of resources between basic research and applied research related to the country's needs. Workshop participants from the Philippine Congress, Administration, and the NSDB succeeded in obtaining congressional passage of new revenue-producing legislation specifically to support Philippine science, which significantly increased the NSDB's grant-making resources. Concurrently, the NSDB undertook a re-examination of its allocations for research with the view toward obtaining a ratio between basic and applied research activity more in conformity with the experience of the more industrially advanced countries.

In 1966, the NAS-NSDB science cooperation program received unusual recognition in the joint communique of Presidents Johnson and Marcos on the conclusion of Marcos's official visit to the United States. The communique commended the program and expressed hope for its continuation and expansion.

The Workshop on Fisheries and Oceanography led to the establishment of a National Advisory Commission on Industrial Research with participation from the NSDB, Council for Economic Development, National Institute of Science and Technology, and private industry. Co-sponsorship of the Workshop by the NSDB, the Economic Development Foundation, and the Council for Economic Development was an unprecedented collaboration between a government agency and private institutions in the Philippines.

Despite these early developments, the NAS-NSDB program can point to few subsequent achievements, partly because of lack of internal and external funding and partly because of organizational and jurisdictional problems, as well as political difficulties, in the Philippines. In 1970 the NSDB canceled a joint workshop on food technology because of student unrest.

In the fall of 1971, General Florencio A. Medina, Chairman of the NSDB, met in Washington with Harrison Brown, NAS Foreign Secretary, and OFS staff and discussed possible resumption of institutional cooperation to consider such matters as environmental pollution, food production, and food technology. In January, 1972, Chairman Medina sent a letter to Dr. Brown inviting members of the NAS staff to visit Manila to discuss future cooperative programs.

REPUBLIC OF CHINA (TAIWAN)

At the Centennial Celebration of the National Academy of Sciences in October, 1963, Shih-chieh Wang, President of the Academia Sinica, met with the Foreign Secretary and members of the Pacific Science Board and requested NAS support in planning the development of science and technology in Taiwan. The first joint meeting sponsored by the two academies was held in Taipei in April, 1964, to delineate areas for cooperative programs. The NAS panel of eight was headed by Walter G. Whitman, former Science Adviser to the Secretary of State, and the Chinese group of fifteen, by Dr. Wang. At this meeting, the two academies agreed to form a Sino-American Science Cooperation Committee to recommend programs in areas of science relevant to Taiwan's socioeconomic development. Since AID was phasing out its program in Taiwan, support for NAS participation was obtained from the Asia and Ford Foundations, with supplementary support from the National Science Foundation, the Smithsonian Institution, and the Department of State.

The major topics covered at the first workshop meeting were (1) science policy, (2) manpower and graduate training, (3) marine resources, and (4) medical sciences. In considering cooperative programs, the Chinese expressed a desire to include the social sciences and humanities, as well as science and engineering. A major problem of the Chinese was the "brain drain," caused in part by the lack of adequate graduate training facilities in Taiwan. The workshop adopted these recommendations for immediate action: (1) inventorying ongoing research projects and research manpower; (2) establishing institutional cooperation between Chinese and U.S. universities and research institutes; (3) establishing well-equipped and competently staffed research centers in Taiwan; (4) developing closer collaboration between research institutes and industries in Taiwan; and (5) continuously appraising high-priority research targets important to the economic development of Taiwan.

Shortly after the first workshop, the Chinese took several steps to follow through on these recommendations. To establish institutional ties, Chinese representatives who were interested in atomic energy, building research, marine sciences, and manpower studies visited counterpart institutions in the United States in 1964. K.T. Li, Vice Chairman of the Council of International Economic Development and Cooperation (CIEDC) and a workshop participant, visited the United States with a CIEDC staff member. The NAS arranged for their visits to private scientific institutions and governmental offices, including the White House

Office of Science and Technology and the Agency for International Development. Subsequently, Mr. Li was appointed Minister of Economic Affairs, and Chen-Hsing Yen, another workshop participant, became Minister of Education. In their new capacities, both have continued to be active in the cooperative program.

Other actions undertaken soon after the first meeting led to the implementation of some major recommendations adopted in Taipei. One such action was the Academia Sinica's request for a science policy advisor. In 1964, Joseph B. Platt, a physicist and president of Harvey Mudd College, spent several weeks in Taiwan reviewing governmental policy structures and graduate education in the sciences. The recommendations submitted to the Premier of the Republic of China by Dr. Platt and his Chinese colleagues, K.T. Li, C.C. Yao, and S.L. Chien, were instrumental in modifying science policy mechanisms within the government. For example, in 1967 the National Science Council was created to replace the National Council on Science and Development, and the Committee for Science Development was formed within the National Security Council.

Efforts to stem the brain drain and to improve facilities for graduate education and research resulted in a variety of activities. Shortly after the April, 1964, meeting, the Chinese conducted a survey and inventory of scientific manpower in some 40 institutions. For its part, the NAS, through its Office of Scientific Personnel, compiled a roster of Chinese scientists and engineers in the United States. This roster helped the Chinese to recruit scholars for the graduate research centers created in 1965 for (1) agriculture, (2) chemistry, (3) physics, (4) biology, (5) mathematics, and (6) engineering. The Chinese appropriated over U.S.$3 million for 4 years for the centers, created special chairs at the universities, and increased salaries to draw scholars for short-term and long-term appointments. The effort to improve graduate education has been further strengthened by the intergovernmental Sino-American agreement signed in early 1969. This agreement, administered by the National Science Council of Taiwan and the U.S. National Science Foundation, provides for the exchange of scientific and technical information and personnel and the support of cooperative research projects.

Between 1964 and 1971, six joint Sino-American workshops were held, alternately in the United States and Taiwan. In addition to the tasks already mentioned, the Chinese have systematically undertaken action programs in, for example, marine sciences, industrial research, scientific and technical information, and the social sciences and humanities--

all of which have been the subject of discussion at the bilateral meetings.

Participants in the first and second workshops made proposals for cooperative research in marine biology and the creation of an institute of oceanography. A program in oceanography was later developed through the cooperative efforts of Y.S. Tsiang of the Joint Commission on Rural Reconstruction, Burr Steinbach of the Woods Hole Oceanographic Institution, and I.E. Wallen of the Smithsonian Institution. The Institute of Oceanography was created in 1968 at the National Taiwan University, and the next year, a U.S. ship for research and training purposes was procured on a lend-lease basis. The last Sino-American meeting in May, 1971, focused on ocean resources. The major recommendation of the meeting proposed the creation of a National Commission on Marine Sciences to serve as a coordinating and policy making body.

Industrial research was the focus of a major workshop sponsored by the Academia Sinica and the NAS in 1968. The meeting was attended by approximately 40 Chinese scientists, industrialists, and government officials, including the Vice-President of the Republic and the Ministers of Economic Affairs and Education. NAS participants were selected from leading industries, laboratories, and other institutions representing sectors and activities of interest to the Chinese. Workshop recommendations related to R&D aspects of food technology, textiles, chemicals and plastics, electronics, metals, and energy needs. A committee formed by the National Science Council and the Executive Yuan will oversee implementation of some of the proposed actions. In pursuing these goals, a special committee for marketing research and management was established by the China Productivity and Trade Center, and two high-level groups planned to made a 4-week tour in the United States to study business and industrial management. Other institutions have been designated to implement such recommendations as the development of a Hsinchu Industrial Research Park, the transfer of technology to medium and small industries, and the translation of textbooks for graduate education.

Interest in the bilateral program increased after the visit of Vice-President - Premier C.K. Yen to the United States in 1966 to promote U.S. - Chinese relations. The Premier's interest and commitment, as well as that of Y.S. Tsiang, the present Minister of Education and secretary to the cabinet, helped the science program considerably. In fall 1967, Donald Hornig, the U.S. President's Science Adviser, visited Taiwan. He was followed the next year by

a medical team headed by Ivan Bennett, Deputy Director of the Office of Science and Technology. In 1968, the U.S. Department of State created a new position at the U.S. Embassy in Taipei and appointed Bruce H. Billings as Special Assistant for Science and Technology. Dr. Billings contributed significantly to the cooperative science program, and in 1970, a counterpart, Pan Hsueh-chang, was appointed Science Counselor at the Chinese Embassy in Washington, D.C.

The Chinese have reported that allocations for the support of science research and development from the Government of Taiwan have increased substantially since 1964 to the present level of about 2 percent of the Gross National Product. Numerous institutional ties have been established between Chinese and U.S. universities and institutes in both private and public sectors. The graduate research centers have awarded several hundred masters degrees in the sciences and a few doctorates in physics and engineering. The establishment of a Science Documentation and Instrumentation Center was reported by the Chinese in 1970. The topic of scientific and technical information will be the basis for discussion at the workshop scheduled in the U.S. for 1973.

A parallel program in the humanities and social sciences has been equally active. Begun initially under the auspices of the NAS in 1965, it was subsequently turned over to the American Council of Learned Societies and the Social Science Research Council.

## LATIN AMERICA

### ARGENTINA

Plans for a workshop were initiated by the Argentine member of the U.N. Advisory Committee on the Application of Science and Technology to Development, who was also a member of the Argentine National Academy of Exact, Physical, and Natural Sciences. In mid-1966, the NAS Foreign Secretary visited the Argentine Academy and the National Council of Scientific and Technical Research (CONICET*) in Buenos Aires to discuss the first workshop. At that time, the military had just overthrown President Illia. Shortly thereafter, the difficulties at the universities caused some faculty scientists to emigrate.** Because of this situation, the Argentines postponed the workshop until mid-1969. During this time, because of the unusual circumstances whereby graduate science students at the University of Buenos Aires were stranded in the middle of their study programs, external assistance was requested to relocate students in other institutions. Most students moved to other Latin American countries. The NAS helped to place a dozen students in U.S. institutions.

Plans for the science workshops were resumed through the efforts of the late Bernardo Houssay and his associates. The first workshop, held July 28 - August 1, 1969, at Mar del Plata, focused attention on the following topics designated by the Argentines: (1) food technology, (2) groundwater hydrology, (3) scientific information, and (4) agricultural research and training. After the workshop, in June 1970, the Academy, CONICET, and AID reached an agreement to carry on cooperative programs in the first three of these areas.

The Argentines placed priority on scientific information, and at subsequent meetings, two cooperative projects were agreed upon:

1. The creation of a Telex Network for scientific libraries and documentation centers in Argentina, to facilitate the

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*Changed from initials CNICT in 1971.

**See "A Report to the American Academic Community on the Present University Situation." Special Publication of the Latin American Studies Association. 1967. 44 p.

use of scientific and technical information resources in Argentina as well as the United States, Europe, and other countries in Latin America; and

2. The development of a computer-based literature information service--initially in the chemical sciences--to serve academic, governmental, and industrial scientists in Argentina.

A joint panel meeting in August, 1970, further recommended undertaking the following:

1. Training programs in the United States for the managers of the Telex Network and the computer-based Information Service;

2. Services of U.S. consultants in the development of both projects;

3. Installation of a Telex Network among 14 Argentine institutions, with a link to the United States through CONICET;

4. Provision of subsidized photocopies and microcopies of scientific and technical information to the network by a U.S. library for a 6-month period; and

5. Acquisition of Chemical Abstracts Service data bases.

The manager of the Argentine Telex Network completed a 3-week training program at selected U.S. and Canadian libraries in February, 1971. The network became operational May 1, 1971, when the John Crerar Library of Chicago began providing photocopy services for Argentine requests. The Argentines have developed a manual on procedures and protocol for the network which is being made available to other countries. Arrangements are being made to include other libraries that would provide services in the fields of medicine, agronomy, and technology.

The joint study group on underground hydrology met in Argentina in September, 1970, and recommended an intensive study of salinity and water-management problems in the dry pampas. Plans were subsequently made for a return visit in 1972 by Stanley Davis, NAS panel member, to consult on technical aspects of a proposal being prepared for the Argentine Government and the UNDP for carrying out the research.

A joint study group on food technology met in Argentina in mid-1971 and recommended several research projects on protein concentrates and on the processing of dairy products and fish for human consumption.

In view of AID's phase-out in Argentina, discussions have been under way between Argentines and AID representatives on regional scientific programs in which Argentina can extend cooperation to neighboring countries. Several topics, including scientific information, hydrology, and food technology, were proposed for such regional endeavors.

BRAZIL

The bilateral program in Brazil was initiated by the former NAS Latin America Science Board (LASB) and the Brazilian National Research Council (CNPq). At one of the LASB's meetings in Rio de Janeiro in 1965, exploratory talks were held on areas for establishing cooperative scientific programs. Once the general areas were identified, the two institutions sponsored a workshop to determine the form and content of a bilateral science program. The promising results of the first workshop and the ensuing joint studies laid the basis for a series of workshops and other joint undertakings since that time. In the main, workshops in Brazil have served the dual purpose of reviewing study group activities and identifying new areas for research or cooperative projects.

The first Brazil - U.S. Workshop, The Contribution of Technology to Science and Brazilian Development, sponsored by the CNPq, the Brazilian National Academy of Sciences, and the NAS took place in Itatiaia, 50 miles from Rio de Janeiro in April, 1966. Recommendations adopted at that meeting concerned agriculture, public health, mineral resources, industrial research, communication and transportation in geographic integration, and manpower development. U.S. - Brazilian study groups were later formed to examine (1) industrial research, (2) norms, measurement and testing, (3) agricultural research, (4) agricultural economics, and (5) mineral sciences. A 2-man subcommittee from the workshop met immediately thereafter and recommended certain Brazilian initiatives in steroid chemistry research. As a result, a pilot plant was constructed in Northeast Brazil, which is currently producing hecogenin from sisal, and negotiations for expanding production with European firms are currently under way.

The Second Workshop was held at the NAS in Washington, D.C., in February, 1968. A special 2-day seminar on science policy, chaired by Carroll L. Wilson of MIT, included participants from the National Science Foundation, the Federal Council of Science and Technology, Bureau of the Budget, and the Departments of Agriculture, Commerce, and the Interior. In pursuing the subject of manpower training discussed at the first workshop, the fields of chemistry and computer sciences were recommended for study group analysis. The discussions of Brazilian plans in fields of science and technology related to national goals, were based on a 5-year plan (1968 - 1972) prepared by the CNPq for the President of the Republic. This document had utilized some of the advice generated by the study groups functioning in the interim between the two workshops.

The Third Workshop took place in Rio de Janeiro in April, 1969. In view of the interest aroused by discussions on U.S. science policy at the Second Workshop, the Brazilian CNPq

presented similar discussions by representatives from the Ministry of Planning, the National Bank of Economic Development (BNDE), the National Department of Mineral Production (DNPM), and the Ministry of Agriculture.

Much of the discussion focused on the joint study groups, especially the one on industrial research, whose report was completed in September, 1968; and on the agricultural research and agricultural economic groups which had combined some sessions; and on the chemistry group, which had proposed a major bilateral program for the development of graduate research in two Brazilian universities. Reports on educational aspects of earth science and transportation engineering resulted in the formation of two new study groups. It was also proposed that Brazil sponsor an international conference on patents to develop its own system based on the best available information.

The Fourth and most recent CNPq-NAS workshop (Washington, D.C., November, 1971) reviewed results of the program over 5 years. Small group meetings allowed the working out of operational details, of the chemistry program in particular. William Ellis, USAID Mission Director in Brazil, discussed Brazil's remarkable rate of economic development, praised the participants for their successful joint efforts, and specifically noted the CNPq's dramatic growth since the program was begun.

Some highlights of Brazil's scientific growth over the past 5 years were reported:

1. The CNPq has played a major role in establishing a governmental base for developing science and technology in Brazil.*

2. At present, scientific and technological research hold top priority in the Ministry of Planning's "Program for Aims and Bases of Government Activities," primarily in health, agriculture, industry, and in overall strengthening of scientific and technological capabilities.

3. Investments in science and technology have increased substantially. Estimated expenditures for science and technology by all governmental agencies totaled Cr$402.1 million in 1970, an increase of over 400 percent over 1968, a rate of growth far higher than the rate of inflation.

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*A Presidential decree of May, 1972, gave the CNPq central authority for coordinating national scientific and technological development plans, thereby clarifying its role vis-a-vis the Ministry of Planning.

Appropriations to the CNPq for science and technology during the period 1970-73 totaled Cr$1,470 million compared with Cr$43 million for the year 1967--a sizeable growth even allowing for inflation.

Because the Brazilian government had recently given highest priority to the agricultural sector, the workshop adopted recommendations that two separate study groups be formed under the purview of the agricultural research group. One is to conduct a study on establishing an educational research center in agricultural engineering; the other will study research possibilities in the Brazilian cerrado (savannah).

The NAS experimental project on identifying technologies applicable to underdeveloped countries was discussed. The workshop agreed that a Brazilian member would be added to the advisory committee that oversees this project and that the committee might meet at least once in Brazil.

A half-day seminar on the management and administration of R&D was held during the workshop, with the following principal speakers: George Herbert, President of Research Triangle Institute of North Carolina; Donald Collier, Vice-President for Research, Borg Warner Corporation; and Edward Roberts, Sloan School of Management at MIT.

The Fourth Workshop culminated with the decision to create a continuing committee of three persons from each institution to meet as often as necessary to guide the overall program. Workshops will continue to be held every 2 years.

By the end of 1971, bilateral study groups had functioned in the areas of industrial research, standards and testing, agricultural research, agricultural economics, earth sciences, transportation, computer sciences; and the joint Chemistry Project was under way. The results that have been reported so far are summarized in the next sections.

## Industrial Research

In accordance with a recommendation of the first workshop, a study group on industrial research was formed in April, 1967, of ten Brazilians and ten Americans from research institutes, universities, industry, and government. This group was asked to formulate recommendations for developing Brazilian industrial research capabilities that would contribute to economic growth. Meetings in both countries afforded visits to several research centers. At its final meeting in the United States, the group attended a seminar in Boston on research-management procedures organized by Arthur D. Little, Inc. In its final

report the group recommended actions ranging from budgetary considerations by government and private entities to fiscal incentives, import restrictions, training, patents, the establishment of a model research institute and a national system of information and documentation.

Since the report was issued in 1968, it has been widely disseminated in Brazil and has been discussed at various meetings between representatives of universities, industry, and government. Several measures to implement recommendations in the report have been taken. During 1969 - 1971, the CNPq created working groups to advise it on food technology, ceramics, steel, cellulose and paper. In May, 1971, it sponsored a 3-day meeting attended by 140 participants from 46 industrial research institutes and 31 agencies that support technological research. A high-level coordinating panel established to advise the CNPq on support for industrial research will use the results of this meeting. This panel has suggested the creation of a model research institute that would incorporate the recommendations of the U.S. - Brazil study group.

Certain recommendations on the organization of research have been adopted by the Food Technology Institute (ITAL), the Technological Research Institute (IPT) at the University of São Paulo, the Technological Research Institute of Pernambuco (ITEP), and the National Research Institute (INT). The consultant services of Lawrence Bass were especially helpful in this respect. His book on research-management needs of developing countries has been translated into Portuguese.*

Other developments have resulted from Brazilian efforts to implement joint recommendations: in the Ministry of Industry and Commerce, an institute was created to study patent legislation and collect information on foreign patents. The INT and the National Industry Confederation agreed to create a technological information center. The Brazilian Pharmaceutical Industry established a foundation to support a newly created research institute fashioned on the model outlined in the Joint Industrial Research Report. The CNPq was asked to establish a working group for the pharmaceutical industry. In São Paulo, the Roberto Simonsen Institute of the Federation of Industries sponsored meetings between universities and the chemical, cellulose, and paper industries.

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*The Management of Technical Programs, with Special Reference to the Needs of Developing Countries. Translated into Portuguese by Andre Posello, University of Campinas, São Paulo, Brazil. New York: Praeger, 1965.

The CNPq has supported research on national technological problems and has also substantially increased the number of postgraduate scholarships at the masters and doctorate levels in engineering and supporting areas. In 1970 CNPq also began to publish Revista Brasileira de Tecnología, which it distributed gratis to some 5,000 professionals.

The CNPq initiatives in coordinating industrial research efforts have in turn increased its own capacity to identify national priorities. It has already influenced programs in the Ministry of Planning, the BNDE, and the Inter-American Development Bank. As a result of the priority for iron and steel, a U.S. - Brazil study group to examine the potential for collaboration in this area was discussed.

## Norms, Measurement, and Testing

A recommendation at the first workshop called for a study on the problem of developing standards and testing procedures for Brazilian industry. A study group of 11 persons addressed itself to this problem, and within a year, after meetings in both countries that included visits to appropriate institutions, the group submitted its report to the CNPq. New systems of standards and the establishment of a research laboratory in standards and testing were recommended. Internal policy considerations within Brazil have so far prevented implementation; however, the report, published in Portuguese, has been widely circulated.

## Agricultural Research and Agricultural Economics

The objective of the joint study group on agricultural research has been to formulate recommendations for improving agricultural research in Brazil and identifying research priorities. During the first meeting of the 6-man group in January, 1968, the U.S. members visited Brazil and spent about 3 weeks visiting institutions, mainly in northern Brazil. The group proposed that studies be carried out over 12 months to obtain information on research institutions, manpower and training facilities, the amount of support for agricultural research, and other useful data.

The group also met with members of the 6-man study group on agricultural economics and agreed to promote the inclusion of that discipline, now much neglected, as an integral part of agricultural research and training.

In February, 1969, the two study groups met independently and in joint sessions in Rio de Janeiro. The meeting of the

agricultural research group included a 1-week international seminar on administration of research sponsored by the CNPq and the Ministry of Agriculture. During 1969 a group of young Brazilian agricultural economists visited institutions in Brazil and in the United States. At subsequent meetings, the agricultural economics study group formulated a proposal to strengthen agricultural economics research and analysis in Brazilian agricultural research stations. Patterned after the current CNPq - NAS Chemistry Program, the plan calls for NAS fellowships to allow U.S. doctoral students to conduct their research on Brazilian development problems.

Following visits by the study group to agricultural research centers in southern Brazil, a second seminar on agricultural research administration in Campinas, July, 1970, was attended by 150 representatives from state, federal, and agricultural institutes. According to Brazilian participants, these seminars have helped to improve and coordinate programs of training in and administration of agricultural research. Efforts are being made to expand and improve graduate training at selected institutions. A third seminar on more specific research administration has been proposed, and it has been suggested that future R&D management courses for industrial research directors also include directors of agricultural research.

Heeding the recommendations of the two joint study groups on agricultural research and agricultural economies, the CNPq, at the Fourth Workshop, proposed the creation of an ad hoc committee of two Brazilians and two North Americans to study ways to establish a program for undergraduate teaching and research in agricultural engineering. A region receiving high priority from the Brazilian government is the cerrado, and the CNPq has asked that an ad hoc committee of four members (two from each country) be established to work out a 5-year program of research. These ad hoc committees will work under the general purview of the existing agricultural research and agricultural economics study groups.

## Earth Sciences

The study group on mineral resources created after the Itatiaia meeting proposed a plan for improving higher education in Brazilian schools of geology, primarily through increased assistance for the cooperation program between the Brazilian National Department of Mineral Production (DNPM) and the U.S. Geological Survey (USGS). Subsequently, an AID loan of $8.4 million was made available for the DNPM-USGS program in collaboration with the U.S. Bureau of Mines. This made possible basic training in field geology, mineral evaluation and statistics, and mining technology--all contributing to the general objectives of the bilateral program.

In 1967-68 the CNPq made a survey of Brazilian universities to determine needs for graduate education in geology. The following year, assistance was provided for graduate courses begun in Pôrto Alegre, São Paulo, and Rio de Janeiro. At the 1969 workshop in Rio, two sessions were devoted to earth sciences, with presentations by U.S. members on geochemistry and geophysics. Brazilians presented papers on geochemistry, tropical soils, and general geological studies. A study group of 10 persons was proposed to examine ways of improving the teaching of geochemistry, geophysics, and geomathematics--fields considered important for the long-term development of the mining industry. North American study group members visited Brazilian universities in late 1969 and mid-1970.

The proposal presented at the Fourth Workshop (1971) outlines a cooperative training program that would include the Universities of Rio Grande do Sul, São Paulo, Rio de Janeiro, Brasilia, and Bahía. In the United States, the University of Georgia, Syracuse University, and Stanford University, among others, already have professors who are interested in participating in such a program. It is expected that during the first phase three to six specialists will spend up to 6 months in Brazil, conducting courses and seminars and helping to develop short-term and long-term training programs.

## Transportation

At the Third Workshop, Roberto Leuzinger of the Federal University of Rio de Janeiro and Homero Rosa Rangel of the Brazilian Highway Research Institute discussed transportation engineering and highway research. A study group was proposed to consider university teaching, research, and the labor market in the transportation sector. In mid-1970 Adolph May of the University of California at Berkeley and Joseph Grunewald of Brookings Institution made preliminary visits to Brazil to formulate the terms of reference for a more detailed study. Because of scheduling problems and other priorities the study group was not able to meet as planned in 1971.

## Computer Sciences

In 1968, at the request of the CNPq, Gilbert McCann, Director of the Computer Center at the California Institute of Technology, made a preliminary study of computer facilities in Brazilian universities. He was accompanied by Jean Paul Jacob of IBM, a consultant to the CNPq. Following the initial efforts, the Third Workshop endorsed a computer sciences study group in early 1969. Plans were then made to enable the two

Brazilian members to make an extensive 2-week trip in May, 1970, to several U.S. installations at universities and industrial centers to familiarize themselves with the range of U.S. facilities. Next, the U.S. panel members were selected on the basis of Brazilian interest in the educational aspects of computer sciences. These four U.S. specialists met with Brazilian counterparts in August, 1970, and again in December, 1971, to formulate a program.

Specific recommendations from the panel called for (1) strengthening and closely coordinating graduate programs in computer science at Catholic University, the Federal University of Rio de Janeiro, and the University of São Paulo through several mechanisms, including summer institutes with visiting professors from abroad; (2) improving computer-science teaching in other universities with computers and service departments; (3) establishing closer ties between the computer industry and the universities, as well as clarifying each sector's educational responsibilities; and (4) actively involving the joint study group in the international Rio Symposium on Computer Education for Developing Countries, scheduled for August, 1972.

Chemistry Project

Essentially, this is the only operational project conducted under BOSTID auspices at present. Both the CNPq and the NAS have guided and operated this project, and provided financial support and staffing, to ensure maximum opportunity for its success over a 5-year period.

A U.S. - Brazil study group envisioned the project as an experiment aimed at developing Brazilian graduate education and research in chemistry at the Federal University of Rio de Janeiro and the University of São Paulo, two major universities. When it was adopted in 1968, strengthening chemistry had highest priority in the CNPq's 5-year science plan. Chemistry was described as the "Achilles heel of Brazilian development" by the President of the CNPq, who outlined its importance in agriculture, mineral resources, plastics, and the pharmaceutical industry.

The Brazilians selected eight U.S. members of the study group from the California Institute of Technology, Stanford University, and the University of Michigan because their particular specialties included inorganic, physical, synthetic polymer, and synthetic organic chemistry. After visiting several institutions in Rio de Janeiro and São Paulo, the U.S. professors agreed to establish cooperative research programs with designated counterparts. Each U.S. professor agreed to sponsor one or more of his postdoctoral students who would

undertake research, conduct seminars, and teach at a Brazilian institution for a minimum of 2 years.

For this purpose the NAS created National Academy of Sciences Overseas Research Fellowships, which allow, on a continuing basis, at least 10 Fellows to reside in Brazil. The young postdoctorate from the United States is a key element in research programs undertaken by the U.S. professors with their Brazilian counterparts. Under present arrangements, U.S. professors visit Brazil twice a year, and, when appropriate, Brazilians spend time at their colleagues' U.S. research laboratories. Brazilian students who require courses for their doctorates not available in Brazil are allowed up to 1 year of study in the United States.

The Chemistry Project began in fall, 1969; the first Fellows moved to Brazil in February, 1970. At the end of 1971, four Fellows were in Rio, and five in São Paulo. The CNPq committed over U.S.$700,000 for equipment, chemicals, laboratory modification, and travel grants for Brazilian professors and graduate students coming to the United States.

Statements from representatives of the CNPq, Brazilian universities, and the Brazilian Ministry of Economic Planning indicate that this program is recognized as an important element of Brazil's efforts to improve its capabilities in science and technology and relate them to economic development. Moreover, it is seen as an important mechanism for strengthening U.S. - Brazilian scientific cooperation, at the level of young post-doctoral research scientists, as well as senior scientists.

Indiana University has since become a cooperating institution for research on electron, atomic, and molecular beam scattering conducted at the University of São Paulo.

The considerable interest and activity generated by this program are already evident: reports indicate the work of Eloisa Mano, responsible for Polymer Chemistry in Rio, is also having a significant impact in Recife and São Paulo. She has helped modernize the undergraduate curriculum at the University of Recife and is accepting Recife graduate students who are expected to return as faculty members. Plans are under way to repeat an introductory course in macromolecular chemistry that Dr. Mano and two other members of the program gave last year in São Paulo.

The close collaboration between all the cooperating universities has allowed frequent contact and exchange of information, including lectures by visiting professors. The NAS Fellows are also encouraged to keep current in their respective fields by attending meetings in the United States at least once every other

year. Three NAS Fellows have extended their stay in Brazil for a third year. Up to the present, 5 Brazilians have been awarded masters degrees; 29 others have degrees in progress; and 3 doctorate programs are under way. Under the joint research program, 11 technical papers have been published, and 10 more have been submitted for publication. In São Paulo the number of graduate students rose from 25 in 1969 to 116 in 1971. Another accomplishment attributable to CNPq efforts was an increase in salaries for Brazilian professors.

A better understanding of how effective this program is will no doubt be possible at the end of its first 5 years in 1974. Whether to continue the program will be decided then, although one can already surmise that the time has been insufficient in terms of the many obstacles to be overcome. Other Brazilian institutions have expressed an interest in participating, and the program may eventually be expanded. The initial 5-year limit of the experiment is now being re-examined and a 2-year extension is proposed to allow a more realistic time for substantial results.

In addition to the support from the USAID Mission in Rio for U.S. costs, financial assistance has been provided by the National Science Foundation, the Anderson and Atlantic Richfield Foundations, and the Brazilian subsidiary of the Atlantic Petroleum.

## Other Activities

The NAS has also been engaged in discussions with representatives of the USAID Mission in Rio about a project for a systems approach to utilizing science and technology in development efforts of the state of São Paulo.

CHILE

In spring, 1970, the Chilean National Commission for Scientific and Technological Research (CONICYT) requested technical assistance from the USAID Mission. Eventually, the request resulted in a jointly sponsored CONICYT-NAS workshop organized to review the technical areas suggested by the Chileans. The workshop was held in Santiago, January, 1971, shortly after Salvador Allende became President of Chile.

The workshop was organized into five working groups: national science policy, nutrition and food technology, marine sciences, computer sciences and applied mathematics, and research and development in copper technology. Each made recommendations in its particular field.

On food and nutrition, over 20 recommendations were adopted; among them were proposals that a national nutrition office be established and that a national nutrition policy be formulated, using the expertise of governmental, industrial, and university representatives. A thorough study of the food industry was suggested to develop national policies to improve food production.

The working group in marine sciences examined a wide range of topics on the exploitation of marine resources: the upwelling phenomenon, fish resources in the distinct ocean regions along Chile's coast, marine pollution, ocean-air interaction, and marine geology. Recommendations called for the development of institutional coordination of all activities in the marine sciences and improved communication among Chilean and international institutions.

The working group on copper technology and the group on mathematics and computer sciences concluded that the most critical problem was a lack of qualified personnel, and recommended specific steps for all levels of the educational system.

Immediately after the workshop the Allende government reorganized the administration of CONICYT. Nonetheless, CONICYT officials have proceeded to develop policies influenced by the workshop recommendations in at least three areas --marine sciences, applied mathematics and computer sciences, and nutrition and food technology.

The interest of Chileans in copper technology prompted cooperation between the United States and Chilean participants. During the summer of 1971 Albert Schlechten, one of the U.S. participants, arranged for two U.S. professors to give short courses at the University of Chile on the use of the computer in the "analysis optimization and control of

mineral processes." Following these courses, the U.S. professors were invited to the University of Concepción to confer on the curriculum of the Department of Metallurgical Engineering.

In May, 1971, Hellmuth Sievers, a marine scientist at the Chilean Naval Hydrographic Institute and a workshop participant, visited the NAS to discuss the workshop's marine science report. A CONICYT policy planning group had met in early May and had accepted the entire report. Follow-up activity with NAS was discussed, particularly concerning the upwelling phenomenon, meteorology, and marine pollution.

At the invitation of CONICYT, an NAS staff member visited Chile in July, 1971, and met with the new chairman, Victor Barberis. At that time, it was learned that a national office of nutrition had been set up. According to a CONICYT staff officer, three of the recommendations on mathematics were being implemented. In September, 1971, Max Rutman, a Chilean food technologist and also a workshop participant, visited the NAS, reported the creation of a National Protein Committee, and proposed collaborative activity in this area.

Specific activities under the NAS-CONICYT relationship have been awaiting the results of a National Science Congress, scheduled in mid-1972 in Chile.

COLOMBIA

In 1967 a study of foreign assistance programs in Colombia was undertaken by a team headed by the Foreign Secretary of the NAS and commissioned by the International Technical Cooperation and Assistance Panel of the President's Science Advisory Committee (PSAC) of the White House. On that occasion discussions were also held with Colombians and U.S. Embassy and AID officials on the role of science and technology in the development process. These discussions led to the present bilateral program.

The first workshop with the NAS, held in Fusagasugá, February 26 - March 1, 1968, was convened by the Colombian Minister of Education. Recommendations were formulated on education, industry, agriculture and natural resources, and a national science policy. Following the meeting, participants were invited to the Presidential Palace, where they presented a report to President Carlos Lleras Restrepo and his cabinet.

Colombians gave priority to the establishment of (1) a top-level Council for Science and Technology to deal with policy questions and (2) an operating funding agency within the Colombian Government for the promotion of science and technology. In pursuing these objectives, the Minister of Education requested consultant services from UNESCO for advice on the structure and functions of an organization for science and technology. The NAS Foreign Secretary undertook the mission; UNESCO submitted his report* to the government of Colombia in the fall of 1968. In December, a cabinet-level Colombian National Council for Science and the Colombian Fund for Scientific Research and Special Projects "Francisco José de Caldas" (COLCIENCIAS) were created by Presidential decree. COLCIENCIAS was placed within the Ministry of Education and given legal status as an operating agency with a budget for supporting scientific research, manpower training, and special studies. Ing. Alberto Ospina was appointed gerente (manager) of COLCIENCIAS.

At the first workshop attention focused on problems of industrial research resulted a few weeks later in a meeting of industrial leaders in Medellín. This in turn led to a seminar in August, 1969, on the administration of scientific research,

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*"Preliminary Report on Science Policy." Harrison Brown. 13 p. + 13 p. annexes. Second part, "Report on Colombian Science Policy Mission," 56 p. Paris: UNESCO, August 1968.

sponsored by COLCIENCIAS and the Colombian Institute of Cultural Integration and assisted by the OAS, the West German Government, and AID. An NAS consultant conducted a course on administration during the seminar. Also during the summer of 1969, COLCIENCIAS co-opted the services of an NAS staff member to assist in administrative and organizational aspects of the new agency.

Early in 1970, representatives of the NAS, COLCIENCIAS, the Colombian National Planning Office, and the Institute for the Development of Higher Education (ICFES) met in Washington and agreed to conduct a series of jointly sponsored studies of graduate education and research potential in chemistry, biology, mathematics, physics, earth sciences and engineering. The chemistry panel met in Colombia in February, 1971, and the mathematics panel in March, 1971. Because many Colombian universities were closed in April, 1971, the work of the remaining four study groups was postponed. A joint panel on engineering, earth sciences, and physics is scheduled to meet in February, 1972.

PERU

The bilateral program with Peruvian scientists emerged from activities of the Latin American Science Board, which met in Lima in 1964 and continued to maintain its relationship with the scientific community, including technical personnel assigned to AID-supported programs in Peru.

In April, 1966, an ad hoc group of Peruvian scientists participated with the NAS in organizing the first U.S. - Peru workshop on The Role of Science and Technology in Peruvian Economic Development, held in Paracas. The workshop considered ways for improving scientific and technological research and education in Peru, and adopted several recommendations. The Peruvians gave priority to their own recommendation calling for the creation of a national research council.

The first effort to obtain support for the proposed NRC was a visit in summer, 1966, by the President of the Peruvian Academy of Sciences and the Foreign Secretary of the NAS with President Fernando Belaúnde Terry. The President, however, showed no particular interest in the proposal. Subsequently, a panel of four Peruvians met with NAS colleagues in Washington to formulate the bases for a proposed charter. Charters and statutes of several NRCs were examined.

Legislation necessary for the creation of the NRC was delayed until 1969. During the interim, however, other efforts to examine and improve Peruvian science took place. UNESCO advisor, Jacques Ruffie, consulted with the Peruvian Ministry of Education between mid-1967 and 1968 and submitted recommendations for the creation of an office for scientific and technical affairs and an NRC. In June, 1967, a team headed by the NAS Foreign Secretary studied the foreign assistance implications of science and technology in Peru for the International Technical Cooperation and Assistance Panel of the President's Science Advisory Committee (PSAC) of the White House. At this time, plans were already under way for a second workshop, which took place in November, 1967, sponsored by the NAS and the Peruvian Academy of Sciences. At this workshop, the Peruvians founded on their own initiative the Peruvian Association for the Advancement of Science (APAC), and a grant from the Ford Foundation helped it get started. The NAS arranged for the APAC's first president to visit the United States in 1968 to meet with officers of the AAAS and other U.S. science institutions, and to attend the second NAS - Brazil workshop in Washington.

The Peruvian National Research Council was brought into being by President Juan Velasco in January, 1969, and was based on the recommendations of the joint panel, mentioned earlier,

which had met 2 years previously in Washington. Its first chairman, Alberto Giesecke, Director of the Geophysics Institute of Peru, was one of the prime organizers of the two workshops. The initiation of joint projects subsequently discussed has been delayed because the U.S. - Peru political impasse since the military coup in 1968 has resulted in a lack of funds. However, there have been frequent contacts and informal visits in both directions. The acting chairman of the Peruvian NRC visited the NAS in May, 1971. Peruvians have attended other NAS workshops and meetings.

An NAS staff member visited Peru in July and December, 1971, to meet with representatives of the Peruvian NRC, the National Council of the Peruvian Universities (CONUP), the National Engineering University, Cayetano Heredia University, and the USAID Mission. At the invitation of the Peruvian National Planning Office, the NAS planned a joint workshop on food technology and nutrition to consider Peruvian national nutrition plans.*

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*The workshop planned for 1972 was subsequently postponed by the Peruvian organizers because of lack of funds and difficulties caused by personnel shifts.

# APPENDIX B

## SPECIAL STUDIES AND PROJECTS, 1968 - 1972

Board on Science and Technology for International Development
Office of the Foreign Secretary
National Academy of Sciences
Washington, D.C. 20418

# APPENDIX B: SPECIAL STUDIES AND PROJECTS

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## INTRODUCTION

In addition to bilateral programs with specific countries, the NAS has sponsored conferences and undertaken special studies for AID on various technical and administrative aspects of international development. One study concerned the future of technical assistance in Korea; another examined a new structure and orientation for U.S. foreign technical assistance. Other studies undertaken or sponsored by BOSTID panels have dealt with needs common to underdeveloped countries in, for example, industrial research and the agricultural and food-production sciences. Still other studies inventory or assess the state of the art of particular areas of scientific knowledge, such as solar energy, and examine their applicability in underdeveloped countries.

Summaries of studies, conferences, and other projects follow. See Appendix C, Part II, for reports and publications.

## COMPLETED STUDIES AND PROJECTS

### AFRICA

#### CONFERENCE ON AGRICULTURAL RESEARCH PRIORITIES FOR ECONOMIC DEVELOPMENT IN AFRICA

In 1966 the NAS Africa Science Board began informal discussions with interested individuals and organizations which led to a conference in 1968 organized with the Food and Agriculture Organization (FAO) and the Government of the Ivory Coast. In March, 1967, an NAS organizing committee met at the University of Ghana with a group of distinguished African scientists and representatives from AID and FAO.

In April, 1968, about 200 agricultural scientists and agriculture officials from 32 countries (Africa, Europe, North America, Asia) participated in the 1-week conference. Participants came as individual experts, not institutional or national representatives. In June further planning in Paris included representatives of French, Belgian, and British technical cooperation agencies and several tropical agriculture research organizations.

The conference produced papers and commission reports on the following subjects:

-Soil and Water Management

-Animal Production and Health

-Major Problems Affecting Cereal Production

-Major Problems Affecting the Production of Industrial Crops in the Savannah Zone

-Economic Aspects of Agricultural Production and Marketing

-Major Problems Affecting Legume and Root Production

-Major Problems Affecting the Production of Industrial Crops in the Humid Tropics

-Education: The Role of Universities and Schools of Agriculture in Research and Manpower Production

-Crop Protection and Storage: Prevention of Waste

-Agricultural Research Institutions: National and Regional. The Problem of Increasing Effective Research

-The Development of Regional Research Programs on the Basis of Ecological Zones

-Farming Systems in Africa: Mechanization and Innovation

The conference was the largest ever held of agricultural scientists and officials from both English- and French-speaking African countries; it started a movement, still unfolding, for scientific cooperation in agricultural research across linguistic, national and regional boundaries.

John J. McKelvey, Jr., of the Rockefeller Foundation, provided leadership in the organization of the Association for the Advancement of Agricultural Sciences in Africa (AAASA), the first pan-African scientific society. The meeting produced the first all-Africa report on specific agricultural studies. A permanent executive committee was elected to conduct the affairs of AAASA, and an editorial board was established to oversee two publications, the AAASA Newsletter and the AAASA Quarterly Journal. Present paid membership exceeds 200; the AAASA plans to launch a membership drive and to get more subscriptions to their journal

from libraries, institutions, and organizations in African countries. The AAASA has received financial support from AID, the Rockefeller Foundation, and several African governments. The AAASA held its first annual meeting in Addis Ababa, August, 1971.

The three-volume conference report, published by the NAS in English (700 copies) and French (500 copies), has had worldwide, free distribution, is now frequently quoted in the relevant literature, and continues in high demand although the supply is exhausted.

The conference and its report have stimulated further African agricultural research meetings, under FAO auspices, in the various research problem areas to which it was addressed. Another development has been the creation of a Committee on African Agricultural Research Capabilities established by the NAS at the request of AID.

## AFRICAN AGRICULTURAL RESEARCH CAPABILITIES

Following the Abidjan Conference on agricultural research priorities, sponsored by the NAS in 1968, AID in 1970 requested a comprehensive study on African research capabilities in the agricultural sciences.

This project was undertaken by the NAS Agricultural Research Board, under the auspices of BOSTID. A committee was created under the chairmanship of John. J. McKelvey, Jr., with 17 members from Africa, Europe, and North America. It worked under the following terms of reference:

1. To review, analyze, and establish, if necessary, the priorities in research and education that will enable agriculture to make its maximum contribution to the development goals of Africa as identified in such recent national and international studies as the FAO Indicative World Plan for Africa and the NAS-organized 1968 Abidjan Conference on Agricultural Research Priorities;

2. To specify the institutions and systems of agricultural research and research-related education--international, regional, and national--needed to achieve the goals;

3. To determine the most appropriate roles and modes of operation, and, where advisable, the subject areas and locations for non-African agencies to provide coordinated support for agricultural research and education in Africa, taking into account the developing contributions of African institutions;

4. To suggest appropriate channels of communication and cooperation among nations, institutions--inside and outside Africa--in agricultural research and educaton;

5. To outline the means by which research and education can be applied most effectively to African agricultural development;

6. To make a broad assessment of the scientific manpower needs related to the proposed research system(s) and institutions recommended by the committee; also, to assess the African scientific personnel available at the present time and identify scientific manpower gaps and needs and establish priorities.

The Committee met twice in Washington, D.C.; in Addis Ababa in September, 1971, at the time of the first annual meeting of the AAASA; and finally in Bellagio, Italy, March, 1972.

## ASIA

### EAST PAKISTAN LAND AND WATER DEVELOPMENT AS RELATED TO AGRICULTURE

At the request of the Near East and South Asia Bureau in AID, an ad hoc committee was created, with nine experts familiar with East Pakistan's agriculture and water management. Under the chairmanship of Dean Peterson of Utah State University, the committee held three 2-day meetings at the NAS in 1971.

AID was interested in obtaining an evaluation of an $800 million multiyear program proposed by the World Bank for water and agricultural development in East Pakistan, a scheme which was to be supported by the multinational aid-to-Pakistan consortium of which the United States is a member. This examination was undertaken within a broader review of factors inhibiting the economic and social development of East Pakistan. The ad hoc committee, created in consultation with the NAS Agricultural Board and the Committee for the International Hydrological Decade, heard experts associated with the World Bank, AID, and the Harvard Development Advisory Service.

The study furnished advice to AID on the ordering of priorities related to water and agricultural problems in East Pakistan, as well as an assessment of the World Bank's program proposal.

## THE FUTURE OF U.S. TECHNICAL COOPERATION WITH KOREA

In 1969, the anticipated phase-out by 1972 of the U.S. AID program in Korea prompted AID to obtain the advice of NAS on actions it should take before that date to ensure Koreans continued access to U.S. technical resources in support of development objectives. Specifically, the NAS was asked to identify Korean long-term needs for technical assistance, types of machinery that might best be adopted for transfer of technical assistance, and cooperative linkages between U.S. and Korean institutions.

An ad hoc panel of five persons, under the chairmanship of Walter Orr Roberts, President, University Corporation for Atmospheric Research, spent 2 weeks in Korea, in July, 1969, and subsequently met on three occasions to complete its report.

The panel report advocated the establishment, as a successor to the USAID Mission in Korea, of the Korean-American Development Institution (KADI), a foundation-type organization to be financially supported by both countries on a long-term basis. The panel recommended that KADI be established as an autonomous, nongovernmental institution with a broad mandate to support cooperative programs and activities that will help Korea achieve balanced economic growth, develop its intellectual and human resources, and further its social and civil modernization.

The panel's recommendations have not been implemented so far, because the U.S. government has decided to extend the life of the USAID Mission in Korea for several years. However, the concept of a bilateral foundation-type instrumentality for technical cooperation has received attention, both within and outside AID, as a unique way to achieve technical assistance objectives. A variation of this concept was advocated by the BOSTID ad hoc Committee on the International Development Institute as a central element in its recommendations for the future conduct of technical assistance.

### Science Advisory Mission

In 1971, the NAS received a subsequent request for advice from the USAID Mission in Korea. A three-man panel from the NAS visited Korea in January, 1972, to advise the Korean Ministry of Science and Technology on the formulation of a policy and program for its Five-Year Plan. Roger Revelle,

serving as panel chairman, was accompanied by Frank Long of Cornell and Hubert Heffner of Stanford.

The panel visited most of the principal research institutions in Korea, as well as universities and other scientific and technical institutions. In addition, extensive discussions were held with the key members of the Korean Ministry, the Korean Economic Planning Board, and representatives of private industry.

In several long sessions with the Minister of Science and Technology, and through a series of 15 written reports, the panel made observations and recommendations on the following topics:

-The organization and activities of the Ministry,

-The Ministry's role in strengthening Korea's universities,

-The problems of scientific and technical manpower,

-Ways of strengthening particular research institutions, and

-The characteristics of a possible Korean support agency for research and graduate education in science and technology.

## THAILAND SEMINAR ON PROTEIN FOOD PROMOTION

The USAID Mission in Thailand requested NAS participation in this seminar on the invitation of the Institute of Food Research and Product Development of Kasetsart University and the Thai Department of Health. The 1-week multinational seminar in Bangkok, November, 1970, included an NAS panel of 7 persons among the 25 participants.

The AID program in Thailand has had a 3-year project aimed at improving human nutrition in rural areas through the development of inexpensive high-protein food supplements for weanlings and preschool children. The first phase of the project, research and development of food supplements, was carried out by the Institute of Food Research and Product Development. Phase two, field testing, was conducted by the Department of Health. Phase three, being undertaken by the Institute, is aimed at stimulating the promotion and marketing of these products by local industry.

The Seminar on Protein Food Promotion was part of phase three. Sponsored jointly by AID/Thailand and the two

local agencies, the seminar brought together representatives of the Thai scientific community, the Thai government, local and international industry, FAO, World Health Organization (WHO), and overseas nutritionists, agriculturalists, and food technologists. The NAS helped plan the seminar.

The meeting exposed Thai scientists and food industry representatives to the latest information on food and nutrition problems with particular reference to protein. Senior government officials took part in the conference, including--at one half-day session--the Prime Minister of Thailand.

The seminar produced varied recommendations on research needs, problems of market research and new materials supply, and government policies to encourage production of high-protein foods and to strengthen national food and nutrition policy.

The recommendations were submitted to the cabinet of the Government of Thailand, which has forwarded them to appropriate agencies for action. The cabinet has also adopted a National Nutrition Policy and established a National Institute of Nutrition, which will conduct nutrition research and act as the coordinating body for all nutrition-related activities in Thailand.

## LATIN AMERICA

### CENTRAL AMERICAN WORKSHOP ON THE ENVIRONMENT AND DEVELOPMENT

A new aspect of AID policy in foreign assistance gives greater emphasis to the environmental consequences of development. The report of the NAS ad hoc panel on International Aspects of Man's Effect upon the Environment (January, 1970) led the AID Regional Office for Central America and Panama (AID/ROCAP) to express interest in sponsoring a Central American regional seminar on environmental problems. The Central American Research Institute for Industry (ICAITI) had already engaged in measuring pesticide residues and water pollution and, when approached by AID, was enthusiastic about sponsoring the meeting.

The Central American Bank for Economic Integration joined ICAITI and the NAS in sponsoring the meeting.

The major objectives of the seminar were to (1) provide a forum for discussing environmental problems in Central

America and (2) recommend action programs for governments and regional organizations to alleviate or avoid present and future problems.

The seminar was attended by representatives of planning offices from each Central American country and observers from the World Bank, the Inter-American Development Bank, the General Secretariat of the General Treaty for Central American Economic Integration, the Pan American Union, and others. The principal recommendations were on demography and statistics, criteria for pesticide use, industrial potential for tropical forest products, economic modeling as a tool for planning in Central American integration, and environmental research priorities. ROCAP and ICAITI have expressed interest in continuing their relationship with the NAS during the implementation of seminar recommendations.

The NAS Foreign Secretary and staff have maintained liaison with the director and staff of ICAITI to assist in implementing workshop recommendations.

## GENERAL SCIENCE AND TECHNOLOGY

### INTERNATIONAL ASPECTS OF MAN'S EFFECT UPON THE ENVIRONMENT

An ad hoc advisory panel of 16 members, chaired by Roger Revelle, Deputy NAS Foreign Secretary, met in January, 1970, to examine the following topics:

-Aspects of AID assistance programs that create problems of environmental degradation,

-Areas that should receive priority attention,

-Ways to strengthen capabilities of AID and developing countries to deal with environmental problems.

The panel identified these principal problems:

-Management and use of pesticides and other biocides,

-Environmental interactions of engineering projects,

-Schistosomiasis and other infectious "environmental" diseases,

-Human ecological implications of major engineering works, and

-Environmental consequences of rural-urban displacement.

Recommendations to strengthen AID's capabilities in dealing with environmental problems called for the preparation of a manual of engineering procedures, creation of an advisory committee to AID on environmental factors, endorsement of increased research and regional ecological studies, strengthening training programs and workshops on environmental problems.

The panel's report was the first attempt to provide an overview of environmental aspects of AID programs that require attention. It contributed to a wide-ranging internal AID review of its own activities. In June, 1971, AID announced the establishment of a permanent Committee on Environment and Development, to be chaired by the Deputy Administrator, whose task will be to "refine and coordinate environmental policies and activities to be followed by AID." AID informed its overseas missions of the NAS panel's findings and recommendations, and encouraged them to solicit NAS assistance, by means of workshops, in clarifying problems of the environment for the benefit of local authorities. Initial responses to this circular resulted in a Central American Workshop on Development and the Environment in July, 1971, in Guatemala; a workshop on water resources and the environment in September, 1971, in India; and a Southeast Asian regional workshop on the same theme in Singapore, proposed for April, 1972.

## THE INTERNATIONAL DEVELOPMENT INSTITUTE

Undertaken at the request of the White House Office of Science and Technology (OST) and AID's Technical Assistance Bureau, this study was to parallel a study by an interagency task force under the chairmanship of the OST Deputy Director.

An ad hoc committee of 12 persons was drawn from universities, foundations, and organizations concerned with various aspects of technical assistance and the application of U.S. scientific and technical resources to economic development; its chairman was Robert A. Charpie, President of the Cabot Corporation and member of the National Science Board of the National Science Foundation (NSF). The committee held four 1-day meetings at NAS between October, 1970, and January, 1971. The committee was charged with considering the character, purposes, and functions of an International Development Institute, proposed by the President of the United States in a message to Congress, on September 15, 1970, to make the application of science and technology to the problems of development a major element of a reorganized foreign aid program.

The committee recommended that U.S. funds for technical assistance be concentrated on major R&D efforts to solve critical problems inhibiting the development process.

THE ROLE OF SCIENCE AND TECHNOLOGY IN INTERNATIONAL DEVELOPMENT IN THE 1970's

For 5 or 6 years, the OFS and several AID offices have thought of formulating a solid rationale for the application of science and technology to development. The NAS proposed this study in 1969, and it is now getting under way. AID's increasing concern with technical assistance and the plan to establish a new International Development Institute gave special impetus to the study.

The first step in the study was a conference held at Woods Hole (August 15 - 21, 1971) with 30 participants representing UNIDO, OAS, IBRD, the Canadian International Development Research Centre, UNDP, and the Sussex Science Policy Research Unit, six developing countries, and the U.S. scientific, academic, and industrial communities. The conference was chaired by Roger Revelle, chairman of BOSTID.

The study will address such issues as the following:

1. Identification of development problems whose solution seems to be most susceptible to scientific research or technological application;

2. Ways to help developing countries create or expand their indigenous capability to develop and utilize science and technology;

3. The contributions that the scientific and engineering communities of the industrialized countries are particularly qualified to make to the solutions of these problems;

4. Identification of new developments in science and technology that show promise for economic and social development.

5. A rationale or set of guidelines that will assist administrators of technical assistance agencies to utilize science and technology in development problems during the next decade.

The object of the Woods Hole conference was to assess the feasibility of the proposed study and to suggest its scope, dimensions, depth and the best ways to conduct it. Papers will be commissioned on specific issues, in preparation for a second meeting late in 1972. A report committee, supplemented by topical task forces, will review papers and develop recommendations.

## SCIENTIFIC AND TECHNICAL INFORMATION FOR DEVELOPING COUNTRIES

In early 1971, to develop a rationale and a program, AID requested advice on the problem of acquiring and disseminating scientific and technological information in developing countries.

A panel of 10, chaired by John Green, formerly with the Department of Commerce, was established, with members from universities, technical societies, and various public and private organizations, all of whom are concerned with various problems of information handling, transfer, and development. The panel heard 15 experts from national and international institutions engaged in related activities. It sought to determine the requirements of developing countries for more effective acquisition and dissemination of scientific and technical information, with particular reference to information needs for industrialization, natural resource development, and the natural sciences.

The panel formulated a rationale for U.S. technical assistance in the field of scientific and technical information that should provide AID with policy, programming and priority guidelines. It recommended 14 specific projects for strengthening the capabilities of developing countries for acquiring, processing, and disseminating information, and for improving the transfer of information to and among them. The panel also offered recommendations on programming and management guidelines for administering technical assistance programs in scientific and technical information.

## SOLAR ENERGY UTILIZATION FOR DEVELOPING COUNTRIES

In view of the rising interest in applications of solar energy, particularly in developing countries, AID in early 1971 requested an assessment of research.

An ad hoc advisory panel met in May, 1971. Chaired by Manfred Altman of the University of Pennsylvania, it had 12 members, 7 from the United States and 1 each from Canada, Australia, Niger, Israel, and India.

The panel was charged with the following:

1. To assess the state of the art in solar energy utilization in different areas of potential application for developing countries, including current practical applications;

2. To identify promising areas of research and development and indicate requirements for fostering efforts in such areas;

3. To examine the desirability of establishing an International Solar Energy Institute in North Africa.

The panel concluded that solar energy "has the capability to meet energy needs substantially beyond the applications now being made," but the best course would be a study of the general energy needs of developing nations and the various ways of meeting those needs, without placing excessive hope in promising but unproven applications of the sun's energy. The panel recommended establishing regional centers in developing nations to evaluate supplies and uses of all types of energy and to launch research and development efforts on applications particularly suitable to local conditions. According to the report, "the rational development of uses of solar energy to benefit the developing countries must rest on a clear picture of the 'energy niche' in which solar energy will best fit." At present, there seems to be no data base for determining such a niche.

## IN PREPARATION BY BOSTID PANELS (WORKING TITLES)

### APPROPRIATE TECHNOLOGIES FOR DEVELOPING COUNTRIES

Begun in 1971 under the title, "Labor-Intensive Technologies for Developing Countries," this study was broadened in 1972 to include a wider range of topics that affect the industrialization process. The study now deals with labor-intensive versus capital-intensive techniques; strategies on import substitutions, tariffs, and capital; managerial factors in production and marketing; and noneconomic factors in the technology-transfer process. With the assistance of the Overseas Development Council, a review paper was prepared, Economically Appropriate Technologies for Developing Countries: A Survey. In February, 1972, an NAS-NAE ad hoc panel was convened under the chairmanship of Bruce S. Old, Foreign Secretary of the NAE, with the following objectives:

1. To appraise the relationship between technology and employment in developing countries;

2. To determine means whereby developing countries can achieve indigenous capacity to select, adapt, and invent technologies appropriate to their needs;

3. To identify research needs that are relevant to adapting technology; and

4. To survey U.S. capabilities to help developing countries achieve these goals.

Because the task is so complex, the study of economically appropriate technologies is expected to continue through calendar-year 1972 along the following lines:

1. Organization of special task-force groups to examine ongoing experiments in adaptive technology in selected product-process areas -- for example, housing, road construction, small-scale chemical manufacture, agricultural technology, and small-scale mining and mineral technology; and

2. Convening a specialized panel to explore the economic alternatives in technology adaptation, from the viewpoint of national planning priorities.

In addition, several other areas related to appropriate technology development will be considered, such as managerial factors, skilled manpower requirements, and a "systems approach" to technology choices. A series of monographs are to be published on housing, chemical products and processing industries, metal and machine processing, and iron and steel industries.

## MEETING THE CHALLENGE OF INDUSTRIALIZATION: PROPOSAL FOR AN INTERNATIONAL INDUSTRIALIZATION INSTITUTE

Acting on a recommendation by the Airlie House Advisory Committee in December, 1971, AID requested the NAS-NAE to assess the need, feasibility, viability, and demand for the services of a proposed International Industrialization Institute designed to aid underdeveloped countries in the industrialization process. The NAS-NAE is to examine the following:

1. The scope and objectives of such an institute,

2. Its structure and nature,

3. Initial staffing requirements,

4. Funding needs and sources,

5. Initial program directions, and

6. Relationships to the U.N. Industrial Development Organization and other agencies or institutes concerned with industrialization in the developing countries.

Under the chairmanship of Bruce S. Old, Foreign Secretary of the National Academy of Engineering (NAE), a panel of 20 specialists was created, from the private and public sectors of this country and several underdeveloped countries. In a preliminary assessment, the panel affirmed the need for such an institute, and it now expects to make recommendations on its structure and operational aspects.

## ROLE OF U.S. ENGINEERING SCHOOLS IN TECHNICAL ASSISTANCE

Discussions between AID and the NAS-NAE in 1970 revealed a common desire to see U.S. engineering schools play a more active and relevant role in overseas technical assistance efforts, a role comparable to that of agriculture schools and experiment stations of U.S. land grant universities. AID subsequently asked the NAS-NAE to undertake a study of the subject.

An eight-member ad hoc advisory panel, formed under the auspices of BOSTID with the advice of NAE, met in May, 1971, under the chairmanship of Dean Harold Hoelscher, University of Pittsburgh School of Engineering. The panel met again in September, 1971, and produced a draft report of its recommendations. At a third meeting, in conjunction with the International Division of the American Society for Engineering Education, in January, 1972, the draft recommendations were discussed with the engineering community attending the meeting. The results of these discussions are now being incorporated into a revised draft report.

The panel's terms of reference are as follows:

1. To identify interests and capabilities of U.S. engineering schools relevant to developing countries' needs, such as curriculum reform, training and orientation of teachers, and development of indigenous institutions;

2. To recommend needed changes in U.S. engineering school curricula to orient training of engineers more directly to the problems of developing countries;

3. To examine means of relating research interests of U.S. schools to specific developing country problems and recommend ways in which AID can mobilize U.S. schools for this role; and

4. To assess the interest and capabilities of U.S. engineering schools in acting as intermediate contract organizations in implementing development projects.

## TRAINING LDC RESEARCH ADMINISTRATORS AND TECHNICAL MANAGERS

AID requested this study on the recommendation of BOSTID, which was convinced, after several workshops on industrial research, that the absence of properly trained R&D administrators was a serious obstacle to the growth of industry-orientated, applied research in developing countries. The workshops have recommended that training programs in research management be developed.

An ad hoc panel of 15 persons, chaired by K.N. Rao of the Ford Foundation, was drawn from U.S. government laboratories, industrial firms, contract research organizations, and graduate management schools.

The panel convened in June and September, 1971, under the following directives:

1. To identify elements and characteristics of alternative training programs for research management and senior staff that U.S. organizations might undertake in the host country, or in the United States;

2. To assess the interest and potential contributions of U.S. universities and government and industrial laboratories and research institutes in such programs;

3. To recommend to AID steps for setting up training programs.

## U.S. INTERNATIONAL FIRMS IN R,D&E IN DEVELOPING COUNTRIES

BOSTID's bilateral workshops on industrial research in five developing countries have revealed possible ways for U.S. firms operating in developing countries to help strengthen indigenous capabilities for research, engineering, and development. To clarify these possibilities and to guide its own policies, AID in March, 1971, requested the NAS to study the questions in collaboration with the NAE.

An ad hoc advisory panel of some 15 members was constituted: chaired by Charles Dennison, former vice-president of the International Minerals and Chemicals Corporation, the panel was comprised of persons drawn from multinational corporations, universities, and public and private developmental institutions. Subpanels for several industrial sectors included about 30 persons. Panel and industry subpanels have convened several times since September, 1971.

The panel's terms of reference are as follows:

1. To examine the past role of U.S. private investment in strengthening R,D&E capabilities of developing countries;

2. To examine the potential role of the U.S. corporation to assist in developing local R,D&E capabilities through

a. conducting local in-house R,D&E programs;

b. identifying and designing R,D&E projects or processes of specific relevance to the host country;

c. adapting existing advanced technology to local conditions;

d. utilizing local R,D&E facilities and personnel; and

e. training research workers in local and U.S. laboratories.

3. To identify major factors that either strengthen or inhibit the initiation and expansion of the activities listed above.

BOSTID expects the report to be of significant interest to corporation executives in the United States and developing countries.

## TECHNOLOGY INNOVATION PROJECT

A different type of experiment* has been undertaken under the auspices of BOSTID at the request of AID.

Although underdeveloped countries are usually aware of the problems they face in the process of development, they often are not in a position to avail themselves of all the possibilities that technology can offer for solving these problems. These technologies may be latent, or they may be already utilized in the United States or other industrialized countries, but in a way that would not be suited to the social or economic conditions of developing countries.

Many national and international bodies are now concerned with the problem of technology for developing countries; however, most of them are generally concerned with complex technology (e.g., UNIDO, NASA), the strategy for technological development, with the transfer of existing technologies (e.g., OECD), or providing information for the solution of relatively small technological problems (VITA). The problem of how to identify and transfer innovative intermediate technologies--and how to foster the related R&D activities--that may make important contributions to developing countries remains a major gap in the spectrum of assistance that developed nations are providing.

To examine more carefully the need for special technological innovation, an Advisory Committee on Technological Innovation was established in July, 1971, and met for the first time in September, 1971, under the chairmanship of George Bugliarello of the University of Illinois. The program supervised by this committee has two specific objectives: (1) to generate ideas for innovative applications of present-day technological developments to immediate problems of developing countries; and (2) to identify areas of research in which concerted effort can drastically shorten the time lag characteristic of the normal progression from scientific advance to potential application.

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*The experimental project aimed at developing graduate education and research in chemistry has been described under the Brazil program, Appendix A.

The ideas and projects included in this program must be compatible with the following criteria:

1. They must have the potential to accelerate the development of one or more developing countries.

2. They must directly involve science or technology as the major component.

3. They must be beneficial in terms of human needs and values, and they should take account of local cultures.

4. They must not involve the exploitation of any country by another or of any group by another.

5. They must be innovative. (Consulting firms can better handle conventional technologies.)

6. They must not be projects that would, or could, otherwise be developed for a proprietary interest by a profit-making group.

7. The solutions should be realistically implementable, and the proposals should include plans for implementation.

In addition to the committee, appropriate panels will assist in evaluating specific technologies. The following panels are already under way:

1. Ferrocement; applications in developing countries

2. New technology solutions to roofing problems in developing countries*

3. Nonfood uses of unutilized proteins

4. Low power sources of electricity for use in rural areas (e.g., for communications)

5. Unsolved problems in food sciences for developing countries

6. Mosquito control: some perspectives for developing countries

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*Undertaken by the NAS Building Research Advisory Board.

# APPENDIX C

## REPORTS AND PUBLICATIONS, 1963 - 1972

Board on Science and Technology for International Development
Office of the Foreign Secretary
National Academy of Sciences
Washington, D.C. 20418

## APPENDIX C: REPORTS AND PUBLICATIONS, 1963 - 1972
(In Chronological Order by Country)

All items with PB numbers are available from the National Technical Information Service (NTIS), Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22151. Order by accession (PB) number.

## PART I. BILATERAL PROGRAMS

### AFRICA

#### Ghana

RESEARCH PRIORITIES AND PROBLEMS IN THE EXECUTION OF RESEARCH IN GHANA, Accra, January 18-22, 1971. Part I, Summary, 60 p,; Part II, Full Report, 299 p. Council for Scientific & Industrial Research, Ghanaian Universities & NAS. Part I, PB 203-329; Part II, PB 203-330.

REPORT OF A WORKSHOP ON RESEARCH PRIORITIES AND PROBLEMS IN THE EXECUTION OF RESEARCH IN GHANA, Accra, January 18-22, 1971. NAS. 40 p. No copies available.

REPORT OF THE JOINT U.S.A.-GHANA COMMITTEE ON AGRICULTURAL EXTENSION AND RESEARCH, Accra, September 27-October 8, 1971. Council for Scientific & Industrial Research. 45 p. PB 208-605.

#### Nigeria

REPORT OF A WORKSHOP ON SCIENCE AND NIGERIAN DEVELOPMENT, Bellagio, Italy, August 12-25, 1965. NAS. 100 p. PB 203-390.

#### Zaire

SUMMARY REPORT OF WORKSHOP ON THE ROLE OF SCIENCE & TECHNOLOGY IN THE ECONOMIC DEVELOPMENT OF THE CONGO DURING THE 1970'S, January 1972. NAS. 25 p. No copies available.

REPORT OF THE U.S.-ZAIRE JOINT STUDY GROUP ON DEMOGRAPHIC TRAINING AND RESEARCH IN THE REPUBLIC OF ZAIRE, January 24-28, 1972. ONRD & NAS. 32 p. (Fr., 34 p.) No copies available.

REPORT OF THE U.S.-ZAIRE JOINT STUDY GROUP ON GEOLOGICAL TRAINING AND RESEARCH IN THE REPUBLIC OF ZAIRE, November 1972. NAS. 29 p. No copies available.

## ASIA

### India

REPORT OF THE INDO-U.S. WORKSHOP ON THE MANAGEMENT AND ORGANIZATION OF INDUSTRIAL RESEARCH, Baroda, March 2-6, 1970. NISI. New Delhi, India. 57p. PB 203-311.

SUMMARY REPORT OF A WORKSHOP "WATER IN MAN'S LIFE IN INDIA," New Delhi, September 13-18, 1971. NAS. 28 p. No copies available; full proceedings by INSA, not yet published.

### Indonesia

REPORT OF THE LIPI-NAS WORKSHOP ON FOOD, Djakarta, May 1968. Vol. I, Overall Findings & Recommendations, 34 p.; Vol. II, Reports of the Working Groups, 154 p.; Vol. III, Keynote Address, List of Participants & Background Papers, 166 p. LIPI. Vol. I, PB 203-370-U. Vol. II, PB 203-371-U. Vol. III, PB 203-372-U.

REPORT ON THE LIPI-NAS WORKSHOP ON INDUSTRIAL & TECHNOLOGICAL RESEARCH, Djakarta, January 18-30, 1971. Vol. I, Findings and Recommendations, 31 p.; Vol. II, Plenary Sessions and Working Groups, 60 p.; Vol. III, Program Design, 104 p. LIPI. Vol. I, PB 217-118. Vol. II, PB 218-724. Vol. III, NTIS No. not yet available.

SUMMARY REPORT OF AN INDONESIA-U.S. WORKSHOP ON INDUSTRIAL & TECHNOLOGICAL RESEARCH, Djakarta, January 18-30, 1971. NAS. 29 p. No copies available.

REPORT ON THE LIPI-NAS WORKSHOP ON NATURAL RESOURCES, Djakarta, September 11-16, 1972. LIPI. 97 p. PB 217-293.

SUMMARY REPORT OF THE NAS-LIPI WORKSHOP ON NATURAL RESOURCES IN INDONESIA, December 1972. NAS. 37 p.
No copies available.

Republic of the Philippines

PHILIPPINES-U.S. WORKSHOP ON SCIENTIFIC & TECHNOLOGICAL COOPERATION & DEVELOPMENT, Manila, November 22-26, 1965. NSDB-NAS. 166 p. No copies available.

REPORT OF A PHILIPPINES-U.S. WORKSHOP ON SCIENTIFIC & TECHNOLOGICAL COOPERATION & DEVELOPMENT, Manila, November 22-26, 1965. Part I, Report of Workshop, 10 p.; Part II, Appendices (unpaged). NAS.
Part I, PB 203-394-U; Part II, PB 203-395-U.

SECOND U.S.-PHILIPPINES WORKSHOP ON SCIENTIFIC & TECHNOLOGICAL COOPERATION & DEVELOPMENT, Pacific Grove, California, November 6-10, 1966. NAS. 104 p. PB 204-407.

COOPERATION IN OCEANOGRAPHY & FISHERIES RESEARCH: REPORT ON RECOMMENDATION V OF THE SECOND U.S.-PHILIPPINES WORKSHOP, April 1967. NSDB. 105 p. No copies available.

PHILIPPINES-U.S. WORKSHOP ON FISHERIES AND OCEANOGRAPHY, December 4-9, 1967. NSDB-NAS. 150 p. PB 203-365-U.

PHILIPPINES-U.S. WORKSHOP ON INDUSTRIAL RESEARCH, January 26-February 1, 1969. Part I, Summary Report, 30 p.; Part II, Working Papers, 155 p. NSDB-NAS.
Part I, PB 203-376-U; Part II, PB 203-377-U.

Republic of China (Taiwan)

PROGRESS REPORT, CHINA COMMITTEE ON SINO-AMERICAN SCIENCE COOPERATION, Nankang, Republic of China, January 1965. Academia Sinica. 24 p. No copies available.

OCEANOGRAPHY REPORT. I.E. Wallen. March 1966. 17 p.
No copies available.

PROGRESS REPORT, CHINA COMMITTEE ON SINO-AMERICAN SCIENCE COOPERATION, Nankang, Republic of China, March 1967. Academia Sinica. 14 p. No copies available.

THIRD JOINT CONFERENCE FOR SINO-AMERICAN SCIENCE COOPERATION, April 5-7, 1967. Academia Sinica-NAS Report. 107 p.
Available from BOSTID, NAS.

PROGRESS REPORT, CHINA COMMITTEE ON SINO-AMERICAN SCIENCE COOPERATION, Nankang, Republic of China, February 1968. Academia Sinica. 9 p. No copies available.

FOURTH CONFERENCE ON SINO-AMERICAN SCIENCE COOPERATION: REPORT OF RECOMMENDATIONS, August 26-30, 1968. Academia Sinica-NAS. 12 p. No copies available.

PROGRESS REPORT, CHINA COMMITTEE ON SINO-AMERICAN SCIENCE COOPERATION, Nankang, Republic of China, September 1969. Academia Sinica. 9 p. No copies available.

A REPORT ON THE SINO-AMERICAN COLLOQUIUM ON OCEAN RESOURCES, April 28-May 6, 1971. Academia Sinica-NAS. 44 p. Available from BOSTID, NAS.

REPORT ON GRADUATE CENTERS IN ENGINEERING AND SCIENCE, Republic of China, Joseph B. Platt, May 1971. 34 p. No copies available.

Thailand

WORKSHOP ON SCIENCE PLANNING AND POLICY IN THAILAND, Bangkok, July 3-6, 1972. Thai NRC. 45 p. NTIS No. not yet available.

SUMMARY REPORT OF THE NAS-NRC WORKSHOP ON SCIENCE PLANNING AND POLICY IN THAILAND, July 3-6, 1972. NAS. 17 p. No copies available.

LATIN AMERICA

Argentina

REPORT OF THE ARGENTINE-U.S. WORKSHOP ON SCIENCE & TECHNOLOGY IN ECONOMIC DEVELOPMENT, Mar del Plata, July 28-August 1, 1969. NAS. 79 p. PB 203-378-U.

ARGENTINE-U.S. PANEL ON SCIENTIFIC INFORMATION: REPORT OF THE FIRST MEETING. INTERIM REPORT. August 24-25, 1970. NAS. 16 p. + attachments. No copies available.

PRELIMINARY ASSESSMENT OF SOME PROBLEMS OF THE HYDROGEOLOGY OF THE DRY PAMPAS IN BUENOS AIRES PROVINCE, ARGENTINA. INTERIM REPORT. Stanley Davis and John Winslow. September 1970. NAS. 13 p. No copies available.

A REPORT OF THE ARGENTINE-U.S. STUDY GROUP ON FOOD TECHNOLOGY. INTERIM REPORT. July 1971. NAS. 30 p.
No copies available.

Brazil

BACKGROUND INFORMATION FOR BRAZIL-U.S. WORKSHOP ON SCIENCE, TECHNOLOGY, AND DEVELOPMENT, 1966. NAS. 179 p.
PB 203-939-U.

SCIENCE AND BRAZILIAN DEVELOPMENT, Itatiaia, Brazil, April 11-16, 1966. Part I, Report of a Workshop on Contribution of Science & Technology to Development, 39 p.; Part II, Contributed Papers, 132 p. NAS.
Part I, PB 203-413-U; Part II, PB 203-938-U.

REPORT OF THE JOINT STUDY GROUP ON STANDARDS, TESTS, AND WEIGHTS AND MEASURES IN BRAZIL, Rio de Janeiro, 1968. CNPq. 39 p. Portuguese only. No copies available.

SCIENCE AND BRAZILIAN DEVELOPMENT: REPORT OF THE SECOND WORKSHOP ON CONTRIBUTION OF SCIENCE & TECHNOLOGY TO DEVELOPMENT, February 5-9, 1968. NAS. 102 p. PB 203-366-U.

REPORT OF THE JOINT STUDY GROUP ON INDUSTRIAL RESEARCH AS A FACTOR IN ECONOMIC DEVELOPMENT, September 1968. NAS. 34 p. PB 203-373-U.

SCIENCE AND BRAZILIAN DEVELOPMENT: REPORT OF THE THIRD WORKSHOP ON CONTRIBUTION OF SCIENCE & TECHNOLOGY TO DEVELOPMENT, Rio de Janeiro, Brazil, April 7-11, 1969. NAS. 71 p. PB 203-391-U.

SCIENCE AND BRAZILIAN DEVELOPMENT: REPORT OF THE FOURTH WORKSHOP ON SCIENCE & TECHNOLOGY IN DEVELOPMENT, November 1-5, 1971. NAS. 87 p. PB 210-345.

RECOMMENDATIONS FOR IMPROVING COMPUTER SCIENCE EDUCATION IN BRAZIL. U.S.-BRAZIL STUDY GROUP. December 1971. NAS-CNPq. 19 p. + 3 appendices. No copies available.

IMPROVING COMPUTER SCIENCE EDUCATION IN BRAZIL. SECOND REPORT OF NAS-CNPq STUDY GROUP. August 1972. CNPq-NAS. 69 p.
No copies available.

STUDY FOR AGRICULTURAL ENGINEERING DEVELOPMENT IN BRAZIL: REPORT OF THE JOINT STUDY GROUP ON AGRICULTURAL ENGINEERING DEVELOPMENT IN BRAZIL, July 24-August 12, 1972. NAS. 34 p. PB 214-534.

SCIENCE AND TECHNOLOGY IN SÃO PAULO'S DEVELOPMENT, July 1972. NAS. 100 p. No copies available.

Chile

SUMMARY REPORT OF THE CHILE-U.S. WORKSHOP ON THE CONTRIBUTION OF SCIENCE AND TECHNOLOGY TO DEVELOPMENT, Santiago, January 11-15, 1971. NAS. 28 p. No copies available.

Colombia

INSTITUTIONS OF HIGHER EDUCATION, RESEARCH AND PLANNING IN COLOMBIA. BACKGROUND INFORMATION FOR COLOMBIA-U.S. WORKSHOP. February 1968. NAS. 65 p. No copies available.

REPORT OF THE COLOMBIA-U.S. WORKSHOP ON SCIENCE AND TECHNOLOGY IN DEVELOPMENT, Fusagasugá, Colombia, February 26-March 1, 1968. Vol. I, Proceedings & Recommendations, 55 p.; Vol. II, Contributed Papers, 98 p. NAS-Colombia Ministry of Education. Vol. I, PB 203-374-U, Vol. II, PB 203-375-U.

SEMINARIO SOBRE CIENCIA Y TECNOLOGÍA PARA EL DESARROLLO, Fusagasugá, Colombia, February 26-March 1, 1968. Vol. I, 134 p., Vol. II, 209 p. Colombian Ministry of Education. No copies available.

REPORT TO THE AID MISSION IN COLOMBIA. Jay Davenport. August 1969. NAS. 17 p. + appendices. No copies available.

SEMINARIO SOBRE ADMINISTRACIÓN DE LA INVESTIGACIÓN CIENTÍFICA, Agosto 4-14 de 1969. Instituto de Integración Cultural & COLCIENCIAS. 285 p. Spanish only. No copies available.

PROGRAMA DE IMPULSO A LA INVESTIGACIÓN Y A ESTUDIOS DE POSGRADO EN LAS UNIVERSIDADES COLOMBIANAS--INFORME DE LA MISIÓN DE QUÍMICA, Febrero 22-27 de 1971. COLCIENCIAS. 40 p. No copies available.

SUMMARY REPORT OF A COLCIENCIAS-NAS PANEL STUDY OF GRADUATE EDUCATION IN CHEMISTRY IN COLOMBIA, Bogotá, February 22-27, 1971. NAS. 16 p. No copies available.

PROGRAMA DE IMPULSO A LA INVESTIGACIÓN Y A ESTUDIOS DE POSGRADO EN LAS UNIVERSIDADES COLOMBIANAS--INFORME DE LA MISIÓN DE MATEMÁTICAS, Marzo 15-20 de 1971. COLCIENCIAS. 47 p. No copies available.

SUMMARY REPORT OF A COLCIENCIAS-NAS PANEL STUDY OF GRADUATE EDUCATION AND RESEARCH IN MATHEMATICS IN COLOMBIA, Bogotá, March 15-20, 1971. NAS. 20 p. No copies available.

PROGRAMA DE IMPULSO A LA INVESTIGACIÓN Y A LOS ESTUDIOS DE POSGRADO EN LAS UNIVERSIDADES COLOMBIANAS--INFORME A LA MISIÓN DE INGENIERÍA, Febrero 14-25 de 1972. COLCIENCIAS. 185 p. No copies available.

SUMMARY REPORT OF THE COLOMBIA-U.S. STUDY PANEL ON THE POTENTIAL FOR GRADUATE EDUCATION AND RESEARCH IN ENGINEERING, PHYSICS AND APPLIED GEOLOGY IN COLOMBIA, February 14-25, 1972. NAS. 26 p. No copies available.

PROGRAMA DE IMPULSO A LA INVESTIGACIÓN Y A LOS ESTUDIOS DE POSGRADO EN LAS UNIVERSIDADES COLOMBIANAS--INFORME DE LA MISIÓN DE BIOLOGÍA, Mayo 31-Junio 13 de 1972. COLCIENCIAS. No copies available.

SUMMARY GENERAL REPORT OF THE COLOMBIA-U.S. STUDY GROUP ON THE POTENTIAL FOR GRADUATE EDUCATION AND RESEARCH IN THE BIOLOGICAL SCIENCES IN COLOMBIA, Bogota, May 29-June 13, 1972. NAS. 25 p. No copies available.

PROGRAM FOR THE IMPROVEMENT OF GRADUATE EDUCATION AND RESEARCH IN COLOMBIAN UNIVERSITIES IN THE SCIENCES AND ENGINEERING: FINAL STAFF SUMMARY REPORT, October 1972. NAS. 28 p. No copies available.

Peru

BASIC DATA AND BACKGROUND INFORMATION FOR THE WORKSHOP ON THE ROLE OF SCIENCE AND TECHNOLOGY IN PERUVIAN ECONOMIC DEVELOPMENT, 1966. NAS. 128 p. No copies available.

REPORT OF A WORKSHOP ON THE ROLE OF SCIENCE AND TECHNOLOGY IN PERUVIAN ECONOMIC DEVELOPMENT, April 17-22, 1966. NAS. 85 p. PB 203-362-U.

ORGANIZATION OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH, Lima, September 1966. Paracas Group Committee. 29 p. Spanish only. No copies available.

SECOND PERU-U.S. WORKSHOP ON SCIENCE AND TECHNOLOGY IN ECONOMIC DEVELOPMENT, November 20-24, 1967. Vol. I, Report, 62 p.; Vol. II, Contributed Papers, 308 p. NAS. Vol. I, PB 203-363-U; Vol. II, PB 203-364-U.

LA CIENCIA Y LA TECNOLOGÍA EN EL DESARROLLO, November 1968. Office of Research and Development, Ministry of the Navy. 256 p. Spanish only. No copies available.

## PART II. SPECIAL STUDIES AND PROJECTS

### PUBLISHED REPORTS BY AREA

#### Africa

AGRICULTURAL DEVELOPMENT SCHEMES IN SUB-SAHARAN AFRICA: A BIBLIOGRAPHY. Ruth S. Freitag (compiled for the NAS Africa Science Board). 1963. Library of Congress. 189 p. Limited copies available from BOSTID, NAS.

TRADITIONAL AGRICULTURAL METHODS IN THE CONGO BASIN. Marvin P. Miracle (for the NAS Africa Science Board). 1964. Food Research Institute, Stanford University, Stanford, California. Approx. 300 p. unpaged. Limited copies available from BOSTID, NAS.

MAN-MADE LAKES: A SELECTED GUIDE TO THE LITERATURE. Gabrielle Edgcomb. September 1, 1965. NAS. 98 p. Limited copies available from BOSTID, NAS.

REPORT OF THE STUDY GROUP ON ANIMAL DISEASES IN AFRICA, April 20, 1965. NAS. 60 p. PB 203-361-U.

RESEARCH SERVICES IN EAST AFRICA. The East African Academy (Financed by NSF grant through NAS). 1966. East African Publishing House, Nairobi, Kenya. 239 p.

AGRICULTURAL RESEARCH PRIORITIES FOR ECONOMIC DEVELOPMENT IN AFRICA, Abidjan, Ivory Coast, April 5-12, 1968. Vol. I, English, Conference Report, 139 p. (French 144 p.); Vol. II, Contributed Papers (Soils, etc.), 473 p. (French 513 p.); Vol. III, Contributed Papers (Animal Production, etc.), 437 p. (French 487 p.). NAS. (French volumes available from BOSTID).
Vol. I, PB 203-367-U.
Vol. II, PB 203-368-U. Vol. III, PB 203-369-U.

REPORT OF THE AFRICA SCIENCE BOARD COMMITTEE ON AGRICULTURE TO AID ON RECOMMENDATIONS FROM THE APRIL 5-12, 1968, CONFERENCE ON AGRICULTURAL RESEARCH PRIORITIES FOR ECONOMIC DEVELOPMENT IN AFRICA, Abidjan, Ivory Coast, December 1968. NAS. 9 p. No copies available.

## Asia

THE FUTURE OF U.S. TECHNICAL COOPERATION WITH KOREA: A REPORT TO AID BY A PANEL OF BOSTID, November 1969. NAS. 50 p. PB 203-325-U.

THAILAND SEMINAR ON PROTEIN FOOD PROMOTION, Bangkok, November 22-December 1, 1970. Vol. I, Background (unpaged); Vol. II, Proceedings (unpaged). AID/Thailand, Institute of Food Research & Product Development, and Department of Public Health. In Thai and English. NTIS Nos. not yet available.

EAST PAKISTAN LAND AND WATER DEVELOPMENT AS RELATED TO AGRICULTURE, January 1971. NAS. 67 p. PB 203-328.

SUMMARY REPORT OF THE NAS ADVISORY PANEL TO THE MINISTRY OF SCIENCE & TECHNOLOGY. Republic of Korea. January 10-21, 1972. NAS. 16 p. No copies available.

REGIONAL WORKSHOP ON WATER RESOURCES, ENVIRONMENT AND NATIONAL DEVELOPMENT, Singapore, March 13-17, 1972. Vol. I, Proceedings, 116 p.; Vol. II, Selected Papers (not yet published). Science Council of Singapore. Vol. I, PB 217-117.

SUMMARY REPORT OF A "REGIONAL WORKSHOP ON WATER RESOURCES, ENVIRONMENT AND NATIONAL DEVELOPMENT," Singapore, March 13-17, 1972. NAS. 34 p. No copies available.

## Latin America

A PROPOSAL FOR THE CREATION OF A TROPICAL RESEARCH FOUNDATION, March 1, 1965. NAS. 95 p. No copies available.

THE CASE FOR GRADUATE ENGINEERING EDUCATION IN LATIN AMERICA. Frank Tiller (for the Latin America Science Board). NAS. 91 p. No copies available.

CONSERVACIÓN DEL MEDIO AMBIENTE FÍSICO Y EL DESARROLLO, PRIMER SEMINARIO, Antigua, Guatemala, Julio 25-30 de 1971. ICAITI. 288 p. Spanish only. PB 217-119. Limited copies also available from BOSTID, NAS.

REPORT ON THE CENTRAL AMERICAN WORKSHOP ON THE ENVIRONMENT AND DEVELOPMENT, Antigua, Guatemala, July 25-30, 1971. NAS. 32 p. No copies available.

PUBLISHED REPORTS, GENERAL

SCIENCE BOOK PROGRAM: FINAL REPORT AND RECOMMENDATIONS, 1968. NAS. 7 p. + appendix 4 p. No copies available.

INTERNATIONAL ASPECTS OF MAN'S EFFECT UPON THE ENVIRONMENT: REPORT TO AID, 1970. NAS. 8 p. + appendix 15 p. PB 203-379.

RAPID POPULATION GROWTH: CONSEQUENCES AND POLICY IMPLICATIONS. Vol. I, Summary & Recommendations, 105 p.; Vol. II, Research Papers, 690 p. Baltimore: Johns Hopkins Press (for the NAS). 1971.

THE INTERNATIONAL DEVELOPMENT INSTITUTE: REPORT OF AN AD HOC COMMITTEE OF BOSTID, July 1971. NAS. 57 p. PB 203-331.

SCIENTIFIC AND TECHNICAL INFORMATION FOR DEVELOPING COUNTRIES, 1972. NAS. 63 p. and bibliography. PB 210-107.

SOLAR ENERGY IN DEVELOPING COUNTRIES: PERSPECTIVES AND PROSPECTS, March 1972. NAS. 48 p. PB 208-550.

IN PREPARATION BY BOSTID PANELS (WORKING TITLES)

AFRICAN AGRICULTURAL RESEARCH CAPABILITIES.

FERROCEMENT: APPLICATIONS IN DEVELOPING COUNTRIES. (in press)

MEETING THE CHALLENGE OF INDUSTRIALIZATION: PROPOSAL FOR AN INTERNATIONAL INDUSTRIALIZATION INSTITUTE.

MOSQUITO CONTROL: SOME PERSPECTIVES FOR DEVELOPING COUNTRIES. (in press)

NEW TECHNOLOGY SOLUTIONS TO ROOFING PROBLEMS IN DEVELOPING COUNTRIES.

ROLE OF THE U.S. ENGINEERING SCHOOLS IN TECHNICAL ASSISTANCE.

STUDY OF APPROPRIATE TECHNOLOGIES FOR DEVELOPING ECONOMIES.

STUDY OF THE ROLE OF SCIENCE & TECHNOLOGY IN INTERNATIONAL DEVELOPMENT IN THE 1970'S.

TRAINING OF LDC RESEARCH ADMINISTRATORS AND TECHNICAL MANAGERS.

U.S. INTERNATIONAL FIRMS AND R, D & E IN DEVELOPING COUNTRIES.

# APPENDIX D

## STAFF AND PROGRAM PARTICIPANTS, 1963 - 1972

Board on Science and Technology for International Development
Office of the Foreign Secretary
National Academy of Sciences
Washington, D.C. 20418

# APPENDIX D: STAFF AND PROGRAM PARTICIPANTS, 1963 - 1972

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# INTRODUCTION

It has long been recognized and often emphasized that a major strength of the National Academy of Sciences has been and continues to be its ability to call on members of the scientific and technical community in the United States to participate in its activities. This capability has been amply demonstrated in the NAS international development activities where, through membership in regional science boards, workshops, study groups, conferences, and studies, hundreds of specialists have voluntarily devoted their time and energies to consideration of science, technology, and international development.

The list that follows contains the names of participants and staff in international programs conducted by the Office of the Foreign Secretary with colleagues in Africa, Asia, and Latin America since 1963. Foreign participants are also included and account for more than half the list. Care has been taken to ensure that participants' names and affiliations are correct as of the time of their actual participation. However, a few listings are incomplete because primary sources were not available and further verification was impractical.

## STAFF OF AFRICAN, ASIAN AND LATIN AMERICAN PROGRAMS, 1963 - 1972

HARRISON BROWN, Foreign Secretary, National Academy of Sciences, 1962-; Professor of Geochemistry, 1951-; and Professor of Science and Government, 1967-, California Institute of Technology
W. MURRAY TODD, Executive Secretary, Office of the Foreign Secretary, 1962-

### Africa Science Board (1962-1963)

THERESA TELLEZ, Professional Assistant, 1962-63
WILTON DILLON, Head of African Affairs, 1963-66
MARYANNE DULANSEY, Professional Associate, 1966-67
M.G.C. McDONALD DOW, Head of African Affairs, 1967-68

### Pacific Science Board (1963-1970)*

HAROLD J. COOLIDGE, Head, Pacific-Far Eastern Affairs, 1963-70
ROBERT E. SHEEKS, Associate Director, 1963-68
MARYANNE DULANSEY, Professional Associate, 1967-68
JOHN TAYLOR, Professional Associate, 1966-67
WILLIAM L. EILERS, Associate Director, 1968-70

### Latin America Science Board (1963-68)

WILLIAM C. PADDOCK, Executive Secretary, 1963-65
HERBERT J. PULSIFER, Professional Associate, 1963-65
DIANA RIEHL, Research Assistant, 1963-68
THERESA TELLEZ, Professional Associate, 1963-67; Head of Latin American Affairs, 1967-70
VICTOR RABINOWITCH, Professional Associate, 1965-67

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*The PSB was created in 1946 and Mr. Coolidge served as director until 1970.

Science Organization Development Board (1966-68)

WILTON DILLON, Director, 1966-68
M.G.C. McDONALD DOW, Professional Associate, 1966-67
MARYANNE DULANSEY, Professional Associate, 1966-68
WILLIAM EILERS, Professional Associate, 1968
JULIEN ENGEL, Professional Associate, 1966-68
CLEARTHOS LOGOTHETIS, Head, Middle East/South Asian Affairs,* 1964-67
VICTOR RABINOWITCH, Professional Associate, 1965-67, Deputy Director, 1967-68; Director, 1968-69
ROBERT E. SHEEKS, Professional Associate
ROBERT SOLO, Professional Associate, 1965
THERESA TELLEZ, Professional Associate, 1966-68

Board on Science and Technology in International Development (1969 -)

WILLIAM L. EILERS, Staff Director, 1969-70; Head of Bilateral Programs, 1970-71
VICTOR RABINOWITCH (February 1969-March 1970, State University of New York); Staff Director, 1970-
ROSE AMESER, Professional Assistant, 1969-70; (November 1970-July 1971, overseas travel); Assistant to the Director, 1971-
ROBERT BRAINERD, Professional Associate, 1970-71
NORMAN L. BROWN, Professional Associate, 1970-
B.K. WESLEY COPELAND, Professional Associate, 1969-
JAY J. DAVENPORT, Professional Associate, 1969-
DIOSDADA DELEVA, Librarian, 1971-
M.G.C. McDONALD DOW, (December 1968-September 1972, Haile Selassie I University) Deputy Director, September 1972-
JULIEN ENGEL, Deputy Director, 1969-; Head of Special Studies, 1970-
JOHN G. HURLEY, Professional Associate, 1970-
JANE LECHT, Editor, 1971-
LORETTA POTTS, Librarian, 1970-71
THERESA TELLEZ, Head of Latin American Affairs, 1967-70; Professional Associate, 1970-
NOEL VIETMEYER, Professional Associate, 1970-
JUDY WERDEL, Professional Assistant, 1970-
ADOLPH WILBURN, Professional Associate, 1970-71
EARL YOUNG, Professional Associate, 1970-71
JAMES ZAVISTOSKI, Professional Associate, 1970-72

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*The Middle East/South Asia Science Board, created in 1964, met only once and thus is omitted from this list.

THAYER SCUDDER, Anthropology, California Institute of Technology
HAROLD E. THOMAS, U.S. Geological Survey, Menlo Park, California
THOMAS H. WELLER, Tropical Public Health, Harvard University

Subcommittee on Animal Disease in Africa, 1964-65

CARL BRANDLY, Dean of Veterinary College, University of Illinois
M. R. CLARKSON, President, American Veterinary Medical Association
WILLIAM O. JONES, Food Research Institute, Stanford University
J. G. MATTHYSE, College of Agriculture, State University of New York
JOHN J. McKELVEY, JR., Agricultural Sciences, The Rockefeller Foundation
GEORGE P. MURDOCK, Anthropology, University of Pittsburgh
FREDERICK D. PATTERSON, President, Phelps-Stokes Fund
GEORGE C. POPPENSEIK, Dean of Veterinary Medicine, Cornell University

Study Group on Animal Disease in Africa, 1964-65

NELS M. KONNERUP, Department of Health Data, Walter Reed Army Institute of Research
HARRY E. FERGUSON, President, Mt. Haggin Livestock Company
PETER HAMMOND, Anthropology, Indiana University
D. E. HOWELL, Entomology, Oklahoma State University
ROBERT C. REISINGER, Agricultural Research Service, U.S. Department of Agriculture
JAMES R. PICK, Institute of Laboratory Animal Resources, National Academy of Sciences

PACIFIC SCIENCE BOARD, 1963-70*

RALPH E. CLELAND, Chairman, 1963-67, Genetics, Indiana University, 1963-70
H. BURR STEINBACH, Chairman, 1967-70, Woods Hole Oceanographic Institution, 1966-70
HARRISON BROWN, ex officio, Foreign Secretary, National Academy of Sciences
JOHN E. BARDACH, School of Natural Resources, University of Michigan, 1968-70
PRESTON E. CLOUD, JR., Paleontology, University of Minnesota, 1963-66
HAROLD C. CONKLIN, Anthropology, Yale University, 1963-66
FRED R. EGGAN, Anthropology, University of Chicago, 1968-70
ROLAND W. FORCE, Bernice P. Bishop Museum, 1966-68
WARD H. GOODENOUGH, Anthropology, University of Pennsylvania, 1963-66
H. BENTLEY GLASS, Biology Science Education, State University of New York at Stony Brook, 1968-70
FRANK H. GOLAY, Southeast Asia Program, Cornell University, 1968-70
Y. BARON GOTO, Center for Cultural and Technical Interchange Between East and West, 1966-69
STERLING B. HENDRICKS, Plant Physiology, U.S. Department of Agriculture, 1963-67
ROBERT W. HIATT, Zoology, University of Hawaii, 1963-65
CARL L. HUBBS, Scripps Institution of Oceanography, 1963-66
HARRY C. KELLY, Physics, North Carolina State College, 1963-68
WILLIAM A. KREBS, Vice President, Arthur D. Little, Inc., 1968-70
JOHN M. H. LINDBECK, Columbia University, 1968-70
ARTHUR P. LONG, Preventive Medicine, University of California, 1963-66
C. E. PEMBERTON, Entomology, Hawaiian Sugar Planters Association, 1963-65
JOSEPH B. PLATT, President, Harvey Mudd College, 1965-70
WALTER ORR ROBERTS, National Center for Atmospheric Research, 1963-68
A. C. SMITH, Botany, University of Hawaii, 1963-65
ATHELSTAN F. SPILHAUS, Dean, Institute of Technology, University of Minnesota, 1968-70
M. H. TRYTTEN, Office of Scientific Personnel, National Academy of Sciences, 1968-70
I. E. WALLEN, Director, Harbor Branch Foundation Laboratory, 1966-70

*The Pacific Science Board was created in 1946.

JOHN C. WARNER, President, Carnegie Institute of Technology, 1965-67
ALAN T. WATERMAN, Director, National Science Foundation, 1965-68
JOHN S. WELLINGTON, University of California, 1966-68
GEORGE P. WOLLARD, Geophysics, University of Hawaii, 1963-66

LATIN AMERICA SCIENCE BOARD, 1963-68

WILL M. MYERS, Chairman, Agronomy, University of Minnesota, 1963-65
HARRISON BROWN, Acting Chairman, NAS Foreign Secretary, 1965-66
CARL DJERASSI, Chairman, Chemistry, Stanford University, 1966-68
T. J. CUNHA, Animal Sciences, University of Florida, 1966-68
ALLAN R. HOLMBERG, Anthropology, Cornell University, 1963-67
JAMES G. HORSFALL, Director, Connecticut Agricultural Experiment Station, 1963-67
W. D. JOHNSTON, JR., U.S. Geological Survey, 1965-68
DAVID B. KING, U.S. Forest Service, U.S. Department of Agriculture, 1967-68
RALPH A. KRAUSE, Consultant, International Science and Technology, 1963-64
ROY L. LOVVORN, Agriculture and Life Sciences, North Carolina State University, 1967-68
STACY MAY, (Retired) Rockefeller Brothers Fund, 1965-67
CHARLES L. MILLER, Civil Engineering, Massachusetts Institute of Technology, 1965-68
NORMAN MOORE, Consulting Scientist, 1967-68
FRANKLIN A. NEVA, Tropical Public Health, Harvard University, 1963-68
JOHN S. NIEDERHAUSER, Agriculture, Rockefeller Foundation (Mexico), 1963-64
RICHARD W. PATCH, Anthropology, State University of New York at Buffalo, 1967-68
A. J. RIKEN, Plant Pathology, University of Wisconsin, 1963-64
STEFAN H. ROBOCK, Graduate School of Business, Columbia University, 1967-68
MILNER B. SCHAEFER, Science Adviser, Department of the Interior, 1963-68
THEODORE W. SCHULTZ, Economics, University of Chicago, 1963-64
J. MAYONE STYCOS, Sociology, Cornell University, 1963-65
FRANK M. TILLER, Dean of Engineering, University of Houston, 1963-65
KENNETH L. TURK, Animal Husbandry, Cornell University, 1963-65
MERLE A. TUVE, Terrestrial Magnetism, Carnegie Institution of Washington, 1963-65

Task Force on Tropical Agriculture, 1964-65

ELMER A. BEAVENS, Food Technologist, U.S. Department of Agriculture
T. J. CUNHA, Animal Sciences, University of Florida
NATHAN A. HAVERSTOCK, Writer, Washington, D. C.
WALTER HOFMANN, U.S. Geological Survey, Menlo Park, California
ERNEST P. IMLE, American Cocoa Research Institute
NORTON C. IVES, Consulting Engineer, Rolfe, Iowa
HENRY KERNAN, Forestry, State University of New York
DAVID B. KING, U.S. Forest Service, U.S. Department of Agriculture
ROY L. LOVVORN, Agriculture and Life Sciences, North Carolina State University
EILIF MILLER, Rural Development, Agency for International Development
RICHARD W. PATCH, American Universities Field Staff, Lima, Peru
VIRGIL PETERSON, Rural Development, Agency for International Development
CLARENCE E. PIKE, Agricultural Economist, U.S. Department of Agriculture
LEONARD ROSENFELD, Metropolitan Hospital, Detroit, Michigan
HUBERT J. SLOAN, Animal Scientist (retired), St. Paul, Minnesota
DAVID TIMOTHY, Crops, North Carolina State University
JOSÉ VICENTE-CHANDLER, Soils, U.S. Department of Agriculture

## DEVELOPMENT BOARDS AND PANELS

### SCIENCE ORGANIZATION DEVELOPMENT BOARD, 1966-68

ROGER REVELLE, Chairman, Director, Center for Population Studies, Harvard University
HARRISON BROWN, ex officio, Foreign Secretary, National Academy of Sciences
ROBERT McCORMICK ADAMS, Director, Oriental Institute, University of Chicago
JAMES R. ARNOLD, Chemistry, University of California at La Jolla
CARL DJERASSI, Chemistry, Stanford University
ANTOINE M. GAUDIN, Mineral Engineering, Massachusetts Institute of Technology
F. F. HILL, Vice President for Agriculture, The Ford Foundation
ROBERT N. KREIDLER, Executive Vice President, Alfred P. Sloan Foundation
WILLIAM J. LAWLESS, JR., Office of the Director of Corporate Planning, International Business Machines
JOHN J. McKELVEY, JR., Associate Director, Agricultural Sciences, The Rockefeller Foundation
JOSEPH B. PLATT, President, Harvey Mudd College
M. B. RUSSELL, Agriculture Experiment Station, University of Illinois
STEPHEN H. STACKPOLE, Carnegie Corporation of New York
ALVIN M. WEINBERG, Director, Oak Ridge National Laboratory
JOHN M. WEIR, Director of Medical and Natural Sciences, The Rockefeller Foundation
CARROLL L. WILSON, Management, Massachusetts Institute of Technology

BOARD ON SCIENCE AND TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT, 1969-1973

ROGER REVELLE, Chairman, 1968-72, Director, Center for Population Studies, Harvard University, 1968-
CARL DJERASSI, Chairman, 1972- , Chemistry, Stanford University, 1968-
HARRISON BROWN, ex officio, Foreign Secretary, National Academy of Sciences
THOMAS F. MALONE, ex officio, Deputy Foreign Secretary, National Academy of Sciences
BRUCE S. OLD, ex officio, Deputy Foreign Secretary, National Academy of Sciences
C. ARNOLD ANDERSON, Anthropology, University of Chicago, 1971-72
IVAN L. BENNETT, JR., Medicine, New York University, 1971-
NYLE C. BRADY, College of Agriculture, Cornell University, 1970-71
GEORGE BUGLIARELLO, Dean of Engineering, University of Illinois, 1972-
CHARLES DENNISON, Consultant, New York City, 1972-
D. MARK HEGSTED, Nutrition, Harvard University, 1970-72
LADY BARBARA WARD JACKSON, Economics, Columbia University, 1971-72
WILLIAM A. W. KREBS, Arthur D. Little, Inc., 1968-
ROBERT N. KREIDLER, Executive Vice President, Alfred P. Sloan Foundation, 1969-
ROY L. LOVVORN, State Research Service, Department of Agriculture, 1968-72
JOHN J. McKELVEY, JR., Agricultural Sciences, The Rockefeller Foundation, 1968-72
EDWIN MUNGER, Geography, California Institute of Technology, 1968-71
JOSEPH PETTIT, President, Georgia Institute of Technology, 1972-
JOSEPH B. PLATT, President, Harvey Mudd College, 1968-
H. F. ROBINSON, Provost, Purdue University, 1968-72
STEFAN H. ROBOCK, Graduate School of Business, Columbia University, 1968-72
H. BURR STEINBACH, Woods Hole Oceanographic Institution, 1968-72
CLIFTON WHARTON, President, Michigan State University, 1968-70
GILBERT WHITE, Geography, University of Colorado, 1972-
CARROLL L. WILSON, Management, Massachusetts Institute of Technology, 1968-72
STERLING WORTMAN, Director, Agricultural Science, The Rockefeller Foundation, 1972-

Advisory Committee on Technology Innovation, 1971-73

GEORGE BUGLIARELLO, Chairman, Engineering, University of Illinois
ERNST R. PARISER, Food Science, Massachusetts Institute of Technology
CHARLES A. ROSEN, Electrical Engineer, Stanford Research Institute
STANISLAW ULAM, Mathematics, University of Colorado
LEWIS PERINBAM, Advisor, International Organizations, Canadian International Development Agency

# BILATERAL WORKSHOPS AND STUDY GROUPS

## AFRICA

### GHANA

WORKSHOP ON RESEARCH PRIORITIES AND PROBLEMS IN THE EXECUTION OF RESEARCH IN GHANA, Accra, January 18-22, 1971

Ghanaian Participants and Observers

Ministers and Ministry Representatives

A. E. K. ASHIAGBOR, Ministry of Finance and Economic Planning
J. S. EDOO, Ministry of Trade, Industries and Tourism
HENRY HOPP, Ministry of Agriculture
A. A. LARYEA, Ministry of Agriculture
JONES OFORI-ATTA, Ministry of Finance and Economic Planning
R. A. QUARSHIE, Minister of Trade, Industries and Tourism
K. SAFO-ADU, Minister of Agriculture
C. E. TAGOE, Ministry of Agriculture

Council for Scientific and Industrial Research

M. DOWUONA, Chairman, National Council for Higher Education
M. A. ADANSI, Crops Research Institute
F. W. ADDO-ASHONG, Director, Forest Products Research Institute
W. K. AGBLE, Director, Crops Research Institute
YAW ASANTE, Building and Road Research Institute
E. J. A. ASOMANING, Director, Cocoa Research Institute
NII BOI AYI-BOTELEY, Water Resources Research Unit
A. J. E. BUCKNOR, Animal Research Institute
R. J. G. BUTLER, Institute of Standards and Industrial Research
M. CAURIE, Food Research Institute
ST. JOHN A. CLOTTEY, Food Research Institute
J. W. S. DE GRAFT-JOHNSON, Director, Building and Road Research Institute
W. D. G. ERBYNN, Crops Research Institute
A. E. KPEKATA, Institute of Aquatic Biology
E. LARTEY, Director, Institute of Standards and Industrial Research
VERONICA A. MARTINSON, Cocoa Research Institute

H. B. OBENG, Officer-in-Charge, Soil Research Institute
LETITIA E. OBENG, Director, Institute of Aquatic Biology
E. D. OFFORI, Animal Research Institute
C. S. OFORI, Soil Research Institute
A. OFOSU-ASIEDU, Forest Products Research Institute
A. A. OWUSU, Institute of Standards and Industrial Research
P. O. RIPLEY, Agricultural Research Coordinator

University of Ghana, Legon

D. K. ACQUAYE, Department of Crops Science
E. K. AGYEI, Department of Physics
D. A. BEKOE, Department of Chemistry
E. BORTEI-DOKU, Department of Agricultural Economics and Farm Management
G. C. CLERK, Department of Botany
W. Z. COKER, Department of Zoology
J. A. DADSON, Department of Agricultural Economics and Farm Management
D. W. EWER, Head, Department of Zoology
J. A. HAIZEL, Department of Crops Science
J. K. M. HODASI, Department of Zoology
A. A. KWAPONG, Vice Chancellor
S. LA-ANYANE, Dean, Faculty of Agriculture
E. LAING, Department of Botany
G. W. LAWSON, Head, Department of Botany
A. N. MAY, Head, Department of Physics
E. N. W. OPPONG, Department of Animal Science
J. A. K. QUARTEY, Department of Chemistry
E. J. THOMPSON, Department of Crops Science
F. G. T. O'B. TORTO, Head, Department of Chemistry

University College of Cape Coast

E. A. BOATENG, Principal
B. A. DADSON, Department of Chemistry
K. N. EYESON, Department of Zoology
J. YANNEY EWUSIE, Dean, Faculty of Science
M. M. HOSNY, Head, Department of Zoology
R. OTENG, Head (Acting), Department of Physics

University of Science and Technology, Kumasi

E. EVANS-ANFOM, Vice Chancellor
E. P. DZIWORNOOH, Department of Physics
F. A. KUFUOR, Head, Department of Chemistry
E. B. KWAKYE, Pro Vice-Chancellor, Electrical Engineering

Other Government Agencies

T. ACKOM-MENSAH, Ghana Industrial Holding Corporation
P. E. AMOAH, Ghana Industrial Holding Corporation
J. E. CUDJOE, Geological Survey
ERIC KWEI, Officer-in-Charge, Fishery Research Unit
M. A. MENSAH, Fishery Research Unit
G. T. ODDOYE, National Council on Higher Education
TWUM-BARIMA, Chairman, Cocoa Marketing Board

United States Participants

JOHN J. McKELVEY, JR., Chairman, Agriculture, Rockefeller Foundation
DAVID E. APTER, Political Science and Sociology, Yale University
DONALD BARTON, Agriculture, Cornell University
HARRISON BROWN, Foreign Secretary, National Academy of Sciences
JAMES P. CARTER, Pediatrics and Nutrition, Vanderbilt University
WALTER H. LEWIS, Missouri Botanical Garden
JAMES W. MOYER, Xyzyx Information Corporation, Reseda, California
ARTHUR N. PRATER, Consultant on Foods, Encino, California
ROGER REVELLE, Center for Population Studies, Harvard University
THAYER SCUDDER, Anthropology, California Institute of Technology

U. S. Embassy

AMBASSADOR THOMAS McELHINEY
W. HAVEN NORTH, Director, U. S. AID Mission to Ghana
M. FELDSTEIN, U. S. AID Mission to Ghana
WILLIAM LONG, U. S. AID/Washington
JAMES M. TULL, U. S. Information Agency

JOINT U. S.-GHANA COMMITTEE ON AGRICULTURAL EXTENSION AND RESEARCH, 1971

Ghanaian Panelists

C. E. TAGOE, Co-Chairman, Agricultural Development, Ministry of Agriculture
W. K. AGBLE, Crops Research Institute, CSIR, Kumasi

A. E. K. ASHIABOR,* Bank of Ghana, Accra
E. J. A. ASOMANING, Cocoa Research Institute, CSIR, New Tafo
E. BORTEI-DOKU, Agricultural Economics and Farm Management, University of Ghana
J. S. KANKAM, Crop Production, University of Science and Technology, Kumasi

United States Panelists

DONALD W. BARTON, Co-Chairman, Agriculture, Cornell University
ROBERT M. HAGAN, Agriculture and Water Science, University of California
GEORGE HYATT, JR., Agriculture, North Carolina State University
LEONARD F. MILLER, Agricultural Economics and Extension, University of Ibadan
JOHN W. SPAVEN, Communication, University of Vermont

*Mr. Ashiabor was unable to serve on the committee.

## NIGERIA

WORKSHOP ON SCIENCE AND NIGERIAN DEVELOPMENT, Bellagio, Italy, August 12-25, 1965

### Nigerian Participants

OKOI ARIKPO, Secretary-General, National Universities Commission
A. A. AYIDA, Permanent Secretary, Ministry of Economic Development
CHIEF G. AKIN DEKO, African Representative of FAO, Accra
JOSEPH C. EDOZIEN, Dean, Medical Faculty, University of Ibadan
T. A. LAMBO, Psychiatry, Neurology, and Neurosurgery, University of Ibadan
G. E. A. LARDNER, Natural Resources Division, Economic Commission of Africa, Addis Ababa
ENI NJOKU, Botany, Michigan State University
BIDE OKIGBO, Agricultural Biology, University of Nigeria, Nsukka
G. E. OKIY, Permanent Secretary, Ministry of Research and Natural Resources
H. M. A. ONITIRI, Head, Nigerian Institute of Social and Economic Research, University of Ibadan

### Observers

JOHN COCKROFT, The Royal Society
JOSEPH HUTCHINSON, The Royal Society
WALTON NIXON, Director, U. S. AID Mission, Lagos

### United States Participants

HARRISON BROWN, Foreign Secretary, National Academy of Sciences
C. W. DE KIEWIET, American Council on Education
WILLIAM O. JONES, Food Research Institute, Stanford University
FREDERICK C. LINDVALL, Engineering, California Institute of Technology
JOHN J. McKELVEY, JR., Agriculture, Rockefeller Foundation
EDWIN S. MUNGER, Geography, California Institute of Technology
W. M. MYERS, Agriculture, Rockefeller Foundation
LINCOLN R. PAGE, U. S. Geological Survey
FREDERICK D. PATTERSON, Phelps-Stokes Fund
HAROLD E. THOMAS, U. S. Geological Survey, Menlo Park
THOMAS H. WELLER, Tropical Public Health, Harvard University

ZAIRE (former Democratic Republic of the Congo)

ROLE OF SCIENCE AND TECHNOLOGY IN THE ECONOMIC DEVELOPMENT OF THE CONGO DURING THE 1970'S, Kinshasa, June 7-11, 1971

Zairois Participants

JOSEPH ILEO, Chairman, President, Office Nationale de la Recherche et du Developpement (ONRD)
P. ANTUN, Minerals and Geology, Lovanium University
CHRISTIAN BAJIKA, Official University of the Congo, Lumumbashi
GEORGE BAZA, Economics, Lovanium University
A. DE BONT, Biology, Lovanium University
J. DEHASSE, Counselor, Ministry of Education
EMMANUEL DJEMBI, Chemistry and Agricultural Industries, Free University of the Congo
EDMOND FALLAH, Center for Industrial Research in Central Africa (CRIAC)
N. GERLAGH, Agriculture, Free University of the Congo
N. HERNU, Center for Industrial Research in Central Africa
S. KABEYA, Institute for Scientific Research in Central Africa
F. KAMA, Counselor to the President
P. KUNDA, Electrical Engineer, National Electricity Corporation
P. KUNKEL, Institute for Scientific Research in Central Africa
N. LOMA, Ministry of Agriculture
HUBERT LUKINDA, Ministry of Education
A. MALANDA, Office Nationale de la Recherche et du Developpement
FELIX MALU, Applied Sciences, Lovanium University
A. MBURANUMWE, National Congolese Institute for the Conservation of Nature
JONAS MUILAMBWE, Ministry of Education
LEONARD MUKENDI, Secretary General, Ministry of Agriculture
N. MUTETA, Official University of the Congo
M. NORRO, Economics and Social Sciences, Lovanium University
LEON PHAKA, Counselor, Ministry of Social Affairs
A. REYNS, Lovanium University
M. SNELL, National Electricity Corporation
J. J. SYMOENS, Official University of the Congo
N. TAKIZALA, Assistant General Delegate, ONRD
M. TSHIUNZA, Researcher, ONRD
WALTER VAN PEE, Agriculture, Lovanium University
J. VERSCHUREN, Director General, Congo Institute for the Conservation of Nature (INCCN)
S. VIEUX, Counselor for Public Affairs
J. ZAKRZEWSKI, Lovanium University

United States Participants

HARRISON BROWN, Foreign Secretary, National Academy of Sciences
CARL DJERASSI, Chairman, Chemistry, Stanford University
JOHN J. McKELVEY, JR., Vice Chairman, Agriculture, The Rockefeller Foundation
JAMES CARTER, Pediatrics and Nutrition, Vanderbilt University
PAUL DYBCZAK, Dean of Engineering, Tuskegee Institute
CARL K. EICHER, Agricultural Economics, Michigan State University
J. DAVID LOCKARD, Botany, University of Maryland
ERNST R. PARISER, Nutrition and Food Science, Massachusetts Institute of Technology
WILLIAM M. RIDEOUT, JR., Education, Florida State University
ROBERT WEST, Fletcher School of Law and Diplomacy, Tufts University

U. S.-ZAIRE JOINT STUDY GROUP ON DEMOGRAPHIC TRAINING AND RESEARCH IN THE REPUBLIC OF ZAIRE, 1972

Zairois Participants

ADOLPHE NZEZA, Chairman, Director General of National Institute of Statistics (ONRD)
JOSEPH BOUTE, Statistics, University of Zaire
RENE KERSAUZE, Statistics, Ministry of Health
FRANCOIS KIBULA KAPENGA, Administrator, Hospital Management
XAVIER LULANGA, Population, Ministry of Interior
DIDACE MATHINA, Demography, National Institute of Statistics (INS)
M. MUSANGU-LUBILANJI, Director and Planner, Ministry of National Education
PLACIDE MPOYI, Demographic Statistics, INS
PIERRE MVUMU, National Employment Services, Ministry of Labor
M. NKENDA-MPASI, Education Section, ONRD
M. NKONDI, Endemies Service, Ministry of Health
MICHEL NORRO, Economic and Financial Sciences, University of Zaire
M. NZAMU-KWERERA, Director, Planning Division, Ministry of National Education
EMMANUEL OKITO, Demographer, National Statistics Institute
GUSTAVE PAUWELS, Ministry of Interior
N. TAKIZALA, Education Section, ONRD

United States Participants

ANSLEY J. COALE, Chairman, Office of Population Research, Princeton University
JOHN C. CALDWELL, Demography, Australian National University, Canberra
ETIENNE VAN DE WALLE, Demography, University of California, Berkeley

U. S.-ZAIRE GEOLOGICAL TRAINING AND RESEARCH IN THE REPUBLIC OF ZAIRE, 1972

Zairois Participants

Z. BUTSANA, Coordinator, ONRD Secretariat
KABAMBA KANYAMA, Geology, ONRD Secretariat
KANSA-NKULA, Geology, ONRD Secretariat
MAYUBA-NAVUNGU, Geology, ONRD Secretariat
M. THANGOU, Geology, ONRD Secretariat

Resource Persons

PAUL ANTUN, National University of Zaire
DUEME-BONGELI, National Geographic Institute of Zaire
ALEXANDRE EGOROFF, Geology, Ministry of Mines
K. GRZYBOWSKI, National University of Zaire
M. KABOMBO, Geological Engineering, Ministry of Mines
KATANGA-TSHITENGE, Ministry of National Education
KAYEMBE MPUKULA, Geology, Ministry of Mines
I. KEESMAN, National University of Zaire
KISUMUNA NGUMBA, Geology Section, Ministry of Mines
LAURENT VEBEL, Geology, Ministry of Mines
MOKENDE WA NSANGA, National University of Zaire
MONGEKE LITIKZ, Ministry of Mines
S/LT. NGANDI ITOFELE, National Geographic Institute of Zaire

United States Participants

JOHN C. MAXWELL, Chairman, Geological Science, University of Texas
RANDOLPH W. BROMERY, Chancellor and Professor of Geophysics, University of Massachusetts
FRANK C. CANNEY, Exploration Research, U.S. Geological Survey, Denver
MACK GIPSON, JR., Geological Sciences, Virginia State College
LINCOLN R. PAGE, Environmental Geology, U.S. Geological Survey, Boston

# ASIA

## INDIA

### INDO-U. S. WORKSHOP ON THE MANAGEMENT AND ORGANIZATION OF INDUSTRIAL RESEARCH, Baroda, March 2-6, 1970

#### United States Participants

F. K. BURR, Fabric Research Laboratories, Inc.
T. P. CARNEY, Research and Development, G. D. Searle and Co.
H. GERSHINOWITZ, Affiliate Faculty of Rockefeller University
L. H. HATTERY, Government and Public Administration, American University
H. HOELSCHER, Dean, School of Engineering, Pittsburgh University
V. D. LUDINGTON, Director, General Foods Corporation
M. R. McCORKLE, Armour Industrial Chemical Co.
B. S. OLD, Sr. Vice President, Arthur D. Little, Inc.
G. F. TAPE, President, Affiliated Universities, Inc.
G. K. TEAL, Vice President and Chief Scientist, Texas Instruments, Inc.

#### Observers

JAMES CLINTON, USAID Mission, New Delhi
NORMAN DAHL, The Ford Foundation, New Delhi
D. FULLER, Science Attache, U. S. Embassy
G. S. HAMMOND, USAID Mission, New Delhi
WARD MOREHOUSE, Administrative Staff College of India
GLENN SCHWEITZER, Office of Science and Technology, AID/Washington

#### Indian Participants

A. H. AMIN, Director - Research, Alembic Chemical Works, Ltd.
N. B. AMIN, Chairman and Managing Director, Jyoti Limited
DR. ASUNDI, Sr. Vice President, National Institute of Sciences of India (NISI)
N. B. BHATT, Scientific Advisor, Jyoti Limited
K. R. CHAKRAVORTY, Fertilizer Corporation of India
C. J. DADACHANJI, National Organic Chemical Industries, Ltd.
B. R. DEOLALIKAR, Human Resources and Organisational Development
D. C. GAMI, Gujarat State Fertilizers Corporation, Ltd.
R. R. HATTIANGADI, Associated Cement Companies, Ltd.
A. G. JHINGRAN, National Institute of Sciences of India
B. D. KALELKAR, Director General, Technical Development, Govt. of India
J. C. KAPUR, Larsen and Toubro, Ltd.

LAVRAJ KUMAR, Ministry of Petroleum and Chemicals
P. C. MEHTA, Ahmedabad Textile Industry's Research Association
R. P. MHATRE, Indian Institute of Technology
S. L. MUKHERJEE, Calico Chemicals and Plastics
S. MULL, National Institute of Sciences of India
N. R. NADKARNI, Director, Sarabhai Research Centre
B. D. NAGCHAUDHURI, Member, Planning Commission
B. K. NAIR, Council of Scientific and Industrial Research (CSIR)
V. G. PARANJPE, Director of Research, Tata Iron and Steel Co., Ltd.
M. S. PATHAK, Chairman, Engineers India, Ltd.
V. RAJADHYAKSHA, Chairman, Hindustan Lever Limited
M. RAMAKRISHNAYYA, Ministry of Petroleum & Chemicals
A. S. RAO, Managing Director, Electronic Corporation of India, Ltd.
GAUTAM SARABHAI, Chairman, Sarabhai Technological Development
SUHRID SARABHAI, Sarabhai Technological Development
A. SEETHARAMIAH, Sr. Advisor, Director General, Technical Development
SHIVANAND SHAH, Director, Aniline Dyestuff & Chemicals, Ltd.
AMARJIT SINGH, Director, Central Electronics Engineering Research Institute
GURPREET SINGH, Managing Director, Continental Devices Ltd.
JAGJIT SINGH, Chairman, Indian Drugs and Pharmaceuticals Ltd.
V. SRINIVASAN, Director, Sarabhai Research Centre
B. D. TILAK, Director, National Chemical Laboratory
G. R. TOSHNIWAL, Chairman, Toshniwal Brothers (P) Ltd.
M. J. THIRUMALACHAR, Superintendent, Research Hindustan Antibiotics, Ltd.
D. M. TRIVEDI, Project Manager, Synthetics and Chemicals, Ltd.
S. VARADARAJAN, Research Director, Hindustan Lever Research Centre
B. H. WADIA, Semiconductors, Ltd.
G. R. S. RAO, Technical Director, Telerad Pvt. Ltd.

WORKSHOP ON "WATER IN MAN'S LIFE IN INDIA," New Delhi, September 13-17, 1971

United States Participants

ROGER REVELLE, Chairman, Director, Center for Population Studies, Harvard
MARTIN ALEXANDER, Agriculture and Water Resources, Cornell University
JOHN C. GEYER, Environmental Engineering, Johns Hopkins University
PAUL H. JONES, Water Resources Division, U. S. Geological Survey

THOMAS MADDOCK, JR., Water Resources Division, U. S. Geological Survey
PERRY L. McCARTY, Environmental Engineering, Stanford University
DAVID PIMENTEL, Insect Ecology, Cornell University
DONALD W. PRITCHARD, Chesapeake Bay Institute, Johns Hopkins University
GERARD A. ROHLICH, Water Resources Center, University of Wisconsin
ROBERT L. SMITH, Civil Engineering, University of Kansas
HAROLD A. THOMAS, Civil and Sanitary Engineering, Harvard University
NATHANIEL WOLLMAN, Economics, University of New Mexico

Indian Participants

P. G. ADYALKAR, Groundwater Division, Geological Survey of India
P. R. AHUJA, Chairman, Tungbhadra Board, Ministry of Irrigation and Power
R. ANANTHAKRISHNAN, Indian Institute of Tropical Meteorology
S. C. AWASTHI, Geological Survey of India
P. S. HARIHARA AYYAR, Director, Hydrometeorology
S. BANERJI, Council of Scientific and Industrial Research
B. K. BAWEJA, Director, Geological Survey of India
T. R. BHASKARAN, Technical Adviser, George Miller and Co. Pvt., Ltd.
O. P. CHADHA, Chief, Irrigation, Yojana Bhavan
R. N. CHAKRABARTY, Principal Engineer, George Miller and Co. Pvt., Ltd.
R. B. CHAKRAVARTY, Director, Metropolitan Water and Sanitation Authority
S. K. CHANDRA, Geology, Nehru University
G. P. CHATTERJEE, Hindustan Steel, Ltd.
M. C. CHATURVEDI, Senior Professor, Indian Institute of Technology
J. M. DAVE, Ministry of Health and Family Planning
J. D'CRUZ, Water Supply and Sewage Disposal Undertaking
H. J. DESAI, Director, Central Water and Power Commission
M. V. DESAI, Adviser, Planning Commission
D. S. DESHMUKH, Director, Geological Survey of India
G. P. DUBEY, Director, Fisheries
T. DURAIRAJ, Deputy Adviser, Ministry of Health and Family Planning
GAJENDRA GADAKER, Victoria Jubilee Technical Institute
S. V. GANAPATI, Principal Investigator, M. S. University
O. P. GARG, Ganga Basin Water Resources Organization
R. S. HAMSAGAR, General Manager, Hindustan Insecticides, Limited
J. K. JAIN, Joint Commissioner to Government of India
M. N. JAIN, Chief Engineer, Water Supply and Sewage Disposal Undertaking

V. G. JHINGRAN, Director, Central Inland Fisheries Research Institute
I. P. KAPILA, Secretary, Central Board of Irrigation and Power
G. N. KATHPALIA, Director (Irrigation) Planning Commission
A. J. KIDWAI, Additional Secretary, Department of Science and Technology
V. C. KULANDAISWAMY, College of Engineering, Guindy
C. V. KURIAN, Marine Biology & Oceanography, Ernakulam
A. MOHAL LAL, Chairman, Delhi Milk Scheme, Government of India
U. N. MAHIDA, Member of Parliament
N. MAJ MDAR, India Institute of Hygiene and Public Health
B. L. MARWAHA, Project Officer, Delhi Administration
P. KESAVA MENON, Director, Joint Cipher Bureau
R. C. MISRA, Head of the Department of Geology, Lucknow
A. N. MITRA, Professor of Physics, University of Delhi
G. J. MOHANRAO, Central Public Health Engineering Research Institute
K. S. S. MURTHY, Member Secretary, Irrigation Commission
N. G. K. MURTI, Water and Power Development Consultancy Services of India
J. P. NAEGAMVALA, Member, Central Water and Power Commission
P. NATARAJAN, Indian Institute of Technology
T. K. NATARAJAN, Central Road Research Institute
B. N. NIYOGI, Geologist (Senior), Geological Survey of India
K. PAHADIA, OSD Insecticides, Ministry of Agriculture
PITAMBAR PANT, Chairman, Committee on Human Environment
T. K. PARTHASARTHY, Editor, Central Health Education Bureau
B. D. PATHAK, Geological Survey of India
N. N. PILLAI, Punjab Engineering College, Chandigarh
S. C. PILLAI, Biochemistry, Indian Institute of Technology
MATA PRASAD, F.N.A., Ex. Vice-Chancellor, Vikram University
K. D. PURI, D.C.M. Chemical Works
DR. RAMA, Tata Institute of Fundamental Research
V. RAMAKRISHNA, Regional Adviser in Health Education, WHO
K. R. RAMANATHAN, Professor, Physical Research Laboratory
C. RMASWAMY, Ex-Director General of Observatories
L. A. RAMDAS, F.N.A. Scientist Emeritus
N. A. RAMIAH, Deputy Secretary, Sugar Industry Enquiry Commission
S. RANGASWAMI, Chemistry, University of Delhi
A. V. S. PRABHAKARA RAO, Indian Institute of Technology
N. U. RAO, Central Public Health Engineering Institute
K. V. RAGHAVA RAO, Central Ground Water Board, Ministry of Agriculture
T. RAMACHANDRA RAO, Indian Council of Medical Research
K. V. SREENIVASA RAO, Water Resources, Central Water Power Commission
KAMLESH RAY, Council of Scientific and Industrial Research
STAYA PRASAD RAYCHAUDHURI, Chief Agronomist, Shriram Khad Programme

A. K. ROY, Chief Engineer, Local Self-Government Engineering Department
A. K. ROY, Director, Geological Survey of India
T. C. ROY, Director, Farm Information, Directorate of Extension
H. RUDRASWAMY, Senior Civil Engineer, Synthetic Drug Township
N. K. SAHA, Physics, University of Delhi
PURAN SINGH SANGWAN, National Commission on Agriculture
K. SEETHRAMIAH, Civil and Hydraulic Engineering, Indian Institute of Science
B. R. SESHACHAR, President, Indian National Science Academy
B. R. SETH, Mathematics, Indian Institute of Technology
T. D. SETH, Industrial Toxicology Research Centre
JAGJIT SINGH, Indian Drugs and Pharmaceutical, Ltd.
SARANJIT SINGH, Indian Institute of Technology
M. M. SINGHVI, Executive Engineer, R.W.S.S. (Health), Jaipur
SUBRATA SINHA, Geologist (Senior), Geological Survey of India, Calcutta
V. SUBRAMANYAM, Deputy Director General, Geological Survey of India
V. K. SUD, D.C.M. Chemical Works
R. K. SUNDARAM, Director, International Wing, Geological Survey of India
K. R. SWAMINATHAN, Indian Agricultural Research Institute
B. L. TANEJA, Indian Academy of Medical Sciences
PARITOSH C. TYAGI, Joint Director, Planning Commission
DR. UNAKUL, Regional Adviser in Environmental Health, WHO
B. P. VARMA, Planning and Development (Water Supply), Delhi Administration
C. K. VARSHNEY, Planning Commission
K. VENUGOPAL, Mineralogist, National Council of Applied Economic Research
B. L. WATTAL, Deputy Director, National Institute of Communicable Diseases

INDONESIA

INDONESIA-U.S. WORKSHOP ON FOOD, Djakarta, May 1968

Indonesian Participants

SALEH AFIFF, Agriculture, National Development Planning Board
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## PHILIPPINES

### PHILIPPINES-U.S. WORKSHOP ON SCIENTIFIC AND TECHNOLOGICAL COOPERATION AND DEVELOPMENT, Manila, November 22-26, 1965

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SECOND U.S.-PHILIPPINES WORKSHOP ON COOPERATION IN SCIENCE AND TECHNOLOGY, Asilomar, California, November 6-10, 1966

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PATSY McLAUGHLIN, Oceanographic Sorting Center, Smithsonian Institution
MARIO MANANSALA, Bureau of Coast & Geodetic Survey
JUSTO MONTEMAYOR, Philippine Fisheries Commission
GEORGE C. PARMAN, Director, Food from the Sea, AID
NICHOLAS R. PELLICANI, Vice President, Marine Colloids, Inc.
SANTOS RASALAN, Deputy Commissioner, Philippine Fisheries Commission
IGNACIO SALCEDO, Mapua Institute of Technology

LUCIAN M. SPRAGUE, Medical and Natural Sciences, The Rockefeller Foundation
JOSÉ SULIT, Araneta University
DOMINGO TAPIADOR, Deputy Commissioner, Philippine Fisheries Commission
PETER WILSON, Fisheries Management Biologist, Trust Territory of the Pacific Islands

Philippine Consultants

JOSÉ S. DOMANTAY, National Research Council
EINAR KVRAN, UNSF Deep-Sea Fishing Development Project, Philippine Fisheries Commission
MACARIO PALO, National Institute of Science and Technology
CARL TOLMAN, Institute of Applied Geology
DEOGRACIAS V. VILLADOLID, National Research Council

PHILIPPINES-U.S. WORKSHOP ON INDUSTRIAL RESEARCH, Baguio City, January 26 - February 1, 1969

Philippine Participants

JUAN SALCEDO, JR., Chairman, National Science Development Board
EMILIO ABELLO, Chairman, Council for Economic Development
HELENA BENITEZ, Vice-Chairman, Committee on the Advancement of Science and Technology, Philippine Senate
JESUS CABARRUS, SR., Chairman and President, Marinduque Mining and Industrial Corporation
MODESTO CHUA, Chemistry, Ateneo de Manila University
AMANDO CLEMENTE, Chairman, Division of Engineering and Industrial Research, National Research Council
JORGE G. DAVIDE, Esso Standard Fertilizer and Agricultural Chemical Company
CENON FLORCRUZ, Deputy General Manager, Philippine Sugar Institute
VICTOR GUEVARA, General Manager, Mabuhay Vinyl Corporation
JAIME LAYA, Finance and Development, University of the Philippines
VICTOR LIM, President, Philippine Chamber of Industries
THOMAS McHALE, Executive Vice President, Victorias Milling Company
AURELIO MONTINOLA, JR., President, Republic Cement Corporation
IGNACIO PABLO, Director, Philippine Institute of Nutrition, Philippine Women's University

EMMANUEL PELAEZ, Chairman, Committee on the Advancement of Science and Technology, Philippine Senate
SIXTO K. ROXAS, President, Economic Development Foundation, Inc.
DANTE SANTOS, President, Philippine Appliance Corporation
DAVID SYCIP, Vice Chairman, Council for Economic Development
FLORENCIO TAMESIS, General Manager, Nasipit Lumber Co. Inc.
GERONIMO VELASCO, President, Dole Philippines, Inc.
CESAR VIRATA, Chairman, Board of Investments
MANUEL YLANAN, Proctor and Gamble Philippine Manufacturing Corporation
LORENZO P. ZIALCITA, JR., The San Miguel Corporation

United States Participants

SEYMOUR W. HERWALD, Chairman, Vice President-Engineering, Westinghouse Electric Corporation
RICHARD T. ARNOLD, Chemistry, Southern Illinois University
HOWARD E. BAUMAN, Director of Corporate Research, Pillsbury Company
E. FINLEY CARTER, President (retired), Stanford Research Institute
ROBERT L. HERSHEY, Vice President (retired), E.I. DuPont de Nemours and Company
JAMES H. INGERSOLL, Vice President-Marketing, Borg Warner Corporation
WILLIAM A. W. KREBS, Vice President, Arthur D. Little, Inc.
JOSEPH M. PETTIT, Dean, Engineering School, Stanford University
N. ALLEN RILEY, Executive Vice President, Chevron Oil Field Research Company
JOHN A. SWARTOUT, Vice President, Union Carbide Company

Observers

CLARK C. BLOOM, Representative, The Ford Foundation
FRED EGGAN, Anthropology, University of Chicago
WILLIAM D. EVANS, Representative, The Asia Foundation
LUCIEN A. GREGG, The Rockefeller Foundation
WESLEY C. HARALDSON, Director, USAID Mission
DONALD KREISBERG, Science Liaison Officer, U.S. Embassy
CONRADO LOTHO, Industrial Research Center, National Institute of Science and Technology, NSDB
GUILLERMINA MAÑALAC, Industrial Research Center, National Institute of Science and Technology, NSDB
G. W. POTTS, General Manager, Esso Standard Eastern, Inc.

PHILIP W. RUPPERT, Office of Industrial Development, AID
ORLANDO YAP, Techno-Economics Staff, National Institute of Science and Technology, NSDB
FLAVIANO YENKO, Deputy Commissioner, National Institute of Science and Technology, NSDB

Resource Persons

PEDRO G. AFABLE, Commissioner, Philippine Atomic Energy Commission
GERARDO L. AQUINO, Assistant Vice President for Product Research, Commonwealth Foods, Inc.
ANTONIO C. ARIZABAL, Metals Industry Development Center
RODOLFO CASIPLE, Associate Director, Industrial Research Center, U.P.
DOMINADOR G. FAUSTINO, Industrial Investigation Division, Forest Product Research Institute
RUBEN GÓMEZ, Special Assistant of Senator Helena Benitez, Philippine Senate
LEONARDO JAVIER, Republic Cement Corporation
AMANDO KAPAUAN, Chemistry, Ateneo de Manila University
JESUS NATONTON, Assistant Field Manager, Nasipit Lumber Company, Inc.
PERRY ONSTOT, Vice President for Marketing, Esso Standard Fertilizer and Agricultural Chemical Company, Inc. (Phil.)
LUCAS PAREDES, Technical Consultant, Cement Association of the Philippines
MARIANO RAMIRO, Chief National Planner, NEC
JOSÉ VELASCO, Commissioner, National Institute of Science and Technology

## REPUBLIC OF CHINA (TAIWAN)

FIRST JOINT MEETING, SINO-AMERICAN SCIENCE COOPERATION PROGRAM, Nankang, April 14-20, 1964

### Chinese Participants

SHIH-CHIEH WANG, Chairman, President, Academia Sinica
SHIH-LIANG CHIEN, Vice Chairman, President, National Taiwan University
K. T. LI, Vice Chairman, Council for International Economic Cooperation and Development (CIECD)
KO-CHUNG CHEN, Acting President, National Tsing Hua University
HUI HSIEH, Director, Union Industrial Research Institute
VEICHOW C. JUAN, Director General, Academia Sinica
S. M. LEE, Electronic Research Institute, Chiao-tung University
CHI LI, Director, Institute of History & Philology
HSIEN-WEN LI, Director, Institute of Botany, Academia Sinica
HUNG-HSUN LING, Chairman, Chinese Petroleum Corporation
Y. S. TSIANG, Commissioner, Joint Commission for Rural Reconstruction (JCRR)
HUO-YAO WEI, Dean, College of Medicine, National Taiwan University
C. C. YAO, Vice Minister, Ministry of Education
CHEN-HSING YEN, President, Cheng Kung University

### United States Participants

WALTER G. WHITMAN, Chairman, Professor Emeritus, MIT
H. BURR STEINBACH, Zoology, University of Chicago
M. H. TRYTTEN, Director, Office of Scientific Personnel, NAS

#### Consultants

WOLFRAM EBERHARD, Sociology, University of California
ARTHUR R. ECKELS, North Carolina State College
ROBERT A. PHILLIPS, Director, Naval Medical Research Unit No. 2, Taipei

#### Observer

EDGAR N. PIKE, Representative, The Asia Foundation

SECOND JOINT MEETING, SINO-AMERICAN SCIENCE COOPERATION PROGRAM, Washington, D. C., February 23-27, 1965

Chinese Participants

SHIH-LIANG CHIEN, Chairman, President, National Taiwan University
LU-CHENG HAO, Secretary, Vice President, China Petroleum Corporation
CHI LI, Director, Institute of History and Philology, Academia Sinica
HSIEN-WEN LI, Director, Institute of Botany, Academia Sinica
TA-YOU WU, Physics, State University of New York, Albany
CHEN-HSING YEN, President, Cheng Kung University

United States Participants

JOSEPH B. PLATT, Chairman, President, Harvey Mudd College
HARRY C. KELLY, Physics, North Carolina State University
GEORGE P. MURDOCK, Anthropology, University of Pennsylvania
R. A. PHILLIPS, Physiology, U.S. Navy
H. BURR STEINBACH, Zoology, University of Chicago
M. H. TRYTTEN, Director, Office of Scientific Personnel, NAS

THIRD JOINT SINO-AMERICAN SCIENCE COOPERATION PROGRAM, Washington, D. C., April 5-7, 1967

Chinese Participants

SHIH-CHIEH WANG, Chairman, President, Academia Sinica
SHIH-LIANG CHIEN, President, National Taiwan University
PAUL L. C. HAO, Secretary, Vice President, China Petroleum Corporation
HSIEN-WEN LI, Director, Institute of Biology, Academia Sinica
TA-YOU WU, Physics, State University of New York, Buffalo

United States Participants

JOSEPH B. PLATT, Chairman, President, Harvey Mudd College
HARRISON S. BROWN, Foreign Secretary, NAS
RALPH E. CLELAND, Botany, Indiana University
H. BURR STEINBACH, Zoology, University of Chicago
M. H. TRYTTEN, Director, Office of Scientific Personnel, NAS
I. EUGENE WALLEN, Oceanography and limnology, Smithsonian Institution

Graduate Center Directors and U.S. Advisors

LAN-JEN CHU, Electrical Engineering, Massachusetts Institute of Technology
LIANG-HSI CHU, Director, Engineering Sciences Research Center
YI-YUN HSU, Lewis Laboratory, National Aeronautics and Space Administration, Cleveland
PIEN-CHIEN HUANG, Biochemistry, Johns Hopkins University
YUAN-LIANG KU, Director, Agricultural Research Center, Taiwan
SHING-MENG LEE, Director, Mathematics Research Center, Taiwan
YEE-YEN LEE, Acting Director, Physics Research Center, Taiwan
WEI-CHUAN LIN, Director, Chemistry Research Center, Taiwan
W. Y. PAN, Chinese Institute of Engineers, New York
CHANG-LIN TIEN, Mechanical Engineering, University of California, Berkeley
T. C. TSAO, Chinese Institute of Engineers, New York

Other Guests

JOSIAH W. BENNETT, Bureau of East Asian and Pacific Affairs, Department of State
NAI-WEI CHANG, Cultural Counselor, Embassy of the Republic of China
ANN CORWIN, Public Information, NAS
CHO-YUN HSU, History, National Taiwan University
CLARE E. HUMPHREY, The Asia Foundation
ALFRED JENKINS, National Security Council Staff
JOSEPH P. KOZLOWSKI, Economic and Manpower Studies, NSF
HERBERT H. P. MA, School of Law, National Taiwan University
COLIN MACLEOD, Vice President, The Commonwealth Fund
ANDRE E. RHEAULT, Education and World Affairs
EUGENE SKOLNIKOFF, Political Science, Massachusetts Institute of Technology
WILLIAM H. TAFT, III, International Scientific and Technological Affairs, Department of State
ROY WALD, International Scientific and Technological Affairs, Department of State
CHI-WU WANG, Secretary to the Delegation
ALAN T. WATERMAN, Special Consultant to the President, NAS
DONALD M. WEINROTH, Weinroth Associates, Inc.
JOHN D. WILKES, Science Director, Office of Technical Cooperation and Research, AID
MARTIN WONG, Economic Counselor, Embassy of the Republic of China
SHIH-YING WOO, Minister, Embassy of the Republic of China
HAROLD K. WORK, Secretary, NAE

FOURTH JOINT SINO-AMERICAN SCIENCE COOPERATION PROGRAM (WORKSHOP ON THE INDUSTRIAL DEVELOPMENT OF TAIWAN: SCIENCE, TECHNOLOGY AND MANAGEMENT), Taipei, August 26-30, 1968

Chinese Participants

SHIH-CHIEH WANG, Chairman, President, Academia Sinica
SHIH-LIANG CHIEN, Vice Chairman, President, National Taiwan University
K. T. LI, Vice Chairman, Council for International Economic Cooperation and Development (CIECD)
R. W. BELT, Representative, International Executive Service Corps
KUANG-SHIH CHANG, Vice President, Chinese Petroleum Corporation
MING-CHE CHANG, Chairman, Industrial Research Council, Ministry of Economic Affairs
KO-CHUNG CHEN, President, National Tsinghua University
VICTOR C. H. CHENG, Executive Secretary, Atomic Energy Research Institute
SHIH-CHI CHI, General Manager, Metal Industry Development Center
TSU-NIEN CHIN, College of Engineering, National Taiwan University
KOW-KWONG CHOONG, College of Engineering, National Chiaotung University
CHANG CHOW, Administration and Management, Fu Jen University
LAN-JEN CHU, Engineering Sciences Research Center
SUNG-YANG DAO, Co-Chairman, Secretary General, CIECD
JOHN Y. FUNG, President, Wang Laboratory
PAUL L. C. HAO, Executive Secretary, China Committee on Sino-American Science Cooperation
SI-CHIN KAO, General Manager, China Productivity and Trade Center
KAI-YING KING, Chairman, Board of Directors, China Productivity and Trade Center
FENG-JANG LEU, General Manager, Hualoon Textile Corporation
KUN-HOU LI, Chairman, Board of Directors, Taiwan Atlas Corporation
TING-SHENG LIN, President, Tatung Engineering Corporation
YUN-PIN LO, President, Provincial Cheng Kung University
CHIH-LIN LOH, Plant Production, JCRR
CHAO-FENG MIAO, Electronic Industry, CIECD
J. H. MOORE, Engineering Advisor, CIECD
ROBERT B. SHEEKS, President, East West Computer Corporation
TSU-HSIN SHEN, Vice President, USI Far East Corporation
CHING-HWA SUN, Institute of Chinese Mining & Metallurgical Engineers

CHANG-MOU TIEN, Committee for Science Development (NSC)
WILLINGTON Y. W. TSAO, CIECD
TUNG TSENG, Director, Food Research Institute
YIEN-SI TSIANG, Vice Chairman, Committee for Science Development, NSC
TSU-KAI TSUI, CIECD
TA-YOU WU, Chairman, Committee for Science Development National Security Council (NSC)
TSU-PING WU, President, Taiwan Pulp and Paper Corporation
CHEN-HSING YEN, Minister of Education
HUNG-CHIEN YUAN, Director, Union Industrial Research Institute, Ministry of Economic Affairs

Observer

CLARE E. HUMPHREY, Representative, Asia Foundation, Taipei

United States Participants

BRUCE H. BILLINGS, Co-Chairman, Special Assistant for Science and Technology to the U.S. Ambassador, Taiwan
JOSEPH B. PLATT, Co-Chairman, President, Harvey Mudd College
RAY HAROLD BOUNDY, Vice-President (retired), Dow Chemical Company
ROBERT WILLIAM BUCHHEIM, North American Rockwell Corporation
ARTHUR BUSH, Energy Studies, Detroit Edison Company
MICHAEL FERENCE JR., Vice-President, Ford Motor Company
GEORGE RICHARD HERBERT, President, Research Triangle Institute
WILLIAM A. W. KREBS, Vice-President, Arthur D. Little, Inc.
LELAND S. LIANG, President, Textile Marketing Associates
BOR SHIUN LUH, Food Technology, University of California, Davis
GLENN ALBERT NESTY, Vice-President, Allied Chemical Corporation
GEORGE C. SPONSLER, Executive Secretary, Division of Engineering, National Academy of Sciences (NAS)
C. EUGENE SUNDERLIN, Special Assistant to President, NAS
DEAN ALLEN WATKINS, Chairman, Watkins-Johnson Company

Observers

PHILIP W. RUPERT, Industrial Officer, AID, Manila
EUGENE SULLIVAN, AID Advisor to Ministry of Industry, Thailand

FIFTH JOINT MEETING, SINO-AMERICAN SCIENCE COOPERATION PROGRAM, Washington, D. C., October 27, 1969

Chinese Participants

SHIH-CHIEH WANG, Chairman, President, Academia Sinica
TA-YOU WU, Chairman, National Science Council

United States Participants

BRUCE H. BILLINGS, Special Assistant for Science and Technology to the U.S. Ambassador, Taiwan
JOSEPH B. PLATT, President, Harvey Mudd College

SIXTH JOINT MEETING, SINO-AMERICAN SCIENCE COOPERATION PROGRAM (COLLOQUIUM ON OCEAN RESOURCES), Taipei, April 28 - May 6, 1971

Chinese Participants

TSU-YOU CHU, Chairman, Director, Institute of Oceanography, National Taiwan University (IONTU)

Marine Geology and Geophysics

CHING-CHANG BIQ, Director, Taiwan Geological Survey
LI-CHO CHANG, Senior Geologist, Taiwan Geological Survey
STANLEY S. L. CHANG, Geologist, Chinese Petroleum Corporation
CHIN CHEN, Visiting Scientist, IONTU
JU-CHIN CHEN, Geochemistry, IONTU
THOMAS W. C. HILDE, Visiting Scientist, IONTU
CHUN-SUN HO, Senior Geologist, Taiwan Geological Survey
P. T. HSIAO, Geologist, Chinese Petroleum Corporation
S. H. HSIEH, Geologist, Chinese Petroleum Corporation
CHIN-CHENG HU, Geologist, Chinese Petroleum Corporation
CHUN-KIANG HUANG, Chairman, Geology Department, NTU
VEICHOW C. JUAN, Geology, National Taiwan University (NTU)
CHAO-CHI LIN, Geology, NTU
TING-YING H. MA, Geology, NTU
C. Y. MENG, Chief Geologist, Chinese Petroleum Company
YUH-SHENG PAN, Geophysicist, Chinese Petroleum Company
YUAN WANG, Geology, NTU
T. P. YEN, Senior Geologist, Taiwan Geological Survey

Marine Biology and Fisheries

KUN-HSIUNG CHANG, Research Fellow, Institute of Zoology, Academia Sinica
TUNG-PAI CHEN, Chief, Fisheries Division, JCRR
YOUNG-MENG CHIANG, Research Fellow, Institute of Zoology, Academia Sinica
TSU-CHANG HUNG, Ecology, IONTU
YUN-SHENG LIANG, Zoology, NTU
I-CHIU LIAO, Director, Tungkang Marine Laboratory
HSI-CHIANG LIU, Marine Biology, NTU
Y. C. LIU, Chairman, Fisheries Development Committee, Ministry of Economic Affairs
SHIH-CHIEH SHEN, Fishery Biology, NTU
JONG-CHING SU, Director, Institute of Zoology, Academia Sinica
HUO-TU TENG, Director, Provincial Fisheries Research Institute
WEN-YOUNG TSENG, Specialist, Provincial Fisheries Research Institute
NGANSHOU WAI, Director, Institute of Chemistry, Academia Sinica
RONG-TSZONG YANG,Marine Biology, NTU
TAO-YI YAO, Head, Taiwan Provincial Fisheries Bureau
PO-WEI YUAN, Senior Specialist, Fisheries Division, JCRR

Sino-American Science Cooperation Committee (Republic of China)

WANG SHIH-CHIEH, Chairman, China Committee for Sino-American Science Cooperation
PAUL L. C. HAO, Director, Union Industrial Research Institute (UIRI)
K. T. LI, Minister of Finance
Y. S. TSIANG, Secretary General, Executive Yuan
CHI-WU WANG, Deputy Secretary-General, National Science Council
C. S. YEN, President, NTU

United States Participants

JOHN P. CRAVEN, Chairman, Marine Affairs, University of Hawaii
JOSEPH B. PLATT, President, Harvey Mudd College

Marine Geology and Physical Oceanography

KENNETH O. EMERY, Senior Scientist, Woods Hole Oceanographic Institute
M. GRANT GROSS, Marine Sciences, State University of New York at Stony Brook

P. KILHO PARK, Oceanography, National Science Foundation
FRANK F. H. WANG, Marine Geologist, U.S. Geological Survey, Menlo Park
WARREN S. WOOSTER, Scripps Institution of Oceanography, La Jolla

Marine Biology and Fisheries

WILLIAM I. ARON, Director, Oceanography & Limnology Program, Smithsonian Institution
JOHN E. BARDACH, Natural Resources, University of Michigan
HARVEY R. BULLIS, JR., National Marine Fisheries Service, Interior Department
LUCIUS ELDRIDGE, Marine Biology, University of Guam
RICHARD GRIGG, Marine Biology, Hawaii Institute of Marine Biology
ROBERT JONES, Marine Biology, University of Guam
IRA RUBINOFF, Zoology, Smithsonian Tropical Research Institute, Canal Zone
H. BURR STEINBACH, Zoology, Woods Hole Oceanographic Laboratory
I. EUGENE WALLEN, Environmental Sciences, Smithsonian Institution
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Observers

FRANK ALLEN, Geophysicist, Gulf Oil Company, Taiwan
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J. T. CHOW, Chinese Petroleum Corporation
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CHI-TSENG CHENG, Keelung Maritime College
CHUANG-TI CH'UEH, Joint Commission on Rural Reconstruction
ROBERT DONWOODY, Geophysicist, American Oil Company, Taiwan
T. T. FENG, Mining Research and Service Organization, Ministry of Economic Affairs
ARTHUR F. FINDEIS, National Science Foundation, Tokyo Office
ROBERT W. HIATT, Physical Science Officer, Department of State, American Embassy, Tokyo
T. L. HSU, Earth Sciences, Taiwan Provincial Cheng Kung University
T. Y. HUANG, Chinese Petroleum Corporation
CLARE E. HUMPHREY, Representative, Asia Foundation, Taipei
S. Y. JIN, Research and Development, Chinese Petroleum Corporation

ROBERT JOHNSTON, Geophysicist, Gulf Oil Company, Taiwan
ROBERT JONES, Director of Marine Laboratory, Guam University
WILLIAM A. W. KREBS, Vice President, Arthur D. Little, Inc.
SHIH-CHIEH KUAN, Institute of Oceanography, College of Chinese Culture
CH'ANG-LAI LEE, Keelung Maritime College
W. T. LI, Mining Research and Service Organization, Ministry of Economic Affairs
SHAO-WEN LIN, Food and Agriculture Organization
PEI-YIN LIU, Institute of Oceanography, NTU
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DAVID SHUMWAY, Institute of Oceanography, NTU
Y. K. TAI, Institute of Geophysics, National Central University
LI-PING T'AN, Institute of Geology, NTU
TEIN-HSI T'AN, Zoology and Fishery Biology, NTU
M. TOMINAGA, Institute of Oceanography, NTU
YIN-MING TSENG, Institute of Geology, NTU
W. S. TU, Geologist, Mining Research and Service Organization, Ministry of Economic Affairs
I-SHEW TUNG, Zoology and Fishery Biology, NTU
Y. C. TUNG, Board Member, Chinese Petroleum Corporation
CHE-MING WANG, Institute of Geology, NTU
NAI-TIM WANG, Institute of Geology, NTU
T. M. WU, Vice President, Chinese Petroleum Corporation
Y. F. YANG, Vice President, Chinese Petroleum Corporation
H. S. YAO, Chief Engineer, Chinese Petroleum Corporation
SHUN YAO, Director, Bureau of International Cultural and Education Relations, Ministry of Education

## THAILAND

### WORKSHOP ON SCIENCE PLANNING AND POLICY IN THAILAND, Bangkok, July 3-6, 1972

#### Thai Participants

##### Industry and Engineering

PAKORN ADULBHAN, System Engineering and Management Division, AIT, Bangkok
KASEM BALAJIVA, Applied Scientific Research Corporation of Thailand (ASRCT)
R. M. BELL, Science Policy Studies Unit, ASRCT
DECHA BOONCHOOCHAUY, Deputy Secretary-General, Office of the Board of Investment
CHAI MUKTABHANT, Engineering, Chulalongkorn University
PRAPRIT NA NAGARA, Department of Science, Ministry of Industry
CHAROON OONJITT, Technical and Planning Office, Ministry of National Development
VIRA OSATANANDA, Manpower Planning Division, National Economic Development Board
SUNT RACHDAWONG, Department of Mineral Resources, Ministry of National Development
BANCHA UDOMSAKDHI, Chemical and Technology Group, ASRCT

##### Natural Resources Utilization

CHUMNI BOONYOBHAS, Deputy Director, Division of Working Plan, Royal Forestry Department, Ministry of Agriculture
NIKOM CHANDRAVITHUN, Labor Administration, Thammasart University
BOON INDRAMBARYA, Environmental and Ecological Research Institute, ASRCT
NITIPAT JALICHAN, Secretary-General, National Energy Authority, Ministry of National Development
KAMHAENG SATHIRAKUL, Technical and Planning Office, Ministry of National Development
VIJA SETHAPUT, Under-Secretary of State, Ministry of National Development
PISOOT SUDASNA NA AYUTHYA, Department of Mineral Resources, Ministry of National Development
SANARM SUENSILPONG, Department of Mineral Resources, Ministry of National Development
SUTHEP TINSABHAT, Royal Irrigation Department, Ministry of National Development
SITTILARP VASUVAT, Land Development Department, Ministry of National Development

Agricultural Production

SIRIBONGSE BOON-LONG, Inspector-General, Ministry of Agriculture
RATH CHOLLUMPE, Vocational Education, Ministry of Education
NARONG CHOMCHALOW, Agricultural Products Research Institute, ASRCT
D. HISLOP, Science Policy Studies Unit, ASRCT
BUNJIRD KHATIKARN, Dean, Graduate School, Kasetsart University
BHAKDI LUSANANDANA, Department of Rice, Ministry of Agriculture
PHIT PANYALAKSHANA, Director-General, Ministry of Agriculture
CHUA WONGSONGSARN, Department of Livestock Development, Ministry of Agriculture

Medicine, Public Health and Environmental Quality

NATTH BHAMARAPRAVATI, Pathology, Ramathibodi Hospital, Mahidol University
CHAROEN CHAROENRAJAPARK, Meteorological Department, Prime Minister Office
PRAPHORN CHARUCHANDR, Sanitary Engineering Division, Ministry of Public Health
CHITT HEMACHUDHA, Ministry of Public Health
PRASERT LOHAVANIJAYA, Director, Center for Thai National Reference Collections, ASRCT
M. G. McGARRY, Environmental Engineering, AIT
COMMANDER DHAWEE MONTRIVADE, Meteorology Department, Prime Minister Office
AMORN NONDASUTA, Chief Medical Officer, Ministry of Public Health
JAJAVAL OSATHANONDH, Faculty of Social Sciences and Humanities, Mahidol University
TONGCHAI PAPASARATHORN, Dean, Faculty of Public Health, Mahidol University
SAMLEE PLIANBANGCHANG, Division of Health Training, Ministry of Public Health
YUTTANA SUKSAMITI, Director, Health Planning Division, Ministry of Public Health
DUSANEE SUTTAPRIYASRI, Faculty of Public Health, Mahidol University
PRAKORB TUCHINDA, Department of Medical Science, Ministry of Public Health
SAMAN VARDHANABHUTI, Director, Biotechnology Group, Technological Research Institute, ASRCT
PRAWASE WASI, Siriraj Hospital, Mahidol University
CHARAS YAMARAT, Director, Institute for Population and Social Research

Academic Sciences

RAWI BHAVILAI, Physics, Faculty of Science, Chulalongkorn University
VIROOL BOONYASOMBAT, Mathematics, Chulalongkorn University
HENRY R. GLYDE, Science Policy Studies Unit, ASRCT
SIPPANONDHA KETUDAT, Southeast Asian Ministers of Education Secretariat, (SEAMES)
PRASERT NA NAGARA, Deputy Rector of Academic Affairs, Kasetsart University
TAWEESUKDI PIYAKARNCHANA, Marine Science, Chulalongkorn University

United States Participants

Industry and Engineering

BREWSTER C. DENNY, Graduate School of Public Affairs, University of Washington
WILLIAM A. W. KREBS, Vice President, Arthur D. Little, Inc.

Natural Resource Utilization

HARRISON S. BROWN, Foreign Secretary of the National Academy of Sciences
WILLIAM LITTLEWOOD, Associate Director, Office of Science and Technology, AID, Washington

Agricultural Production

ALBERT H. MOSEMAN, Director, Malaysian Agricultural Research Development Institute, Kuala Lumpur, Malaysia

Medicine, Public Health and Environmental Quality

HOWARD A. MINNERS, National Institute of Allergy & Infectious Diseases, NIH
JOHN P. MILTON, Consultant, President's Advisory Panel on Timber & the Environment

Academic Sciences

ARNOLD B. GROBMAN, Dean, Rutgers College, Rutgers University
SIDNEY PASSMAN, Head, Science Policy Research Section,NSF

Observers

RONALD P. BLACK, Senior Systems Analyst, Stanford Research Institute
IRWIN H. BILLICK, UNESCO Adviser, Science Policy
GERARD R. BOWERS, Population Adviser, USOM
DAPT. PRAPAT CHANDAKET, Deputy Director, MRDC
TRITHEP LOHAWISAHANIT, Science Policy Studies Unit, ASRCT
JOSEPH O. MORGAN, Senior Research Physicist, Stanford Research Institute
JARUS D. MURRAY, Chief, Division of Vocational Education, USOM
WIT SATYARAKWIT, Science Policy Studies Unit, ASRCT
ROBERT N. SCHWARTZ, Director, ARPA R & D Center
LEONARD WOOD, OSD/ARAA Environmental Sciences, Military Research and Development Center
C. LEWIS WRENSHALL, UNIDO Project Manager, Technical Research Institute, ASRCT
YONGYUTH YUTHVONG, Biochemistry, Mahidol University
ROBERT F. ZIMMERMAN, Research Officer, USOM

# LATIN AMERICA

## ARGENTINA

### ARGENTINE-U.S. WORKSHOP ON SCIENCE AND TECHNOLOGY IN ECONOMIC DEVELOPMENT, Mar del Plata, July 28-August 1, 1969

#### Argentine Participants

BERNARDO A. HOUSSAY, Chairman, National Council of Scientific and Technical Research (CONICET)
RAUL LUIS CARDON, National Council of Science and Technology (CONACYT)
PEDRO J. CARRIQUIRIBORDE, Vice Chairman, CONICET
PEDRO CATTANEO, University of Buenos Aires
VANANCIO DEULOFEU, National Academy of Exact Physical and Natural Sciences
ERNESTO GALLONI, President, National Academy of Exact, Physical and Natural Sciences
JOSÉ S. GANDOLFO, National Academy of Exact, Physical and Natural Sciences
ANGEL MARZOCCA, National Agricultural Institute (INTA)
FRANCISCO GARCÍA OLANO, National Academy of Exact, Physical and Natural Sciences
JULIO H. G. OLIVERA, Economics, University of Buenos Aires

#### United States Participants

HARRISON BROWN, Foreign Secretary, National Academy of Sciences
C. WAYNE COOK, Range Science, Colorado State University
STANLEY N. DAVIS, Geology, University of Missouri
CARL DJERASSI, Chemistry, Stanford University
JOHN GREEN, Patents, Trademarks and Copyrights Research Institute, George Washington University
ALBERT G. HART, Economics, Columbia University
R. D. OWEN, Biology, California Institute of Technology
EDWARD SELTZER, Food Science, Rutgers University
ALFONSO WILSON, Water Resources Division, U.S. Geological Survey

#### Special Guests and Observers

##### United States

DELBERT FITCHETT, Center for Economic Research, Di Tella Foundation
STANLEY I. GRAND, USAID Affairs Officer
JOHN N. HALPIN, Food and Agricultural Officer, U. S. Embassy

WILLIAM J. LAWLESS, JR., IBM-World Trade Corporation, Montevideo, Uruguay
AMBASSADOR JOHN DAVIS LODGE, Embassy of the U.S.A., Buenos Aires
ANDRÉ SIMONPIETRI, Science Attaché, Embassy of the U.S.A.

Argentina

RODOLFO CARLOS ANTONISSEN, Faculty of Exact Physical and Natural Sciences, University of Buenos Aires
ING. GUIDO SALINGER BECKER, Chemical Engineering, Maize Refineries, S.A.
ING. AGR. JORGE BRUN, FAO/INTA Project for Sheep Production in Patagonia
ROBERTO COUTURE DE TROISMONTS, Director, Library of the National University of La Plata
IGNACIO O. GALLI, Co-director, FAO-INTA Project
ENRIQUE A. GIL, Agriculture, Catholic University of Mar del Plata
OSCAR RUIZ HUIDOBRO, Director, Department of Underground Water
EMILIO JÁUREGI, Director, Computer Center, University of Buenos Aires
GUILLERMO E. JOANDET, Agricultural Experiment Station of Balcárce, INTA
JORGE E. B. OSTROWSKI, Veterinary Medicine, University of Buenos Aires
ANTONIO J. PREGO, Program on Soil Conservation and Management, INTA
MANFREDO A. L. REICHART, Professor Emeritus, Agronomy and Veterinary Medicine, University of Buenos Aires
JOSÉ MARIA SALA, National University of La Plata
JUAN CLAUDIO SANAHUJA, Food Science and Experimental Nutrition, University of Buenos Aires
ALBERTO SORIANO, Plant Physiology and Geography, University of Buenos Aires
ALBERTO TAQUINI, Secretary, CONACYT
JORGE E. WRIGHT, Physical and Natural Sciences, University of Buenos Aires
MARINO J. R. ZAFFENELLA, National Institute of Agriculture and Technology

ARGENTINE-U.S. STUDY GROUP ON GROUNDWATER HYDROLOGY, 1970

STANLEY N. DAVIS, Chairman, Geology, University of Missouri
AMILCAR F. GALVAN, Hydrology, National Office of Geology and Mining
JOSÉ S. GANDOLFO, Chairman, CONICET
DR. OSCAR RUÍZ HUIDOBRO, Geology, University of Buenos Aires
JOHN D. WINSLOW, U.S. Geological Survey, Lawrence, Kansas

JOINT ARGENTINE-U.S. STUDY GROUP ON SCIENCE INFORMATION, 1970

JORGE COMIN, Organic Chemistry, University of Buenos Aires
MELVIN S. DAY, Chairman, Deputy Assistant Administrator for Technology Utilization, NASA
RICARDO A. GIETZ, Center of Scientific Documentation, CONICET
EMILIO H. JAUREGUI, Chairman, Computer Center, University of Buenos Aires
VERN M. PINGS, Kentucky-Ohio-Michigan Regional Medical Library, Wayne State Medical Library
FRED A. TATE, Assistant Director, Chemical Abstracts Service

JOINT ARGENTINE-U.S. STUDY GROUP ON FOOD TECHNOLOGY, 1971

HAROLD E. CALBERT, Dairy and Food Industries, University of Wisconsin
PEDRO CATTANEO, Chairman, Food Science, University of Buenos Aires
C. O. CHICHESTER, Chairman, Food and Resource Chemistry, University of Rhode Island
RODOLFO J. ERTOLA, Industrial Microbiology, University of La Plata
MARTIN W. MILLER, Food Science and Technology, University of California
GEORGE M. PIGOTT, Food Science, College of Fisheries, University of Washington
JUAN C. SANAHUJA, Food Science and Nutrition, University of Buenos Aires

BRAZIL

FIRST BRAZIL-U.S. WORKSHOP ON CONTRIBUTION OF SCIENCE AND TECHNOLOGY TO DEVELOPMENT, Itatiaia, April 11-16, 1966

Brazilian Participants

SYLVIO FROES ABREU, National Institute of Technology
ANNIBAL ALVES BASTOS, Geology, Ministry of Mines and Energy
ANTONIO MOREIRA COUCEIRO, President, Conselho Nacional de Pesquisas (CNPq)
OTACILIO CUNHA, President, Brazilian Physics Research Center
GERHARD JACOB, Physics, University of Rio Grande do Sul
ARISTIDES A. PACHECO LEÃO, Vice President, Brazilian Academy of Sciences
HERALDO SOUZA MATTOS, Ministry of Education and Culture
MANOEL FROTA MOREIRA, Conselho Nacional de Pesquisas
WALTER B. MORS, Centro de Pesquisas de Productos Naturais
WLADIMIR LOBATO PARAENSE, University of Belo Horizonte
JOSÉ R. ANDRADE RAMOS, National Department of Mineral Production (DNPM)
OSCAR SALA, University of São Paulo
HELIO ANTONIO SCARABOTOLO, Ministry of Foreign Relations
HENRIQUE CAPPER DE SOUZA, Ministry of Planning
GLAUCO PINTO VIEGAS, Agricultural Institute of Campinas

United States Participants

HARRISON BROWN, Foreign Secretary, National Academy of Sciences
CARL DJERASSI, Chemistry, Stanford University
W. D. JOHNSTON, JR., Staff Geologist, U.S. Geological Survey
RICHARD C. JORDAN, Mechanical Engineering, University of Minnesota
DIETER KOCH-WESER, Coordinator, Public Health, Harvard University
ROY L. LOVVORN, Agriculture and Life Sciences, North Carolina State University
FRANKLIN A. NEVA, Tropical Public Health, Harvard University
STEFAN H. ROBOCK, International Business Studies, Indiana University
CHARLES WAGLEY, Institute of Latin American Studies, Columbia University

Observers

JAMES ASPER, Assistant Scientific Attaché, United States Embassy
JOHN BAXTER, Ford Foundation, Rio de Janeiro
EUGENE CAMPBELL, Health, USAID Mission
ROSSON CARDWELL, Education, USAID Mission
WILLIAM ELLIS, USAID Deputy Mission Director
THOMAS HAZARD, JR., AID/Washington
RICHARD NEWBERG, Agriculture, USAID Mission
ANDRE SIMONPIETRI, Scientific Attaché, United States Embassy
STUART VAN DYKE, USAID Mission Director
MAX WHITE, U.S. Geological Survey, Rio de Janeiro

SECOND U.S.-BRAZIL WORKSHOP ON CONTRIBUTION OF SCIENCE AND TECHNOLOGY TO DEVELOPMENT, Washington, February 5-9, 1968

Brazilian Participants

ANIBAL ALVES BASTOS, Division of Geology, Ministry of Mines and Energy
AMADEU CURY, Director, Institute of Microbiology, Federal University of Rio de Janeiro
PAULO DE GOES, Scientific Attaché, Embassy of Brazil, Washington, D. C.
ARISTIDES A. PACHECO LEÃO, Acting President, Brazilian Academy of Sciences
MANOEL DA FROTA MOREIRA, Director, Technical-Scientific Department, CNPq
OSCAR SALA, Electrostatic Accelerator Laboratory, University of São Paulo
GLAUCO PINTO VIEGAS, Technical Director, Cargill Company

United States Participants

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WILLIAM D. JOHNSTON, JR., Staff Geologist, U.S. Geological Survey
RICHARD C. JORDAN, Mechanical and Aerospace Engineering, University of Minnesota
ROBERT KREIDLER, Vice President, Alfred P. Sloan Foundation
ROY L. LOVVORN, Director of Research, School of Agriculture and Life Sciences, North Carolina State University
ROGER REVELLE, Director, Center for Population Studies, Harvard University

ALBERTO OSPINA, Foundation for Educational Development, Bogota, Colombia
JESSE PERKINSON, Organization of American States
JOHN C. ROTHBERG, Office of Science and Technology, White House
JOHN K. ROULEAU, Department of State
RICHARD SCARFO, Department of State
WILLIAM G. SCHNEIDER, National Research Council, Ottawa, Canada
PHILLIP SMITH, Agency for International Development
ALVIN WEINBERG, Oak Ridge National Laboratory
JOHN D. WILKES, Agency for International Development
FRANCIS A. YOUNG, National Academy of Sciences

THIRD BRAZIL-U.S. WORKSHOP ON CONTRIBUTION OF SCIENCE AND TECHNOLOGY TO DEVELOPMENT, Rio de Janeiro, April 7-11, 1969

Brazilian Participants

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ANTONIO MOREIRA COUCEIRO, President, National Research Council
AMADEU CURY, Director, Institute of Microbiology, Federal University of Rio de Janeiro
RUI RIBEIRO FRANCO, Institute of Atomic Energy
MANOEL DA FROTA MOREIRA, Scientific Director, National Research Council
HECTOR GRILLO, Vice President, National Research Council
NELSON GUTHEIL, Director, Institute of Technology of Rio Grande do Sul
ARISTIDES A. PACHECO LEAO, President, Brazilian Academy of Sciences
WALTER BAPTIST MORS, Director, Research Center of Natural Products, Federal University of Rio de Janeiro
VICTOR PELLEGRINI, Institute of Applied Economic Research, Ministry of Planning
OSCAR SALA, Physics, University of Sao Paulo
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GLAUCO PINTO VIEGAS, Technical Director, Cargill Company

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CARL DJERASSI, Chemistry, Stanford University
WILLIAM D. JOHNSTON, JR., Foreign Geology Branch, U.S. Geological Survey
RICHARD C. JORDAN, Mechanical and Aerospace Engineering, University of Minnesota
ROBERT N. KREIDLER, Executive Vice-President, Alfred P. Sloan Foundation
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WILLIAM A. ELLIS, USAID Mission Director
MILLER N. HUDSON, JR., Science Attache, U.S. Embassy
J. RICHARD SMITH, Human Resources Division, USAID Mission
MAX WHITE, U.S. Geological Survey, Rio de Janeiro

## Brazilian Observers

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DENIS FRANÇA LEITE, COPPE, UFRJ
ROBERTO D. LEUZINGER, COPPE, UFRJ
WENDENLIN FRANZ LOTZE, UFRJ
ELOISA MANO, Chemistry, UFRJ
ANTÔNIO SEABRA MOGGI, Director of Research, Pétrobras
OLINTO DE OLIVEIRA, Director, Rio Data Center, Catholic University of Rio de Janeiro
KURT POLITZER, National School of Chemistry, UFRJ
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HOMERO HENRIQUE ROSA RANGEL, Director, Institute of Highway Research

WALDEMAR SELTZER, Director, Computer Center, University of São Paulo
MARCELO TUNES, Director, DNPM
J. PAULO VELLOSO, Secretary-General, Ministry of Planning
AYRTON ZANON, Office of Research and Experimentation, Ministry of Agriculture

FOURTH BRAZIL-U.S. WORKSHOP ON CONTRIBUTION OF SCIENCE AND TECHNOLOGY TO DEVELOPMENT, Washington, November 1-5, 1971

Brazilian Participants

MIGUEL DE LIMA BOHOMOLETZ, National Steel Industry Development Council
AMADEU CURY, Chairman, CNPq Governing Council
JOHN M. DE ALBUQUERQUE FORMAN, Chairman, Earth Sciences Programs, CNPq
CARLOS A. KRUG, Member, CNPq Governing Council
CARLOS J. PEREIRA DE LUCENA, Computer Science, Pontifical Catholic University
MANOEL DA FROTA MOREIRA, Scientific Director, CNPq
OSCAR SALA, Physics, University of São Paulo
PERSIO DA SOUZA SANTOS, Institute of Technological Research, University of São Paulo
PASCHOAL SENISE, Chemistry, University of São Paulo
CELSO RENNA E SOUZA, Computer Science, UFRJ

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GEORGE BUGLIARELLO, Engineering, University of Illinois
CARL DJERASSI, Chemistry, Stanford University
BRUCE GILCHRIST, Executive Director, American Federation of Information Processing Societies
RICHARD C. JORDAN, Mechanical and Aerospace Engineering, University of Minnesota
ROBERT N. KREIDLER, Executive Vice President, Alfred P. Sloan Foundation
ROY L. LOVVORN, Administrator, Cooperative State Research Service, USDA
BRUCE S. OLD, Foreign Secretary, National Academy of Engineering

Observers

RUBEM AMARAL, JR., Second Secretary in Charge of Scientific Affairs, Brazilian Embassy
FRANCISCO ARINOS COSTA SILVA, Agricultural Projects, Inter-American Development Bank
HENRY ARNOLD, Bureau for Technical Assistance, AID
JOHN BALDESCHWIELER, Deputy Director, Office of Science and Technology, Executive Office of the President
BARRY BOEHM, Rand Corporation
BARBARA BOWIE, Bureau for Latin America, AID
LUÍZ A. BRASIL, Department of Scientific Affairs, Organization of American States
JOSÉ I. CABRAL, Agricultural Projects, Inter-American Development Bank
BILLY E. CALDWELL, Office of Science and Technology, Executive Office of the President
RAÚL CALVIMONTES, Director, Bolivian National Center for Scientific and Technical Documentation, La Paz
DUNCAN CLEMENT, Office of International Programs, NSF
DONALD COLLIER, Vice President for Research, Borg Warner Corporation
JOHN V. N. DORR, Office of International Geology, U.S. Geological Survey
WILLIAM ELLIS, Director, USAID Mission, Rio de Janeiro
KARL FETTERS, Vice President, Planning and Technology, Youngstown Steel
RÓMULO FERREIRA, Department of Scientific Affairs, Organization of American States
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HOWARD LUSK, Director, Human Resources, USAID Mission, Rio de Janeiro
OWEN LUSTIG, Director, Evaluation, USAID Mission, Rio de Janeiro
J. KENNETH MANSFIELD, Bureau for Science and Technology, Department of State
MANUEL A. MORENO, Inter-American Development Bank
NORMAN NEURITER, Office of Science and Technology, Executive Office of the President
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CLARENCE M. PIERCE, Consultant, Inter-American Development Bank
ANTONIO QUESADA, Department of Scientific Affairs, Organization of American States
EDWARD ROBERTS, Sloan School of Management, MIT
PHILIP R. SCHWAB, Bureau for Latin America, AID
GLENN SCHWEITZER, Director, Office of Science and Technology Bureau for Technical Assistance, AID

LAWRENCE J. TATE, Bureau for Latin America, AID
REX S. THOMAS, Deputy Administrator, Agricultural Research Service, USDA
SIMÓN TEITEL, Consultant, Office of the Program Advisor, Inter-American Development Bank
JOYCE TORIO, Agricultural Board, NAS
JAMES TURNBULL, Assistant Administrator, Cooperative Research Service, USDA
ANDRÉS VALEIRAS, Department of Scientific Affairs, Organization of American States
MANUEL VERA, Education, Science and Technology Section, Inter-American Development Bank
MAX WHITE, Staff Director, U.S. Geological Survey, Rio de Janeiro
BOYD T. WHITTLE, Bureau for Latin America, AID

JOINT STUDY GROUP ON APPLICATION OF STEROID CHEMISTRY TO INDUSTRY, 1966

CARL DJERASSI, Chemistry, Stanford University
WALTER B. MORS, Centro de Pesquisas de Productos Naturais, UFRJ

ADVISORY COMMITTEE ON GRADUATE TEACHING AND RESEARCH IN CHEMISTRY, 1968

Brazilian Members

Rio de Janeiro

ELOISA MANO, Chairman, Rio, Institute of Chemistry, UFRJ
LIBERO ANTONACCIO, National Institute of Technology
AIDA ESPINOLA, Institute of Chemistry, UFRJ
AILTON DE SOUZA GOMES, Institute of Chemistry, UFRJ
W. BRUCE KOVER, Institute of Chemistry, UFRJ
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WALTER B. MORS, Institute of Food Technology
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São Paulo

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GEORGE S. HAMMOND, Organic Chemistry, California Institute of Technology
ROBERT E. IRELAND, Organic Chemistry, California Institute of Technology
WILLIAM S. JOHNSON, Organic Chemistry, Stanford University
ROBERT N. KREIDLER, Executive Vice President, Alfred P. Sloan Foundation
ARON KUPPERMANN, Chemical Physics, California Institute of Technology
JAMES A. MARSHALL, Organic Chemistry, Northwestern University
CHARLES G. OVERBERGER, Organic Chemistry, University of Michigan
HENRY TAUBE, Inorganic Chemistry, Stanford University

JOINT STUDY GROUP ON INDUSTRIAL RESEARCH, 1968

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ABRAHAM IACHAN, National Institute of Technology
FRED W. LACERDA, Brazilian Institute of Metallurgy, São Paulo
ANTONIO SEABRA MOGGI, Director of Research, Brazilian Oil, Inc. (PETROBRAS)
GEORGE SOARES DE MORAES, Managing Director, SINVAL, Governador Valadares, Minas Gerais
KURT POLITZER, National School of Chemistry, UFRJ
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DOUGLAS H. GRAHAM, Economics, Vanderbilt University
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WILLIAM A. W. KREBS, Vice President, Arthur D. Little, Inc.
ANTHONY LEEDS, Anthropology, University of Texas
ROBERT W. OLSON, Vice President, Special Projects, Texas Instruments, Inc.
EUGENE P. PFLEIDER, Mines and Metallurgy, University of Minnesota
BERTRAM D. THOMAS, President, Battelle Memorial Institute
ARTHUR W. WEBER, Vice President, Corning Glass Works

JOINT STUDY GROUP ON NORMS, MEASUREMENTS AND TESTING, 1968

Brazilian Members

GERALDO NUÑES DA SILVA MAIA, Chairman, Executive Secretary, Executive Group of Electrical and Electronic Industries
ALBERTO ALBUQUERQUE ARANTES, Mechanical Engineering, Institute of Technological Research
GILSON DE ALMEIDA GOMES, Telefunken do Brazil, S.A.
ALBERTO SINAY NEVES, Standardization Manager, General Electric, S.A.
LUIZ CINTRA DO PRADO, Professor-at-Large, University of São Paulo

United States Members

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F. CRAMPTON FROST, Standardization Programs, U.S. Standards Institute, New York
ROBERT B. HOBBS, Deputy Technical Director, U.S. Government Printing Office
MALCOLM W. JENSEN, Institute for Applied Technology, National Bureau of Standards
ALVIN G. McNISH, Assistant to the Director, National Bureau of Standards

COMPUTER SCIENCES FEASIBILITY STUDY, 1968

JEAN-PAUL JACOB, IBM Consultant to CNPq
GILBERT McCANN, California Institute of Technology

JOINT STUDY GROUP ON COMPUTER SCIENCE, 1971

BARRY W. BOEHM, Rand Corporation
BRUCE GILCHRIST, Executive Director, American Federation of Information Processing Societies, Inc.
HARRY D. HUSKEY, Chairman, Director of the Computer Center, University of California
DENIS FRANCA LEITE, Director of the Computer Center, COPPE, UFRJ
CARLOS JOSÉ PEREIRA DE LUCENA, Coordinator, Rio Datacentro, Catholic University of Rio de Janeiro
MICHEL A. MELKANOFF, Computer Science, University of California
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JOSÉ DION DE MELO TELES, Federal Data Processing Service (SERPR)
OSWALDO FADIGAS F. TORRES, Director, Polytechnical School, University of São Paulo

JOINT STUDY GROUP ON MINERAL RESOURCES, 1968

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WILLIAM D. JOHNSTON, JR., Foreign Geology Branch, U.S. Geological Survey
MAX G. WHITE, U.S. Geological Survey, Rio de Janeiro

JOINT STUDY GROUP ON EARTH SCIENCES, 1970

CLARENCE R. ALLEN, Geological Sciences, California Institute of Technology
JOHN M. ALBUQUERQUE FORMAN, Chairman, Chief, Geology Sector, CNPq
RICHARD H. JAHNS, Chairman, Earth Sciences, Stanford University
GEORGE A. PARKS, Mineral Engineering and Geochemistry, Stanford University

JOINT STUDY GROUP ON AGRICULTURAL RESEARCH, 1968

R. K. FREVERT, Director, Agricultural Experiment Station, University of Arizona
ROY L. LOVVORN, Chairman, Agricultural Experiment Station, North Carolina State University
ROBERTO MEIRELLES DE MIRANDA, Agricultural School, Rural University of Brazil
ADY RAUL DA SILVA, Chairman, Conselho Nacional de Pesquisas
H. REX THOMAS, Crops Research Division, USDA
GLAUCO PINTO VIEGAS, Agriculture, University of São Paulo

JOINT STUDY GROUP ON AGRICULTURAL ECONOMICS, 1968

CONSTANTINO CARNEIRO FRAGA, Secretary of Agriculture, State of São Paulo
RUI MILLER PAIVA, Chairman, Fundaçao Getulio Vargas
VICTOR PELLEGRINI, Institute of Applied Economic Research, Ministry of Planning
G. EDWARD SCHUH, Chairman, Agricultural Economics, Purdue University
D. WOODS THOMAS, International Programs in Agriculture, Purdue University
LAWRENCE W. WITT, Agricultural Economics, Michigan State University

JOINT STUDY GROUP ON AGRICULTURAL ENGINEERING, 1972

SALASSIER BERNARDO, Agricultural Engineering, Federal University of Viçosa
ANIVALDO P. COBRA, Regional Agricultural Engineer, FAO, Santiago, Chile
CARL W. HALL, Engineering, Washington State University
W. G. MATLOCK, Agricultural Engineering, University of Arizona
ANDRE TOSELLO, Food Technology, State University of Campinas

JOINT STUDY GROUP ON TRANSPORTATION, 1970

JOSEPH GUNWALD, Director, Economic and Social Development Studies, Brookings Institution
ROBERTO DORIA LEUZINGER, Chairman, COPPE, UFRJ
ADOLPH D. MAY, Transportation Engineering, University of California, Berkeley
JACQUES DE MEDINA, COPPE, UFRJ
HOMERO H. ROSA RANGEL, Director, Institute of Highway Research

ADVISORY PANEL ON SCIENCE AND TECHNOLOGY IN SAO PAULO'S DEVELOPMENT, 1972

ROBERT N. KREIDLER, Chairman, Alfred P. Sloan Foundation
WILLIAM E. ANDRUS, JR., National Bureau of Standards
JACK BARANSON, Consultant to the Board on Science and Technology for International Development, NAS
KENNETH R. HANSEN, Doxiadis Associates, Inc.
GEORGE R. HERBERT, Research Triangle Institute
BERNARD KUPFERSCHMID, Technology Transfer International
RICHARD O. MASON, Graduate School of Management, University of California
KENNETH K. MABUCHI, Greater Washington Interventure
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## CHILE

### CHILE-U.S. WORKSHOP ON THE CONTRIBUTION OF SCIENCE AND TECHNOLOGY TO DEVELOPMENT, Santiago, January 11-15, 1971

#### Chilean Participants

##### Science Policy

ENRIQUE D'ETIGNY LYON, Chairman, National Commission for Scientific and Technological Research (CONICYT)
EDUARDO BOBADILLA, Acting Executive Secretary, CONICYT
JOAQUIN CORDUA SOMMER, School of Engineering, University of Chile
JUAN DE DOS VIAL CORREA, Faculty of Chemistry and Pharmacy, University of Chile
CARLOS FORTIN CABEZAS, School of Political and Administrative Sciences, University of Chile
BRUNO GUNTHER SCHAFFELD, Institute of Physiology, University of Chile
JOAQUIN LUCO VALENZUELA, Neurophysiology, University of Chile
MARCELO ROBERT PRIERE, Head, Department of Studies, CONICYT
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##### Marine Sciences

ANELIO AGUAYO LOBO, Department of Oceanology, University of Chile
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HECTOR INOSTROZA VILLAGRA, Central Institute of Physics, University of Concepcion
FERNANDO ROBLES GARCIA, Fisheries Research Development Institute
PATRICIO SANCHEZ, Institute of Biological Sciences, Catholic University of Chile
HELLMUTH SIEVERS CZISCHKE, Oceanography, Naval Hydrographical Institute
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## Nutrition and Food Sciences

ANTONIO ARTEAGA LLONA, Nutrition, Catholic University of Chile
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MAX RUTMAN SOUBOTNIK, Fisheries Research Development Institute, CORFO
ALEX TRIER GABLER, Institute of Technology of Chile, CORFO

## Mathematics and Computer Sciences

ROLANDO CHUAQUI, Mathematical Sciences, Physics and Chemistry, Catholic University of Chile
ENRIQUE CANSADO, Director, Inter-American Center for the Teaching of Statistics (CIENES)
JORGE ALVAREZ DE ARAYA, Institute of Mathematics, Catholic University of Chile
JULIAN CORCUERA, Department of Studies, CONICYT
RENE PERALTA, Director, Computation Center, Faculty of Science, Physics and Mathematics

## Copper Technology

CARLOS CAMPINO, Center for Promotion of Uses of Copper
IVAN CASANEGRA, Department of Studies, CONICYT
CARLOS DIAZURIBE, Department of Mines, University of Chile
JOSELIN GONZALEZ M., Engineering Administrator, Ventanas Refinery (ENAMI)
CARLOS LANDOLT, Center for Metallurgical Mining Research
LUIS SOTO-KREBS, Engineering Department, Technological Institute (INTEC)
MATIAS TURTLETAUB, Mechanical Engineering Department, INTEC, CORFO
CARLOS RUIZ FULLER, Institute of Geological Research

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WILLIAM J. DARBY, Vanderbilt University School of Medicine
HENRY S. FRANCIS, JR., National Science Foundation
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WILLIAM F. MILLER, Association of American Universities
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## COLOMBIA

COLOMBIA-U.S. WORKSHOP ON SCIENCE AND TECHNOLOGY IN DEVELOPMENT, Fusagasuga, February 26-March 1, 1968

### Colombian Participants

CANUTO CARDONA, Director, Colombian Agricultural Research Institute
TULIO MARULANDA, Executive Director, Institute of Nuclear Affairs
OLIVERIO PHILLIPS, Industrial Consultant
JOAQUIN PIÑEROS, Executive Director, Commission for Educational Exchange
GABRIEL PROVEDA, Technical Department, National Association of Industries
JESUS RAMIREZ, S.J., Director, Colombian Andes Geophysics Institute
DARIO SUESCUN, Director, Mineral Inventory and National Geological Service
RAMIRO TOBON, Dean, Division of Sciences, Universidad del Valle
NORTON YOUNG, Director, Institute of Technological Research
ZVEN ZETHELIUS, Chemistry, National University of Colombia

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HARRISON BROWN, Foreign Secretary, National Academy of Sciences
STANLEY A. CAIN, Assistant Secretary, Department of the Interior
CARL DJERASSI, Chemistry, Stanford University
KARL FOLKERS, President, Stanford Research Institute
T. KEITH GLENNAN, President, Associated Universities, Inc.
HANS LANDSBERG, Resources for the Future, Inc.
GEORGE WAGGONER, Dean, College of Arts and Sciences, University of Kansas
CARROLL L. WILSON, Sloan School of Management, MIT

### Special Guests

GABRIEL BETANCUR, Minister of National Education
WILLIAM BOLLAY, Aeronautical Engineering, Stanford University
RODRIGO BOTERO, Presidential Economic Secretary
MANUEL CARVAJAL, Carvajal and Company

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FIRST PERU-U.S. WORKSHOP ON SCIENCE, TECHNOLOGY AND DEVELOPMENT, Paracas, April 18-22, 1966

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SECOND PERU-U.S. WORKSHOP ON SCIENCE AND TECHNOLOGY IN DEVELOPMENT, Lima, Peru, November 20-24, 1967

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JOINT STUDY GROUP ON PROPOSED NRC, 1966

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## SPECIAL STUDIES AND PROJECTS

## AFRICA

CONFERENCE ON AGRICULTURAL RESEARCH PRIORITIES FOR ECONOMIC DEVELOPMENT IN AFRICA. Abidjan, April 5-12, 1968

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STUDY ON AFRICAN AGRICULTURAL RESEARCH CAPABILITIES, 1970

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## ASIA

STUDY OF THE FUTURE OF U.S. TECHNICAL COOPERATION WITH KOREA, 1969

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ADVISORY PANEL TO KOREAN MINISTRY OF SCIENCE AND TECHNOLOGY, 1972

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THAILAND SEMINAR ON PROTEIN FOOD PROMOTION, Bangkok, November 22-December 1, 1970

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STUDY ON EAST PAKISTAN LAND AND WATER DEVELOPMENT AS RELATED TO AGRICULTURE, 1971

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REGIONAL WORKSHOP ON WATER RESOURCES, ENVIRONMENT, AND NATIONAL DEVELOPMENT, Singapore, March 13-17, 1972

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# LATIN AMERICA

## CENTRAL AMERICAN WORKSHOP ON THE ENVIRONMENT AND DEVELOPMENT, Antigua, July 25-30, 1971

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## APPLICATIONS OF FERROCEMENT IN DEVELOPING COUNTRIES, 1972

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MOSQUITO CONTROL, 1971

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ROLE OF SCIENCE AND TECHNOLOGY IN INTERNATIONAL DEVELOPMENT IN THE 1970'S, Massachusetts, August 15-21, 1971

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ROLE OF U.S. SCHOOLS OF ENGINEERING IN TECHNICAL ASSISTANCE, 1971

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ROOFING PROBLEMS IN DEVELOPING NATIONS,* 1971

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*Under joint auspices of BOSTID and the NAS Building Research Advisory Board

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SCIENTIFIC AND TECHNICAL INFORMATION FOR DEVELOPING COUNTRIES, 1971

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SOLAR ENERGY IN DEVELOPING COUNTRIES, 1971

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TRAINING OF LDC RESEARCH ADMINISTRATORS AND TECHNICAL MANAGERS, 1971

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U.S. INTERNATIONAL FIRMS AND R,D&E in Developing Countries, 1971

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STUDY ON RAPID POPULATION GROWTH, 1971

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# APPENDIX E

## ABBREVIATIONS

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## APPENDIX E: ABBREVIATIONS

| | |
|---|---|
| AAAS | American Association for the Advancement of Science |
| AAASA | Association for the Advancement of Agricultural Sciences in Africa |
| ACLS | American Council of Learned Societies |
| AID | Agency for International Development (U.S.) |
| AID/ROCAP | AID Regional Office for Central America and Panama |
| AID/W | AID/Washington |
| APAC | Peruvian Association for the Advancement of Science |
| ASB | Africa Science Board |
| BNDE | National Bank of Economic Development (Brazil) |
| BOSTID | Board on Science and Technology for International Development (of NAS) |
| CCTA | Commission for Technical Cooperation in Africa South of the Sahara |
| CIEDC | Council of International Economic Development & Cooperation (Taiwan) |
| CNPq | Conselho Nacional de Pesquisas (Brazilian National Research Council) |
| COLCIENCIAS | Colombian Fund for Scientific Research & Special Projects "Francisco José de Caldas" |
| CONACYT | National Council of Science and Technology (Argentina) |
| CONICET | National Council of Scientific & Technical Research (Argentina) |
| CONICYT | National Commission for Scientific & Technological Research (Chile) |
| CONUP | National Council of Peruvian Universities |
| Cr | Cruzeiros (Brazilian Monetary Unit) |
| CSA | Scientific Council for Africa |
| CSIR | Council for Scientific and Industrial Research (Ghana) |

| | |
|---|---|
| DNPM | National Department of Mineral Production (Brazil) |
| FAO | Food & Agriculture Organization (U.N.) |
| IBRD | International Bank for Reconstruction & Development |
| ICA | International Cooperation Administration |
| ICAITI | Central American Research Institute for Industrial Technology |
| ICFES | Instituto Colombiano para el Fomento de Educación Superior (Colombian Institute for the Development of Higher Education) |
| INSA | Indian National Science Academy |
| INT | National Research Institute (Brazil) |
| IPT | Technological Research Institute (Brazil) |
| ITAL | Food Technology Institute (Brazil) |
| ITEP | Technological Research Institute of Pernambuco (Brazil) |
| KADI | Korean-American Development Institution |
| L.A. | Latin America |
| LASB | Latin America Science Board (U.S.) |
| LDC | Less Developed Country |
| LIPI | Indonesian Institute of Sciences |
| MIPI | Council of Sciences for Indonesia |
| MIT | Massachusetts Institute of Technology |
| NAE | National Academy of Engineering |
| NAS | National Academy of Sciences |
| NASA | National Aeronautics & Space Administration |
| NIST | National Institute of Science & Technology (Philippines) |
| NRC | National Research Council |
| NSDB | National Science Development Board (Philippines) |

| | |
|---|---|
| NSF | National Science Foundation (U.S.) |
| OAS | Organization of American States |
| OECD | Organization for Economic Cooperation & Development |
| OFS | Office of the Foreign Secretary (of NAS) |
| ONRD | Office Nationale de la Recherche et du Developpement (Zaïre) |
| OST | Office of Science & Technology (White House) |
| PSAC | President's Science Advisory Committee (U.S.) |
| PSB | Pacific Science Board (of NAS) |
| R,D&E | Research, Development, and Engineering |
| SSRC | Social Science Research Council (U.S.) |
| S&T | Science & Technology |
| U.N. | United Nations |
| UNDP | United Nations Development Program |
| UNESCO | United Nations Educational, Scientific & Cultural Organization |
| UNIDO | United Nations Industrial Development Organization |
| USAID Mission | United States Agency for International Development Overseas Missions |
| USGS | United States Geological Survey |
| VITA | Volunteers for Technical Assistance (U.S.) |

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