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NAS-CNPq Science Cooperation Program

**STAFF SUMMARY REPORT OF ACTIVITIES
FEBRUARY 1968 - DECEMBER 1972**

**Board on Science and Technology for International Development
Office of the Foreign Secretary
National Academy of Sciences (USA)
and
Conselho Nacional de Pesquisas (Brazil)**



The NAS-CNPq (Brazil) Science Cooperation Program was initiated by the National Research Council of Brazil (Conselho Nacional de Pesquisas - CNPq) and the Board on Science and Technology for International Development, Office of the Foreign Secretary, National Academy of Sciences (NAS) with support of the United States Agency for International Development in Brazil under contract AID/csd-1122, Task Order Number 3. The report covers the period February 1968 through December 1972.

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I

SUMMARY

Since the late 1950's the National Academy of Sciences (NAS) of the United States has participated in collaborative activities in which U.S. scientists and their counterparts in developing countries work together to strengthen the application of science and technology to development. In particular, the NAS has sought ways to supplement local knowledge and experience with the methods and experience more technically advanced countries apply to their own problems. The NAS, through its Board on Science and Technology for International Development (BOSTID), has employed a basically bilateral approach. Many, but not all, of NAS programs have been conducted in cooperation with the U.S. Agency for International Development (AID).

In 1965 a bilateral program with Brazil began when a group of NAS-sponsored U.S. scientists met with representatives selected by the Brazilian National Research Council (Conselho Nacional de Pesquisas, or CNPq) in Rio de Janeiro. The discussions led to a Brazil - U.S. Workshop on the Contribution of Science and Technology to Development, in Itatiaia, Brazil, April 11 - 16, 1966.* At this first workshop, the participants agreed that several problem areas, with scientific and technological dimensions, were impeding economic growth in Brazil. Among these areas

*Through December 1972, four Brazil - U.S. Workshops on the Contribution of Science and Technology to Development have been held:

The First Workshop, April 11 - 16, 1966
The Second Workshop, February 5 - 9, 1968
The Third Workshop, April 7 - 11, 1969
The Fourth Workshop, November 1 - 5, 1971

were manpower resources, agricultural research, industrial research, and utilization of natural resources. The governments of Brazil and the United States, agreeing on the importance of these problems, arranged to finance joint studies by the CNPq and the NAS.

This report summarizes the subsequent activities from February, 1968, through December, 1972, the period when AID funded NAS cooperation with the CNPq under contract AID/csd 1122, Task Order 3. During that time, study groups considered problems in agricultural research; agricultural economics; chemistry; computer science; earth sciences; industrial research; and norms, measurements, and standards. Activities of each study group were discussed and acted upon at the Third Brazil - U.S. Workshop on the Contribution of Science and Technology to Development in Rio de Janeiro, April 7 - 11, 1969, and the Fourth Workshop held in Washington, D.C., November 1 - 5, 1971. Achievements of the joint efforts include

1. Establishment of a 5-year experimental program to strengthen graduate education and research in chemistry in two Brazilian universities.
2. Strengthening communication in agricultural research activities through two national seminars which brought together for the first time leaders from state, university, and federal agricultural research stations.
3. Strengthening communication in agricultural research activities through two national seminars on agricultural research administration.
4. CNPq approval of a proposal to strengthen graduate education and research in computer science in three Brazilian universities.
5. Extension of the role of the CNPq in catalyzing and coordinating industrial research in the public and private sectors.

One of the greatest strengths of the CNPq - NAS program of workshops and study groups is its continuity. Knowledgeable Brazilian and U.S. specialists have been collaborating long enough to become familiar with Brazil's problems and have demonstrated the value of utilizing science and technology to attack them. Both the CNPq and the NAS believe that this bilateral collaboration has been successful and that the success may be seen in the following ways:

1. Since 1965, Brazilian policy makers for science and technology have played an increasingly important role in planning the overall national economic policy. Concurrently, the federal and state governments have increased support for science and technology.

2. Research infrastructure has been strengthened in both the agricultural and industrial sectors.

3. Advanced training and research projects have been established. This progress is particularly evident in chemistry.

4. Participation by the Brazilian scientific community in CNPq programs and other government activities has been increased.

5. Long-term scientific relationships between members of the Brazilian and U.S. scientific and economic development communities have been significantly extended and strengthened.

During 1973, the NAS and the CNPq plan to continue joint study group projects in agricultural engineering education, earth sciences education, and assessment of agricultural research priorities in the campo cerrado. A planning group, or continuing committee, is scheduled to meet in Brazil late in the year to review the overall program. The sponsoring

groups in Brazil and the United States recognize the value of specific development-oriented projects accomplished in the past 10 years and the more indirect, but equally valuable, strengthening of the science and technology infrastructure accrued from the joint collaboration. In the imprecise and often difficult task of formulating policies on science and technology, the NAS-CNPq program is a case study demonstrating the value of joint collaboration to achieve long-term goals.

Readers of this report are invited to comment upon or inquire about specific details concerning the activities summarized in the following pages by writing to:

Dr. Victor Rabinowitch
Staff Director
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Brazil

II

STUDY GROUP ACTIVITIES

AGRICULTURAL RESEARCH

1. Origin and Objectives

The First Brazil - U.S. Workshop (1966) recommended creation of a joint CNPq - NAS Agricultural Research Study Group. Recognizing that agriculture is basic to the economic development of Brazil, the workshop participants urged appointment of a study group to review organizational aspects of Brazilian agricultural research at the state and federal levels and to seek ways to obtain better returns from investments in research.

2. Members, 1968 through 1972

From Brazil

Ady Raul da Silva
Chairman, Brazilian Panel
through 1970
Head, Agricultural Sector
Conselho Nacional de Pesquisas
Rio de Janeiro, Guanabara

Roberto Meirelles de Miranda ^{1/}
Ministry of Agriculture
Brasilia, D.F.

Glauco Pinto Viegas
Conselho Nacional de Pesquisas
Rio de Janeiro, Guanabara

Mozart Teixeira Liberal
Ministry of Agriculture
Rio de Janeiro, Guanabara
(July. 1970, through 1971)

Carlos A. Krug ^{2/}
Chairman, Brazilian Panel,
1971-1972
Counselor for Agricultural Programs
Conselho Nacional de Pesquisas
Rio de Janeiro, Guanabara

^{1/} Left the study group in July 1970 upon assuming directorship of the Department of Research and Agricultural Experimentation (EPF), of the Ministry of Agriculture.

^{2/} Died, February 1973.

From the United States

Roy L. Lowvorn
Chairman, U.S. Panel
Research Director
College of Agriculture and Life
Sciences
North Carolina State University
Raleigh, North Carolina

Richard K. Frevert, Director
Agricultural Experiment Station
University of Arizona
Tucson, Arizona

H. Rex Thomas, Director
Crops Research Division
Agricultural Research Service
U.S. Department of Agriculture
Beltsville, Maryland

James Turnbull, Assistant Administrator
Cooperative State Research Service
U.S. Department of Agriculture
Washington, D.C.
(July, 1970, through 1971)

3. Activities

The study group first met in Rio de Janeiro in January, 1968, to review the situation in Brazilian agriculture and to recommend topics for research priority. Before the meeting, the three U.S. members visited a group of Brazilian agricultural research institutions to observe research programs at the federal, state, and university levels. The joint study group prepared an outline of the information it needed from the CNPq and the Ministry of Agriculture to help it meet the objectives assigned by the First Workshop. Included were questions on organization and operation of research institutions; profile of Brazilian scientific and agricultural manpower; financial support for agricultural research; research priorities; coordination of research; linkages among research, extension and education; national and international technical assistance to agricultural research; and communication of research results. The Agricultural Research Study Group then presented a short progress report to the Second Brazil - U.S. Workshop (1968).

In February, 1969, the CNPq, the Ministry of Agriculture, and the Brazilian Academy of Sciences sponsored an International Seminar

on Agricultural Research Administration with the participation of the joint NAS - CNPq Agricultural Research and the Agricultural Economics Study Groups. The seminar directed attention to the organizational aspects of planning, financing and operating agricultural research programs in Brazilian universities, and state and federal institutes. Participants included senior research and administrative officials from a wide spectrum of Brazilian agricultural, educational, and research institutions.

By the Third Brazil - U.S. Workshop (1969) background data on Brazilian agricultural research requested the previous year from the Ministry of Agriculture was not yet available. The study group suggested to the Ministry that a joint task force, appointed by the interested organizations, collaborate in compiling an inventory of agricultural research in progress in Brazil.

During the rest of 1969 and the early months of 1970 it was not possible to begin the proposed research inventory, mainly because of delays in approval of an AID - Government of Brazil agricultural research loan and because of the reorganization of the Ministry of Agriculture following its move from Rio de Janeiro to the new capital, Brasilia.

To encourage a greater degree of cooperation among the agricultural research institutes of the universities, states, and federal government the CNPq and the Ministry of Agriculture in 1970 sponsored a second seminar on agricultural research administration. The two joint CNPq - NAS study groups were invited to participate by presenting a series of papers. Ten were given by U.S. panelists and 17 by Brazilian panelists of the Agricultural Research Study Group; two were presented by U.S. and four by Brazilian panelists of the Agricultural Economics Study Group.

Approximately 150 persons registered for the seminar, held July 27 - 31, 1970, at Campinas, State of São Paulo. Agricultural scientists and administrators from nearly all state, federal, and private research and teaching institutions in Brazil attended.

Prior to this second seminar, U.S. panelists visited agricultural research facilities in the southern states of Brazil. After the visits and the seminar, the joint study group on agricultural research recommended that (a) the Brazilian government increase its efforts to strengthen agricultural education and research, (b) an ad hoc committee be established to identify the most urgent training and research needs in agricultural engineering and (c) forestry be included as a topic in future activities of the Brazil - U.S. Agricultural Research Study Group.

During the Fourth Brazil - U.S. Workshop (1971) Dr. Carlos Krug of CNPq reported on study group activities. After discussing alternative courses of action, workshop participants recommended that the agricultural research study group be continued and direct its attention to (a) a study of agricultural-engineering teaching and research in Brazil and (b) a study of special needs of the cerrado (savannah) regions of Brazil.

a. Agricultural Engineering

In July and August, 1972, a special Brazil - U.S. Study Group on Agricultural Engineering spent 3 weeks visiting institutions throughout Brazil to observe the needs and the potential for improving agricultural engineering education and research. FAO was also invited by CNPq and NAS to join the study group; participants were:

From Brazil

Dr. Anivaldo P. Cobra
Regional Agricultural Engineer
FAO, Santiago, Chile
(Brazilian agricultural engineer on
leave from the University of São
Paulo)

Professor S. Bernardo
Federal University of Viçosa
Viçosa, Minas Gerais

Dr. Andre Tosello
Director, Food Technology Faculty
State University of Campinas
Campinas, São Paulo

From the United States

Dr. Carl W. Hall
Dean, College of Engineering
Washington State University
Pullman, Washington

Dr. W. G. Matlock
Professor of Agricultural Engineering
University of Arizona
Tucson, Arizona

Dr. Carlos Krug of CNPq coordinated the project, and Dr. David Wolf, a U.S. agricultural engineer serving as a visiting professor at the Federal University of Viçosa assisted the study group as an observer. In its conclusions the study group emphasized the need to establish agricultural engineering as a "new" profession recognized under Brazilian law. To accomplish this goal, a cadre of Brazilian agricultural engineers should receive advanced training outside Brazil; these professionals should then return to teach and conduct research in the universities. To guide this fundamental change in agricultural engineering, the study group suggested that the CNPq create a national agricultural engineering commission. One way to assist in these changes would be to use resources soon to be available under an AID - Government of Brazil agricultural education loan.

b. The Cerrado

Implementation of the Fourth Workshop recommendation for research on problems of the cerrado awaits preparation of the specific terms of reference for a joint study group and funding under a 1973 NAS - AID contract.

4. Observations and Comments

The joint CNPq-NAS Agricultural Research Study Group was formally in existence from January, 1968, through August, 1970. After that period its functions were assumed by Dr. Krug, spokesman for the Brazilian panel at the Fourth Workshop, and by the U.S. panelists, each of whom was present at the workshop. Under a new NAS-AID contract, the NAS and CNPq plan to appoint new panels.

An important task which the study group sought to undertake was a current inventory of Brazilian agricultural research programs. The study was to be made by a team of four persons, two from Brazil and two from the United States. One member was to be a person thoroughly familiar with a parallel inventory of U.S. agricultural research. He would assist with planning in Brazil for a minimum period of one month. A three man survey team of two Brazilians and one U.S. would then visit each research facility in the country, observing and evaluating the work being done. This field survey would require up to 6 months. The first U.S. person would then return for 2 months to help organize the data and summarize it for publication. Once the inventory was made it could be kept up-to-date annually by the Brazilians.

Unfortunately, the inventory was not undertaken. In retrospect one can ascertain some of the factors which prevented the task from being realized. Perhaps the proposed study was too ambitious; it required an input of several man-years, special funding and a clear delegation of authority from the Ministry of Agriculture. In 1968 CNPq did not have the mandate to authorize the study; only in 1972 did the Brazilian government delegate to the CNPq overall responsibility to coordinate research. Because the Ministry of Agriculture moved from Rio to Brasilia

in 1968-69 it was occupied with administrative matters and did not assign a person to coordinate planning for the inventory. Furthermore, protracted negotiations on a U.S. AID - Government of Brazil agricultural research loan delayed funding of activities. Finally, one can conclude that the proposed inventory, although considered an important element of agricultural research planning by the U.S. panelists, appeared premature to many Brazilians. Because a tradition of research cooperation between state and federal agricultural institutions and the universities has not been well established in Brazil, the two seminars on research administration were useful in creating a climate for research coordination. Even in 1973, however, it is not certain that an all-inclusive inventory of research capabilities could be made. It might be preferable to study research capability on the basis of major crops such as coffee, sugarcane, wheat, rice, maize, sorghum, cacao, manioc and oil seeds.

Recognition of agricultural research as an appropriate activity for the CNPq has been increasing since the First Workshop, undoubtedly as a result of the changing attitude toward research priorities in the Brazilian government. There is emphasis upon applied research rather than more fundamental, or basic, research. During the Fourth Workshop, the chairman of the Brazilian group announced that the first priority area for continued CNPq-NAS programs is agricultural research.

During 1973, two projects recommended at the Fourth Workshop have promising prospects for implementation. One would translate recommendations of the agricultural engineering study group into concrete actions. The second would deal with studies of the campo cerrado, emphasizing such aspects as soil fertility and plant physiology as well as broader applications of land and water use planning.

AGRICULTURAL ECONOMICS

1. Origin and Objectives

The CNPq - NAS Agricultural Economics Study Group was appointed in 1968 and charged with analyzing Brazilian agricultural commodities in relation to nutrition, consumer demand, export opportunities, and economic feasibility. From the beginning, the study group worked closely with CNPq, the Ministry of Planning, and the Ministry of Agriculture.

2. Members, 1968 through 1971

From Brazil

Rui Miller Paiva
Brazilian Economics Institute
Getulio Vargas Foundation
Rio de Janeiro, Guanabara
Chairman, Brazilian Panel, 1968

Victor J. Pellegrini, Director
Agricultural Economics Section
Institute of Applied Economics
Research
Ministry of Planning
Rio de Janeiro, Guanabara
Chairman, Brazilian Panel, 1969-1970

Constantino Carneiro Fraga
Director, Institute of
Agricultural Economics
State Secretariat of Agriculture
São Paulo, São Paulo
Panelist, 1968-1970

Fernando Rocha
Federal University of Viçosa
Viçosa, Minas Gerais
Panelist, 1969

Helio Tollini
Director, Institute of Rural
Economics
Federal University of Viçosa
Viçosa, Minas Gerais
Panelist, 1970

From the United States

G. Edward Schuh, Chairman
Department of Agricultural
Economics
Purdue University
Lafayette, Indiana
Chairman, U.S. Panel, 1968-1971

Lawrence W. Witt
Department of Agricultural
Economics
Michigan State University
East Lansing, Michigan

D. Woods Thomas, Director
International Programs in
Agriculture
Purdue University
Lafayette, Indiana

Brazilian panelists served for fairly short periods; U.S. panelists served through the Fourth Workshop in November, 1971, when the study group disbanded. The choice of Dr. G. Edward Schuh as a panelist proved to be especially significant. One of the leading U.S. scholars on Brazilian agriculture, he also served as the Ford Foundation's Latin American agricultural economics advisor, resident in Brazil, for 18 months in 1970 and 1971. During 1971, Dr. Krug, member of the CNPq Council and its director of agricultural programs, assumed responsibility for liaison with the U.S. panel.

3. Activities

The CNPq - NAS Agricultural Economics Study Group first met in Rio de Janeiro in January, 1968, concurrently with the Agricultural Research Study Group. The two study groups held frequent joint meetings thereafter to maintain close cooperation in their work. In January, 1968, the Agricultural Economics Study Group outlined its major functions as follows:

- a. To suggest ways to integrate more effectively agricultural economics with both the physical and the biological sciences in agricultural research;

- b. To suggest ways in which economic analysis could help on a continuing basis to establish research priorities;
- c. To suggest steps that would strengthen agricultural economics as a discipline in Brazil, with special reference to teaching in universities and strengthening research for policy purposes; and
- d. To assist in establishing a permanent council of economic advisors to guide the development of agricultural economics as a profession, advise on national agricultural policy, and advise on proposed international technical assistance projects in the agricultural sector.

During 1968 and 1969 the agricultural economics study group concentrated on potential policy-making and advisory roles for Brazilian agricultural economists. Papers outlining a rationale and recommending a methodology for agricultural economics policy planning were included in the reports of the Second (1968) and Third (1969) Brazil - U.S. Workshops. Because Dr. Schuh was able to spend a considerable period of time in Brazil working with officials of the Ministries of Agriculture, Planning, and Finance, and because the Brazilian panel used its good offices to assist agricultural economists in development planning, the recommendations of the joint study group were incorporated into the overall Brazilian economic development plans.

After the government adopted most of the recommendations of the study group's first two reports, the panelists turned their attention toward forging stronger links between agricultural economics and farm-level research problems in Brazilian agricultural research institutes. In May, 1970, three panelists of the Brazilian study group--Drs. Pellegrini, Carneiro Fraga, and Tollini--visited the United States to observe how

policy research in agricultural economics is undertaken; to study research on farm-level economic problems in the universities, extension services and the government; and to explore possible cooperation between groups in the United States and Brazil. At the conclusion of the visit a meeting of the CNPq - NAS Agricultural Economics Study Group took place at the National Academy of Sciences in Washington, D.C. After evaluating the visit in terms of Brazilian needs, the joint study group agreed on the need for a technical assistance program to send U.S. doctoral candidates to regional research institutes in Brazil to cooperate on farm-level agricultural economics research projects. The proposed project would be similar to the U.S. - Brazil chemistry program conducted by the CNPq and the NAS.

In July, 1970, individuals from the study group participated in a second seminar on agricultural-research administration in Campinas, Brazil. The group prepared a draft project for strengthening agricultural-economics research and analysis in Brazilian agricultural-research stations. Over the next year Dr. Schuh discussed the project with many agricultural leaders in Brazil. Dr. Krug presented the project at the Fourth Brazil - U.S. Workshop (1971). It was sent back to the NAS - CNPq Agricultural Economics Study Group for revision, resubmitted to CNPq, and approved by the CNPq Council in 1972. Implementation of the proposal is under negotiation as a project within a Brazil - U.S. agricultural-education loan program of the U.S. AID with the Ministry of Agriculture. Both Dr. Krug and Dr. Schuh are actively participating in these discussions.

4. Observations and Comments

The early success of the CNPq - NAS Agricultural Economics Study Group in attaining recognition of the importance of agricultural economics in the policy-planning process reflects the quality of its work and its influence within the Brazilian government. The study group established close cooperation with agricultural economists in the Ministries of Agriculture, Planning, and the U.S. AID Mission to reinforce the total program in the Brazilian agricultural sector. Their work also complemented new training programs in agricultural economics in Brazilian universities, supported by the Ford Foundation and the Food and Agricultural Organization of the United Nations.

Again, Dr. Schuh deserves special mention and recognition. Because of his expertise in Brazilian agriculture, his hard work, and his presence in Brazil at a critical time, he provided the link between the study group and high-level decision makers in the Brazilian government. His efforts were essential to the translation of recommendations into policy.

Vision and leadership need reinforcement through constant follow-up activities. Such activities are far less glamorous and often go unnoticed. The growth of agricultural economics as a profession linked to the diverse and expanding agricultural sector is probably assured in Brazil, but cannot be taken for granted. A continuing CNPq - NAS study group, therefore, would serve

a. To provide impartial criticism of agricultural-economics policy in the development process,

b. To serve as an advisor to Brazilian universities in agricultural economics education and research, and

c. To foster cooperation in education and research between agricultural economists in Brazil and in the United States.

COMPUTER SCIENCE

1. Origin and Objectives

In 1968, participants at the Second Brazil - U.S. Workshop recognized the potential value of applying computers to the economic development of Brazil. They suggested that a study group be appointed to review the current status and future role of computer applications in universities, research institutes, government, and industries.

Before a joint study group was formally appointed, the CNPq and NAS agreed to a preliminary survey of current computer applications and an estimate of the growth potential for the geographic region of Rio de Janeiro and São Paulo. Dr. Gilbert D. McCann, Director, Computation Center, California Institute of Technology, and Dr. Jean Paul Jacob, International Business Machines Corporation, Brazil, were the persons asked to do the survey.

McCann and Jacob reported to the Third Brazil - U.S. Workshop (1969) and recommended computer-science education as the priority topic for the study group's attention.

2. Members, 1970 through 1972

From Brazil

Antonio Olinto de Oliveira
Catholic University of Rio de
Janeiro
Rio de Janeiro, Guanabara
Chairman, Brazilian Panel, 1970

Carlos José Pereira de Lucena
Coordinator, Rio Data Center
Catholic University of Rio de
Janeiro
Rio de Janeiro, Guanabara
Chairman, Brazilian Panel, 1971-72

Denis Franca Leite
Director, Computer Center
Graduate Engineering Program
(COPPE)
Federal University of Rio de
Janeiro
Rio de Janeiro, Guanabara
Member, 1970-72

Oswaldo Fadigas F. Torres
Director, Polytechnical School
University of São Paulo
São Paulo, São Paulo
Member, 1970-72

From the United States

Harry D. Huskey
Director, Computer Center
University of California at
Santa Cruz
Santa Cruz, California
Chairman, U.S. Panel, 1970

Bruce Gilchrist
Executive Director
American Federation of Information
Processing Societies, Inc.
Montvale, New Jersey
Member, 1970-72

Barry W. Boehm
Head, Information Sciences
Department
The Rand Corporation
Santa Monica, California
Member, 1970-72

Michel A. Melkanoff
Chairman, Department of Computer
Science
University of California at Los Angeles
Los Angeles, California
Member, 1970-72

3. Activities

In May, 1970, before the formal appointment of the CNPq - NAS Computer-Science Education Study Group, Dr. Olinto and Professor Leite visited eight U.S. institutions to discuss rapidly changing practices in computer-science education and their implications for computer applications in Brazil. The joint study group was appointed in June, 1970, and met in Brazil, August 10 - 14, 1970.

The main objective of the first meeting was to gather comprehensive data on computer technology in Brazil: the number and size of computers installed or purchased; the major applications of computers; the average number and educational background of professionals and technicians associated with computer facilities; and the number of universities with either degree programs in computer sciences or computer service centers.

After analyzing the data, the study group decided to direct its attention to (a) constraints on the development of undergraduate and graduate education in computer sciences and (b) the relationship between universities and industry. Background materials on these subjects were prepared and discussed at the Fourth Brazil - U.S. Workshop (1971), which

subsequently recommended a continued examination of graduate programs to arrive at recommendations for improving planning and coordination among three computer programs at the Catholic University of Rio de Janeiro (PUC), the Federal University of Rio de Janeiro (COPPE), and the University of São Paulo (USP). In December, 1971, the study group met in Brazil once again and recommended to the CNPq the following:

- A major effort to strengthen graduate computer-science education and research programs at PUC, COPPE, and USP;
- Improvement of computer-science teaching in other Brazilian universities, largely through faculty training at the graduate centers (PUC, COPPE, and USP);
- Cooperation in education and training activities between the universities and computer users in government and industry; and,
- Support by Brazilian government authorities and computer users of the Rio Symposium on Computer Education for Developing Countries, scheduled for August 6 - 12, 1972.

In August, 1972, the study group held a third meeting in Brazil. A specific plan to strengthen graduate computer-science education at PUC, COPPE, and USP was submitted to CNPq and to the U.S. AID Mission in Brazil. The plan, in the form of a project proposal, includes technical assistance from foreign visiting professors, fellowships for Brazilians to do advanced study abroad, and short-term study for in-service Brazilian faculty members. Purchase of computer hardware is specifically excluded and is cited as a responsibility of the Brazilian government.

4. Observations and Comments

By the end of 1971, the estimated number of computers installed in Brazil was 630 and the annual growth rate was estimated as 30 percent. In all, 29 universities, 7 independent schools, and 4 research centers had computer centers in operation. Obviously, growth of computer use had reached a state at which investments in machines, auxiliary facilities, and manpower were large. CNPq had shown foresight in 1968 when it saw the importance of computer activities to economic development. By requesting a study group to analyze the consequences of rapid growth in computer usage, CNPq acquired a mechanism for using experts from both Brazil and the United States. This study-group approach in computer sciences illustrates one of the main strengths of the CNPq-NAS program: analysis of a complex scientific-technological problem to provide recommendations that will most likely assure a long-term solution. In this case, the study group found the major problem to be a lack of indigenous Brazilian capability to produce high-level computer scientists to train new generations of computer personnel and to engage in long-term research on local development problems.

The CNPq - NAS Computer-Science Education Study Group, like the Agricultural Economics Study Group, made specific recommendations to CNPq in its area of competence. Each study group prepared a project proposal as one way to stimulate action. In each case the CNPq Council has endorsed the project proposal, and the CNPq, under the cooperative program with the NAS, is seeking to implement long-term programs to strengthen computer-science education and applied research in agricultural economics.

CHEMISTRY

1. Origin and Objectives

The Second Brazil - U.S. Workshop (1968), after analyzing the Brazilian 5-year scientific development plan, gave high priority to strengthening graduate education and research in chemistry. Workshop participants stressed the connection between strong university chemistry programs and development of high technology capabilities in agriculture, mineral resources, pharmaceuticals, and synthetic organic products (plastics, textiles, and chemical intermediates). The CNPq and NAS agreed to establish a joint study group on chemistry to recommend a program for strengthening the fields in chemistry relevant to long-term economic development.

2. Members

From Brazil

Manoel da Frota Moreira
Scientific Director
Conselho Nacional de Pesquisas
Rio de Janeiro, Brazil
Chairman, Brazilian Panel

Marcelo Moura Campos
Professor Catedrático de Química
Orgânica da Escola Politécnica
da Universidade de São Paulo
São Paulo, Brazil

Bernardo Geisel
(Membro do Conselho Deliberativo do
CNPq)
Professor Emérito de Química da
Universidade Federal do Rio
Grande do Sul
Porto Alegre, Brazil

Eloísa Mano
Professora de Química da
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Janeiro
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Ernesto Tolmasquim
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Conselho Nacional de Pesquisas
Rio de Janeiro, Brazil
(Died, 1970)

From the United States

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Department of Chemistry
Stanford University
Stanford, California
Chairman, U.S. Panel

William S. Johnson
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3. Activities

The CNPq - NAS Study Group on Postgraduate Research in Chemistry first met in Brazil, August 5 - 9, 1968, and visited the Federal University of Rio de Janeiro, the Brazilian Center for Physics Research (Rio), and the University of São Paulo. Research collaboration between Brazilian and U.S. panelists was planned in polymer chemistry, synthetic organic chemistry, photochemistry, inorganic chemistry, gamma radiation

in macromolecules, electron spin resonance, and electron scattering. Research topics in these areas were chosen because of (a) joint interest and (b) relationship of the fields to modern industrial chemical development.

In September, 1968, the U.S. panel met separately in Palo Alto, California, to discuss specific research activities. Each panelist pledged himself to work with a Brazilian counterpart in a research project for 5 years.

The Third Brazil - U.S. Workshop (1969) endorsed the 5-year plan proposed by the joint study group. The program was viewed as an experimental one to strengthen chemistry education and research in areas essential to long-term industrial development. Creation of an indigenous capacity to train very high level chemists and sustained research activities evidenced by publication in international journals were to be among the chief indicators of progress in the 5-year cooperative program. Features of the program included:

1. Establishment of a new NAS Overseas Research Fellowship program to attract recent Ph.D's to work in Brazilian laboratories for a minimum of 2 years.
2. Creation of a joint Brazil - U.S. Chemistry Committee of senior professors who would meet at regular intervals to review the progress of programs. The U.S. professors further agreed to visit their Brazilian colleagues' laboratories periodically to collaborate in supervision of the research in progress.
3. Provision of funds for equipment and chemicals not ordinarily available in Brazil and agreement on means to import the materials into Brazil on a timely basis.

4. Creation of a special coordinating office in the CNPq and in NAS as a channel for communication and administration of the program.

By December, 1972, the program was well established in both Rio de Janeiro and Sao Paulo. It is expected that by 1974, the termination of the 5-year period, 11 Ph.D's and an even greater number of M.S. degrees will have been awarded.

The Brazil - U.S. Chemistry Committee has recommended extension of the program through 1976.

4. Observations and Comments

The CNPq - NAS Study Group on Postgraduate Research in Chemistry illustrates, perhaps better than any other study group activity, the process of defining a problem, analyzing alternative actions, making specific recommendations, and implementing the recommendations when approved by a bilateral workshop. Although this experimental program is not yet completed, factors that are contributing to its success are

- a. receptivity by a group of influential Brazilian scientists to a major new program of chemistry teaching and research;
- b. willingness of the CNPq to give high priority to a long-term program;
- c. availability of local and international financial resources;
- d. timely approval of the program proposal;
- e. limitation of effort to three institutions; and
- f. rapport among the scientists in the study group.

Recognition should also be given to the catalytic roles of Dr. Manoel da Frota Moreira, Brazilian panel chairman, and Dr. Carl Djerassi, U.S. panel chairman, who saw the need for a graduate chemistry program and

were able to lead their colleagues in preparing a realistic plan for Brazil.

A second important observation concerns the role of the NAS in the chemistry program through its Board on Science and Technology for International Development. Although the NAS usually limits its activities to problem identification, analysis, and recommendations for appropriate action, it wishes--in its international science-and-technology projects--to test new problem-solving techniques and mechanisms that can be applied by others. Thus, in the chemistry program the NAS Council approved a broader, more operational mode of technical assistance. A detailed evaluation of this experimental approach is planned for 1974.

EARTH SCIENCES

1. Origin and Objectives

The First Workshop (1966) created a joint study group on mineral resources and charged it to suggest ways (a) to strengthen the National Department of Minerals Production (DNPM) of the Ministry of Mines and Energy and (b) to stimulate geology education in Brazilian universities.

In 1969, urgent manpower needs in the earth sciences again led participants in the Third Workshop to recommend that CNPq and NAS study the problems.

By that time an AID - Government of Brazil loan for technical assistance to DNPM had been made and one of the objectives of the original Mineral Resources Study Group was fulfilled, although there was no direct intervention or influence of the CNPq-NAS on the negotiation and granting of the loan. A new joint study group on earth sciences was formed. It was concerned with long-range needs for graduate education and research, particularly in geochemistry and geophysics.

2. Members

CNPq - NAS Mineral Resources Study Group

From Brazil

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Minister of Mines and Energy
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Chairman, Brazilian panel

Imack Carvalho do Amaral
Ministry of Mines and Energy
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From the United States

William D. Johnston, Jr.
Foreign Geology Branch
U.S. Geological Survey
Washington, D.C.
(Died, 1972)

Max G. White
U.S. Geological Survey
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Rio de Janeiro, Guanabara

CNPq - NAS Earth Sciences Study Group

From Brazil

John M. Albuquerque Forman
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From the United States

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George A. Parks
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Although the CNPq did not appoint a counterpart Brazilian panel in 1970, two persons worked closely with Professor John Forman--Dr. Othon Leonardos, Sr., head of the Geosciences Institute at the Federal University of Rio de Janeiro, and Dr. Paulo Leite de Paula Leite, representative of the Minister of Mines and Energy for training programs.

3. Activities

The Mineral Resources Study Group did not function in the usual, rather formally organized and structured manner of the other CNPq-NAS study groups. One of the advisors to the U.S. panelists was a resident of Brazil and maintained regular contact with Brazilian scientists through ongoing U.S. Geological Survey (USGS) - DNPM programs. This afforded an opportunity for periodic meetings in Brazil and facilitated the presentation of a report to the CNPq. Furthermore, recommendations of the First Workshop (1966) did not inaugurate a new activity but underlined an existing plan to strengthen administrative management and training functions at DNPM.

Because the activities recommended by the Mineral Resources Study Group were limited in scope and because a new CNPq survey of earth sciences education in Brazilian universities indicated manpower needs were not being met, the CNPq asked participants of the Third Workshop (1969) to review university programs with particular reference to developing skills needed for long-term analytical and research capabilities, as the existing programs were not satisfactory. From the Workshop discussions came the recommendation to form a new study group concerned with graduate education and research which were being implemented by Brazilian agencies to meet Brazil's long term problem-solving requirements in the geosciences.

In the fall of 1969, a U.S. geochemist attended a national meeting of Brazilian earth scientists in Bahia, where graduate training and research needs were reviewed in light of the CNPq survey. This led to a June, 1970, visit by a panel of three U.S. earth scientists to discuss, with a representative group of Brazilians, the needs for strengthening graduate education and research. The U.S. panel visited a few university centers, but the joint group did not recommend a specific program as they felt that the short visits did not lead to a real knowledge of Brazilian problems. The idea that Brazilian scientists had was to strengthen the graduate courses with help from American professors while Brazilians were taking graduate courses abroad. The U.S. panel recommended an in-depth analysis and evaluation of manpower training and research opportunities in Brazil. The study would involve one and a half man-years of high-level consultation by visiting experts from outside Brazil.

In 1971, the Fourth Workshop approved the general recommendation for an in-depth feasibility study of the potential for graduate education and

research in the earth sciences, emphasizing geochemistry, geophysics and mathematics applied to geology. Later, after examining time constraints, costs, and availability of individuals in Brazil and the United States, NAS decided to reconsider the method for such a feasibility study. In 1973 due to the lack of funds on the NAS side, it was decided to name a coordinating committee that will try to implement an exchange program between the U.S. and Brazil, in order to develop specific fields in geophysics, geochemistry, and geomathematics within the universities that are already giving graduate courses and developing research programs.

4. Observations and Comments

There are several reasons why activities of the CNPq - NAS Earth Sciences Study Group, appointed in 1970, extended over a considerable period of time without leading to a joint program. First, there existed the problem of funding senior U.S. specialists for periods of six months each. Direct grant funding from AID was not available in 1971. Since a mineral resources loan between the U.S. AID and the Ministry of Mines and Energy included provisions for training activities, efforts were made to include the project recommended by the study group under loan funding. The Ministry, however, preferred to offer short courses for its employees rather than provide funds for long term graduate training or research programs in the universities. Thus the mineral resources loan was not available for the program recommended by the study group.

Because no other source of funds became available by late 1972, NAS and CNPq began to consider other alternatives to accomplish the goal of strengthening planning of graduate education and research in the earth sciences. The CNPq had already appointed a special geophysics commission

to review teaching, research and application of geophysical methods in Brazil. Their report was to be available early in 1973. Furthermore, an inventory of general earth sciences education was also undertaken by the CNPq as part of its continuing program to evaluate university programs in the sciences. By building upon these CNPq activities a new joint study group, composed of 3 panelists from Brazil and 2 or 3 from the United States should be able to review available data, and present recommendations to the CNPq in an expeditious fashion. Focus of the work would be limited, at CNPq request, to geophysics, geochemistry and mathematics as applied to geology.

In summary, the immediate goal of a new CNPq - NAS earth sciences study group is to suggest one or more strategies for development of earth sciences teaching and research at the graduate level in the universities. The ultimate objective is to strengthen scientific manpower capabilities in mineral, petroleum and water resources so that there is no need to seek foreign technical assistance in the basic and applied geologic problems of Brazil.

INDUSTRIAL RESEARCH

1. Origin and Objectives

Participants at the First Workshop (1966) recommended the establishment of a joint Industrial Research Study Group to study how the relationship among universities, industry, and government could be improved to strengthen industrial-research capabilities and thereby accelerate development in the Brazilian industrial sector.

2. Members

From Brazil

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Arthur W. Weber
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Corning Glass Works
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3. Activities

The Industrial Research Study Group was active for 16 months--April, 1967, through July, 1968. During that time the Brazilian and U.S. panels met on 4 occasions, while the Brazilian panel by itself met 34 times. The first joint meeting was convened in Rio de Janeiro and São Paulo, Brazil, April 17 - 19, 1967, to establish specific terms of reference, subject areas for the preparation of background papers, and a schedule of activities. A second joint meeting was held at the Battelle Memorial Institute, Columbus, Ohio, August 14 - 16, 1967, to analyze the mechanism and structure of the Brazilian industrial research system. Papers presented by the Brazilian

panelists discussed the current status of industrial research in Brazil, fiscal incentives, and tax legislation and other related matters. After the seminar the Brazilian panelists visited several industrial research laboratories to learn about trends and practices in the United States.

Before the third joint meeting in Belo Horizonte, Brazil, February 19 - 22, 1968, U.S. panelists made individual and group visits to Brazilian industrial research institutes and to industries. These visits, seminars, and discussions enabled both the Brazilian and U.S. panelists to develop rapport with their counterparts and to understand industrial research patterns in both the United States and Brazil. The joint study group prepared a first draft of its report at the meeting in Belo Horizonte.

In July, 1968, Brazilian panelists again visited the United States to participate in a specifically organized 2-day seminar on industrial research management at Arthur D. Little, Inc., Cambridge, Massachusetts, and a final meeting with the U.S. panel July 22 - 26, 1968, to complete the final report. Entitled Industrial Research as a Factor in Economic Development, the report recommended activities in the following areas:

1. Budgetary planning of research expenditures and establishing criteria for determining priority classification of research projects by Brazilian government agencies;
2. Funding of public and private industrial research;
3. Fiscal incentives;
4. Development and improvement of industrial and research management capabilities;
5. Interrelationships of education with other sectors;

6. Training, compensation, and increased output of researchers;
7. Improvement of existing government institutes of technology;
8. National system of scientific-technological information and documentation;
9. Establishment of a model industrial research institute; and
10. Proprietorship of patented processes and products.

The report was submitted to the Third Workshop (1969) and endorsed by the participants. The CNPq has disseminated it widely in Brazil, where it has influenced several specific industrial applications. The Brazilian panel of the joint study group remained in existence to advise the CNPq on industrial research. The CNPq also created local working groups in food technology, ceramics, iron and steel, pulp and paper, and scientific-technological information. In 1970, the CNPq financed a new publication, The Brazilian Journal of Technology, to disseminate information on industrial research in Brazil. In May, 1971, the CNPq sponsored a 3-day conference to discuss current industrial research in Brazil; 6 industrial-research institutions and 31 agencies that fund technological research sent representatives. Under CNPq-NAS sponsorship, Dr. Lawrence Bass, retired vice-president of Arthur D. Little, Inc., visited Brazilian research institutes to lecture on management training. The CNPq increased overall support for fellowships each year from 1967 through 1970, and, according to the latest data available, the percentage of fellowships in the area defined as technology increased from 8 to 15 percent of total fellowships. Since April, 1969, the CNPq and the Ministry of Planning have submitted 12 projects in applied scientific and industrial research for loan funding from the Inter-American Development Bank.

The Fourth Brazil - U.S. Workshop (November, 1971) in a session on industrial research, heard a summary of CNPq activities since 1969. The workshop participants approved a recommendation for further CNPq-NAS cooperation in industrial research, particularly in the management of research and development related to the Brazilian national iron and steel industry.

4. Observations and Comments

The report of the Industrial Research Study Group, published in both Portuguese and English, received wide circulation throughout Brazil. It is notable for its range and directness of approach to problems of industrial-research management. The study group gave Brazilian and U.S. industrialists, university professors, and government officials an unparalleled opportunity to work on common concerns. Because of Brazilian interest in the subject matter, CNPq and NAS support at the highest levels of management, and staff assistance to follow through on the periodic meetings, significant results were achieved during the 16-month life of the project.

The previous section refers to a number of CNPq actions resulting from activities of the Industrial Research Study Group. A more detailed account is given in a paper by Professor Persio da Souza Santos in the report of the Fourth Workshop. (See Bibliography--Science and Brazilian Development: Report of the Fourth Workshop on Contributions of Science and Technology to Development.)

NORMS, MEASUREMENTS, and TESTING

1. During the First Workshop (April, 1966) discussions in the industrialization sessions led to a recommendation that a joint study group be formed to explore establishment of a Brazilian national institute of standards.

Appointed in 1967, the study group broadened its terms of reference to consider a standardization system that would cover both government and private activities and would meet Brazilian requirements for compliance testing and standardization.

2. Members

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Executive Group of Electrical
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(United States, continued)

Malcolm W. Jensen
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National Bureau of Standards
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Alvin G. McNish
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National Bureau of Standards
Washington, D.C.

3. Activities

The Joint Study Group on Norms, Measurements, and Testing met at the National Bureau of Standards in Washington, D.C., May 16 - 19, 1967, and was preceded by a series of visits to U.S. governmental, professional, and industrial organizations concerned with problems of standardization. Under a revised formulation of their terms of reference, the study group directed attention to expansion of Brazilian export industry and the need for a standardization system suited to the requirements of public and private industries. The study group recognized that the diversity and multiplicity of the Brazilian industrial sector demanded a sector-by-sector approach. They agreed to consider, as time and funds permitted, electronic-electrical, mechanical, steel, nonferrous metals, automobile, and shipbuilding industries.

A second joint meeting in Rio de Janeiro, August 28 - September 7, 1967, discussed (a) the importance of greater understanding in the Brazilian government and in industry of the advantages of a standardization system, (b) the need for more active involvement of Brazilian industry in the formulation of Brazilian standards, (c) desired changes in Brazilian institutional arrangements in the standardization process, and (d) methods to motivate voluntary compliance by industry.

The third joint meeting, in Washington, D.C., March 4 - 15, 1968, discussed joint recommendations and drafted a report summarizing the views

of the study group. The report, issued in Portuguese in 1969, recommended the formation, under CNPq auspices, of a National Council for the Coordination of Standardization. The Brazilian Association of Technical Standards, an agency with industrial support recognized by Brazilian law, would be responsible for preparation of standards. A network of testing and reference laboratories was also recommended to complement a new national service for compliance certification and the existing National Institute of Weights and Measures.

4. Observations and Comments

The recommendations of the study group were never adopted by the governing board of the CNPq or transmitted to appropriate authorities of the Brazilian Government largely because of opposition from leaders of existing organizations dealing with weights and measures and standardization. The study group's report will undoubtedly contribute to a modification of the present Brazilian standardization system when industrial and governmental circumstances permit.

TRANSPORTATION RESEARCH

1. Origin and Objectives

During the Third Brazil - U.S. Workshop (April, 1969) a session on Brazilian transportation research needs was held. Workshop panelists recommended creation of a CNPq-NAS study group to review transportation in terms of manpower requirements, education, and research needs.

2. Members

From Brazil

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Federal University of Rio de
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Rio de Janeiro, Guanabara
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Jacques de Medina
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From the United States

Joseph Grunwald
Director, Economic and Social
Development Studies
Brookings Institution
Washington, D.C.

Adolph D. May
Associate Professor of
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University of California
Berkeley, California

3. Activities

The study group held a preliminary meeting on July 9, 1970, in Rio de Janeiro to agree upon the terms of reference for their activities. The Brazilian chairman felt that since no significant transportation research was under way, the study group should suggest research projects on various modes of transportation (particularly air and land) and recommend them

to CNPq for financial support. Because of the need for specialized manpower in transportation, the study group would review, and make recommendations on existing Brazilian graduate programs.

Dr. Grunwald suggested that transport development in Brazil be examined in terms of the total economic development plan. A comprehensive transportation study, prepared for the World Bank, was available to the joint study group. With an understanding of how transportation needs were related to development goals, research recommendations could then be made. Graduate training in transport engineering and transport economics would be one major aspect of the study group's responsibilities.

Inability to agree on the terms of reference for a study group project led the NAS and CNPq to postpone consideration of transportation research.

4. Observations and Comments

Many factors must be present for a study group project to succeed. These include (a) strong support by both sponsoring organizations, (b) clearly defined goals for a study, (c) ability of the study group members to work well together, (d) a sense of urgency of the problem being considered, and (e) staff support for the panels. In the transportation research study group, the panelists could not agree on a definitive set of goals within the broad mandate provided under the Fourth Workshop's recommendations. Largely because of the inability to agree upon the terms of reference, the study group activity was not pursued.

III WORKSHOP ACTIVITIES

Introduction

The principal technique of the Board on Science and Technology for International Development (BOSTID) in its bilateral programs is the joint workshop in which specialists from the United States and a developing country collaborate to assess and analyze a country's research needs and opportunities in terms of its resource base and development goals. Joint workshops recommend ways by which scientific and technological development needs can be met through governmental policies, institutions for training technical manpower, and mechanisms for research coordination and planning. Workshops often lead to the formation of study groups designed to analyze specific problems in greater detail and to recommend policies and programs to local scientific and technological institutions, public and private. This pattern of workshop and study group activities with the CNPq has continued since 1966.

The First Workshop (April, 1966) led to basic understanding by CNPq and NAS of the role of bilateral programs in the development activities of the CNPq. From this understanding grew joint activities for problem analysis in agricultural research; agricultural economics; industrial research; norms, measurements, and testing; and mineral sciences. The study groups that were formed then reported to the Second Workshop in February, 1968. Progress in these early years was slow because work programs had to be defined, funding secured, and organizational details agreed to by CNPq and NAS.

The Third Workshop (April, 1969) provided a forum to review Brazilian science policy. The Minister of Planning outlined the strategic plan for Brazilian scientific and technological development. The role of the National Bank for Economic Development in strengthening scientific and technical areas was explained, and CNPq's changing responsibilities in scientific and technical development discussed. Next, study groups reported on their work and recommendations. These reports, and other events of the Third Workshop, are presented in a separate English-language document entitled Science and Brazilian Development: Report of the Third Workshop on the Contribution of Science and Technology to Development, prepared by NAS (see Bibliography). Study group activities are summarized in Section II of the report.

Among the significant accomplishments of the Third Workshop were

1. Review and discussion of the final report of the Industrial Research Study Group (see Bibliography).
2. Agreement by CNPq and NAS to sponsor an experimental 5-year chemistry program to strengthen graduate research and education in two Brazilian universities and one research institute.
3. Review and discussion of an interim report of the Agricultural Research Study Group, emphasizing management aspects of agricultural research in Brazil.
4. Review and discussion of an interim report in agricultural economics, highlighting education and research needs.
5. Agreement to undertake new joint initiatives in earth sciences, computer sciences, and transportation research.

The Fourth Brazil - U.S. Workshop met at the National Academy of Sciences in Washington, D.C., November 1 - 5, 1971, to review joint activities by study groups on agricultural research, agricultural economics, computer science, earth sciences, and industrial research; to review the chemistry program for 1969 - 1971; and to recommend future directions for CNPq-NAS activities. The NAS report in English, Science and Brazilian Development: Report of the Fourth Workshop on the Contribution of Science and Technology to Development, (see Bibliography) gives a detailed account of workshop sessions.

Among the principal recommendations were the following:

1. Continuation of the Agricultural Research Study Group's work in problems of research management and its expansion to include a study of the potential for agricultural-engineering education in Brazilian universities and a survey of problems of the campo-cerrado areas, leading to recommendations on research priorities;

2. Completion of a definitive proposal to strengthen agricultural-economics research on farm-level production problems through a joint program patterned after the joint CNPq-NAS chemistry program;

3. Renewal of NAS-CNPq study activities in industrial research with particular reference to research, development, and management problems in the iron and steel industry;

4. Reactivation of a joint study group in earth sciences, directed at graduate education and research potential in geochemistry and geophysics; and

5. Completion of a definitive proposal to strengthen graduate education and research in computer science in Brazilian universities.

Workshop Participants

Third NAS - CNPq (Brazil) Workshop

April 7 - 11, 1969, Rio de Janeiro, Brazil

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Fourth NAS - CNPq (Brazil) Workshop

November 1 - 5, 1971, Washington, D. C.

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Washington, D.C.

Observations and Comments

The NAS - CNPq (Brazil) Science Cooperation Program originated at the First Workshop (1966), and joint workshops continue to be the principal forum for discussing development problems in which science and technology are important. Joint workshops also review the progress of individual study group programs, endorsing or modifying conclusions to provide the basis for specific recommendations. Because workshops are not random conferences with agenda based on limited topics, they have become a development technique central to the NAS - CNPq program. Over the years a body of knowledge and expertise has been built up within the Brazilian and the U.S. scientific communities which can be applied to a variety of problem situations. The underlying philosophy of the workshop and study group method is a systems approach to technical aspects of economic development.

The joint workshop technique has been applied by BOSTID in a number of development situations. The Brazilian example is the oldest continuously operating program and, because of the wishes of CNPq, has included many topics. In other countries the subject matter of workshops has been more limited. Examples include three workshops with the Indonesians on natural resources, industrial research, and nutrition, and with Ghana on determination of research priorities. There have also been regional workshops such as one on African agricultural research priorities; another on problems of development and the environment in Central America; and a third on water resources, the environment, and national development in South East Asia. The broad range of NAS workshop activities is the subject of

an analytical report to be issued about July, 1973, by the Office of the Foreign Secretary, National Academy of Sciences.

Perhaps the best measure of the worth of the NAS-CNPq program is the desire by both organizations to continue joint activities. In 1973, study groups are planned in agricultural engineering education, earth sciences education, and analysis of research priorities for the Brazilian campo cerrado. The present summary of ongoing activities for 1968 - 1972 reports on the types of projects that the NAS and CNPq will continue into the 1970's. In the broadest sense, the program demonstrates a joint Brazil - United States commitment to the application of science and technology in the development process.

IV

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APPENDIX A

Board on Science and Technology for International Development (BOSTID)
(Members, 1968 - 1972)

- Roger Revelle, Director, Center for Population Studies, Harvard University, Chairman 1968 - 1972; Member 1968 -
- Carl Djerassi, Department of Chemistry, Stanford University, Chairman 1972 - ; Member 1968 -
- C. Arnold Anderson, Comparative Education Center, University of Chicago, Member 1971 - 1972
- Ivan L. Bennett, Jr., Dean, School of Medicine, New York University Medical Center, Member 1971 -
- Nyle C. Brady, Director of Research, Director of Experiment Station, College of Agriculture, Cornell University, Member 1970 - 1971
- George Bugliarello, Dean of Engineering, University of Illinois, Member 1972 -
- Charles S. Dennison, Former Vice President, International Minerals and Chemicals Corporation, Member 1972 -
- D. Mark Hegsted, Department of Nutrition, Harvard University School of Public Health, Member 1970 - 1972
- Lady Barbara Ward Jackson, Albert S. Schweitzer Professor of International Economic Development, Columbia University, Member 1971 - 1972
- William A. W. Krebs, Vice President, Arthur D. Little, Inc., Member 1968 -
- Robert N. Kreidler, Executive Vice President, Alfred P. Sloan Foundation, Member 1968 -
- Roy L. Lovvorn, Cooperative State Research Service, U.S. Department of Agriculture, Member 1968 - 1972
- John J. McKelvey, Jr., Associate Director, Agricultural Sciences, The Rockefeller Foundation, Member 1968 - 1972
- Edwin Manger, Professor of Geography, Division of Humanities, California Institute of Technology, Member 1968 - 1971
- Joseph Pettit, President, Georgia Institute of Technology, Member 1972 -

- Joseph B. Platt, President, Harvey Mudd College, Member 1968 -
- H. F. Robinson, Provost, Purdue University, Member 1968 - 1972
- Stefan H. Robock, Graduate School of Business, Columbia University,
Member 1968 - 1972
- H. Burr Steinbach, Dean of Graduate Studies, Woods Hole Oceanographic
Institution, Member 1968 - 1971
- Clifton Wharton, President, Michigan State University, Member 1968 - 1970
- Gilbert White, Institute of Behavioral Science, University of Colorado,
Member 1972 -
- Carroll L. Wilson, Alfred P. Sloan School of Management, Massachusetts
Institute of Technology, Member 1968 - 1972
- Sterling Wortman, Vice President, Rockefeller Foundation, Member 1972 -

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- Walsh McDermott, Institute of Medicine, National Academy of Sciences
- Thomas F. Malone, Deputy Foreign Secretary, National Academy of
Sciences
- Bruce S. Old, Foreign Secretary, National Academy of Engineering