Science and Brazilian Development

Report of the Fourth Workshop on Contributions of Science and Technology to Development

NOVEMBER 1-5, 1971 WASHINGTON, D.C.

Conducted by
Office of the Foreign Secretary
National Academy of Sciences
in Cooperation with
National Research Council of Brazil
Conselho Nacional de Pesquisas

NATIONAL ACADEMY OF SCIENCES

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SUMMARY REPORT

Fourth BRAZIL - U.S. WORKSHOP on SCIENCE and TECHNOLOGY in DEVELOPMENT

Washington, D.C.

November 1 - 5, 1971

Sponsored by

The National Research Council of Brazil
(Conselho Nacional de Pesquisas)

and the

U.S. National Academy of Sciences

This summary report records the issues discussed and the conclusions reached at the Fourth Brazil - U.S. Workshop on Science and Technology in Development, held in Washington, D.C., November 1 - 5, 1971. It is not a basic policy document although the recommendations do touch upon policy matters and development strategies. It was compiled from background documents prepared for the Workshop, summaries written by the working groups, and staff notes.

The Workshop was sponsored by the National Research Council of Brazil (Conselho Nacional de Pesquisas) and the Board on Science and Technology for International Development, Office of the Foreign Secretary, National Academy of Sciences with the support of the U.S. AID Mission in Brazil under contract AID/csd-1122, Task Order Number 3.

NOTICE

The study reported herein was undertaken under the aegis of the National Academy of Sciences with the express approval of the Governing Board of the National Academy of Sciences - National Research Council. Such approval indicated that the Board considered that the problem is of national significance; that elucidation and/or solution of the problem required scientific or technical competence and that the resources of NAS were particularly suitable to the conduct of the project. The institutional responsibilities of the Academy were then discharged in the following manner:

The members of the study committee were selected for their individual scholarly competence and judgment with due consideration for the balance and breadth of disciplines. Responsibility for all aspects of this report rests with the study committee, to whom sincere appreciation is expressed.

Although the reports of our study committees are not submitted for approval to the Academy membership nor to the Council, each report is reviewed by a second group of appropriately qualified individuals according to procedures established and monitored by the Academy's Report Review Committee. Such reviews are intended to determine, inter alia, whether the major questions and relevant points of view have been addressed and whether the reported findings, conclusions, and recommendations arose from the available data and information. Distribution of the report is approved by the President only after satisfactory completion of this review process.

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I

INTRODUCTION

The fourth in a continuing series of Workshop meetings, co-sponsored by the Brazilian National Research Council (CNPq) and the U.S. National Academy of Sciences (NAS) through its Board on Science and Technology for International Development (BOSTID), was held in Washington, D.C., November 1 - 5, 1971.

Workshops are binational meetings, convened to bring together representatives from the scientific community, government, and private institutions to discuss informally problems relating to science and economic development. The first Workshop in the series was held in Itatiaia, Brazil, April 11 - 16, 1966. This meeting resulted in the formulation of specific recommendations for continuing Brazil - U.S. activity in five problem areas: (1) industrial research; (2) norms, standards, and measurements; (3) agricultural research; (4) agricultural economics; and (5) mineral sciences.

A second Workshop was held in Washington, D.C., February 5 - 9, 1968, to review the direction and work of the existing joint study groups. A special feature was a seminar on the science-policy-formation process in Brazil and the United States. Discussions of Brazil's science policy were based upon a review of the 1968 - 1972 Five-Year Plan for Scientific and Technological Development presented by CNPq. Two new joint study groups were created: one in postgraduate chemistry research and education and a second in computer sciences.

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A Third Brazil - U.S. Workshop was held in Rio de Janeiro, April 7-11, 1969. In September, 1968, the work of the Joint Study Group on Industrial Research was completed after approximately 15 months of activity. A comprehensive report entitled "Industrial Research as a Factor in Economic Development" was submitted by the Study Group to the CNPq, endorsed by the CNPq Council and transmitted to Brazilian government and industrial officials as well as to the universities. The report on norms, standards and measurements was also completed, presented to the CNPq and distributed in Brazil. The Joint Study Group on Agricultural Research sponsored a seminar on administrative problems in agricultural research in Rio de Janeiro in February 1969. Industrial research and agricultural research, therefore, constituted the major items on the Third Workshop agenda. Discussions of joint projects in earth sciences, agricultural economics, post graduate chemistry education and research and computer sciences were also held.

Interim Activities

During the period between the Third and Fourth Workshops, activities took place in the following fields:

1. Chemistry. The CNPq and NAS began a major effort to strengthen graduate education and research through a joint program in Brazil. Two universities, the Federal University of Rio de Janeiro and the University of São Paulo, were selected as locations for the program. Major funding for equipment, fellowships for Brazilian graduate students, in-country costs, and consultation visits to the United States was provided by CNPq. The NAS funds 10 NAS Overseas Research Fellows and the periodic visits to

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Brazil by members of a U.S. Chemistry Advisory Panel composed of senior professors. NAS support is provided under a contract from the U.S. AID Mission in Brazil and, under grants from the U.S. National Science Foundation, the Anderson and Atlantic Richfield Foundations (U.S.), and the Atlantic Petroleum Company (Brazil). A progress report on the chemistry program by Dr. Paschoal Senise, University of São Paulo, is included as Annex B to this report.

2. Agricultural Research. The Joint Study Group focused primarily upon the study and analysis of agricultural research planning and management in Brazilian federal and state institutions. In July, 1970, a seminar on Agricultural Research Administration was held in Campinas, State of São Paulo, Brazil--the second organized by the Study Group on this general topic. Approximately 150 persons attended, representing nearly all state, federal, and private agricultural research-and-training centers in Brazil.

Before the July, 1970, seminar members of the Study Group made extensive visits to agricultural research-and-training centers in the south of Brazil. In 1969 a similar series of visits had been made in the North. As a result of these activities the Study Group underlined a need for agricultural-engineering training and research in Brazil.

A summary of the Agricultural Research Study Group activities presented to the Workshop by Dr. Carlos Krug, counsellor in agriculture to the CNPq, is included as Annex C.

3. Agricultural Economics. As in agricultural research, this Joint Study Group is primarily concerned with analyzing Brazilian activities, identifying problems, and recommending solutions. In

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1970 the Brazilian members of the Joint Study Group visited several U.S. centers to observe research and discuss agricultural policy planning with U.S. leaders. The Group developed a preliminary program proposal for the strengthening of research and analysis in agricultural economics in Brazilian agricultural research stations. (See Annex D for a revised version of the proposal.) The Joint Study Group also participated in a July, 1970, Agricultural Research Seminar in Campinas, assuming responsibility for the session on agricultural economics.

4. Industrial Research. During the interval between the Third and Fourth Workshops, the Brazilians assumed responsibility for implementing recommendations from the September, 1968, Industrial Research study. An account of these activities is included as Annex E.

5. Computer Science. A Joint Study Group to analyze manpower needs for teaching and research and for computer applications in industry, commerce and government was formed in 1970. Early the same year two Brazilian members of the Study Group visited the United States to observe trends in computer science education and to participate in a major computer conference. The Joint Study Group also held a week long meeting in Brazil. A report on these activities by Professor Carlos J. P. Lucena, Pontifical Catholic University of Rio de Janeiro, is included as Annex F.

6. Earth Sciences. A Joint Study Group was appointed in 1970 to consider needs for graduate training and opportunities at Brazilian universities for study of geology, geochemistry, and geophysics. The general conclusions were presented at the Workshop by Professor John D. A. Forman, CNPq director for earth sciences activities, and are included as Annex G.

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II

SUMMARY OF RECOMMENDATIONS

The Fourth Brazil - U.S. Workshop dealt with a number of separate, specific topics. For convenience the recommendations are summarized in this section without detailed reference to the background papers presented during the Workshop sessions. Additional background information on which the recommendations depend is given in the annexes to this report.

Continuing Committee (CNPq-NAS)

Recognizing the importance of regular, joint consultations in the diverse fields in which the two organizations are cooperating, the Workshop recommends that

1. A six-member Continuing Committee composed of three members designated by each organization be formed for purposes of program planning and implementation. The NAS and CNPq will each designate a senior staff member as a permanent liaison representative on the Continuing Committee; the remaining members may be changed from time to time as program needs dictate. The Committee will meet twice each year, once in the United States and once in Brazil. A July, 1972, meeting in Rio de Janeiro is planned as the first meeting of the Continuing Committee.

2. The series of major Workshops be continued at intervals of approximately 2 years.

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Agriculture

Recognizing that the Government of Brazil has given agriculture the highest priority in the national development plan, the CNPq and NAS have resolved to strengthen their cooperation in this important area. The following are specific projects for implementation:

1. Creation of a four-member joint panel to conduct an in-depth study leading toward an education-and-research center in agricultural engineering in Brazil.

2. Creation of a four-member joint panel to survey research being conducted on problems of the cerrado areas in Brazil, to achieve better program coordination, and to recommend additional research areas.

3. Completion of a definitive proposal for strengthening research in agricultural economics on farm-level production problems.

4. Organization, perhaps jointly with the industrial research study group, of a short course on management of research and development.

Industrial Research

Recognizing the good results obtained by CNPq in 1969 - 1971 in implementing the recommendations of the original CNPq-NAS Industrial Research Study Group, the Workshop recommends that

1. The CNPq and the National Academy of Sciences - National Academy of Engineering (NAE) establish a continuing cooperative program in industrial research.

2. Because the Brazilian National Development Plan for 1972 - 1974 gives priority to the iron and steel industry, the first project should be a joint U.S. - Brazil study group on iron and steel, to be created early

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in 1972. With the objective of strengthening Brazilian research and development capabilities in this sector, the group should examine and make recommendations concerning technology utilization and projected requirements for facilities, manpower, and education-and-training programs in the areas of refractories, continous casting techniques, and the basic oxygen furnace (BOF) steel-making method.

3. The conclusions of the Joint Study Group on Industrial Research on the need and urgency to develop capable industrial research administrators to increase the productivity of industrial research be implemented. One means to accomplish this goal is the organization of special programs and seminars in management science.

Geosciences

Recognizing the need to develop and exploit wisely the mineral resources of Brazil, and the parallel need for a strengthened analytical capacity in geology, geochemistry, and geophysics, the Workshop recommends that

1. The Joint CNPq-NAS Earth Sciences Study Group be continued.

2. An action program be started during 1972 to bring three to six specialists in geochemistry, geophysics, and mathematics applied to geology to Brazilian universities for periods of 1 to 6 months. One university, determined by the specialty of the visitor, would serve as a base for each visit. The specialists would offer courses and seminars and, working with Brazilian geoscientists, formulate short- and long-term program recommendations in each field.

3. After the initial visits in each subject matter area, the CNPq-

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NAS Joint Study Group should establish a coordinated program plan for 1973 and succeeding years.

Computer Science

Recognizing the importance to Brazil of Computers within the scientific, university-research oriented community and within the industrial or applied-research community, the Workshop recommends that:

1. The Joint CNPq-NAS Computer Science Study Group be continued in order to

a. Arrive at a plan for the development of graduate programs in harmony with Brazilian industrial needs, and

b. Strengthen communication and foster cooperation between Brazil and the United States.

2. As one means toward this goal, the CNPq and NAS should collaborate with other national and international institutions that will jointly sponsor the International Symposium on Computer Education for Development planned for August, 1972, in Brazil. An examination immediately after the Symposium of its significance to the Brazilian situation would be a particularly useful task for the Joint Study Group.

Chemistry

Recognizing that the CNPq-NAS chemistry program has been a very promising way to foster technical cooperation, and that a program of this magnitude and complexity requires a number of years for its complete development, the Workshop recommends that

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1. Both the CNPq and the NAS continue to give the chemistry program full attention and support through 1974;

2. Catalysis research be added as one of the research fields within the overall program, provided funds can be made available;

3. During 1972, CNPq and the NAS review the progress of the program with the view to determining if it should be continued for the 2-year period 1974 - 1976;

4. The program not be extended to other Brazilian universities at present;

5. Additional U.S. professors be invited to participate in the U.S. panel for the chemistry program; and

6. Additional steps be taken to resolve problems of duty-free entry for chemicals, supplies, and personal effects of NAS Fellows, and that a full-time program coordinator be appointed by Brazilian authorities.

Technology Monitoring and Innovation

Recognizing that the NAS is engaged in an experimental project on technology monitoring and innovation with the objective of identifying solutions to economic and technical development problems, the Workshop recommends that

1. A Brazilian scientist-technologist be selected by mutual agreement with the NAS and invited to join the Technology Monitoring and Innovation Advisory Committee of the Board on Science and Technology for International Development, travel and per diem to be provided by NAS for no more than three meetings per year over a 2-year period;

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2. The CNPq be encouraged to send, at its expense, one observer to meetings of the Advisory Committee on occasions when the regular Brazilian member is not in attendance; and

3. The Panel consider holding one of its meetings in Brazil at some future time.

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III

WORKSHOP SUMMARY

Background

NAS bilateral programs with a developing country usually begin with a workshop in which specialists from the two countries collaborate by analyzing and inventorying research needs and opportunities in terms of the country's resource base and its socioeconomic development goals. The joint group then proposes recommendations to achieve specific objectives. To reach these objectives it is sometimes necessary to establish new governmental mechanisms or new links between scientists and government decision makers. Workshops also lead to the formation of specialized study groups to investigate particular problems in greater depth and to recommend strategies or policies for solving problems. Occasionally, as in the case of the Brazil chemistry program, a long-term operational activity results from the combined workshop-study group recommendations.

The Fourth Brazil - U.S. Workshop on Science and Technology in Development, held at the National Academy of Sciences in Washington, D.C., November 1-5, 1971, continued the strong bilateral ties between the Academy and the Conselho Nacional de Pesquisas (CNPq). The Workshop had three primary objectives:

1. To review Joint Study Group Activities in agricultural research, agricultural economics, computer science, geosciences, and industrial research;

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2. To review the operations of the Chemistry Program since its inception in 1969 and discuss program strategy for the period 1972 - 1974; and

3. To review and evaluate the NAS-CNPq bilateral relationship since its inception in 1965 and discuss future directions for joint activities.

Ten Brazilian scientists and engineers came to the United States to participate in the Workshop with eight U.S. counterparts. Another ten persons from the U.S. science and technical community assisted the participants in various Workshop sessions.

The Workshop agenda, participants, and observers are given in Chapter IV of this report.

General Sessions

Dr. Philip Handler, President of the National Academy of Sciences, opened the Workshop with extemporaneous remarks on the role of scientists and technologists in the socioeconomic development process of developed and less developed nations. He stressed the importance of bilateral discussions in achieving a better understanding of common problems facing Brazil, the United States, and other nations. He cited as examples rapid population growth and migration, health and nutrition, and productive use of human and natural resources. He specifically stressed the need to recognize the effects of these problems on the quality of man's life.

Dr. Amadeu Cury, president of the CNPq Advisory Council and chairman of the Brazilian participants for the Workshop, reviewed the direction of science policy in Brazil since the First Joint Workshop in 1966. He summarized recent science activities in Brazil, noted some of the charac-

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teristics of scientific-technological growth in his country, and related them to overall national development.

Dr. Manoel da Frota Moreira, CNPq Scientific Director, discussed the "integrating role" of research and education in science and technology development. His remarks, entitled "The National Research Council of Brazil: A Strategy for Science and Technology Development," are found in Annex A of this report.

Mr. William Ellis, Director of the U.S. AID Mission in Brazil, spoke about the role of that Mission in assisting Brazilian science and technology. He endorsed the CNPq-NAS bilateral program as one important element in a limited, but catalytic, function of U.S.-Brazilian cooperation for development.

Specific Sessions

Chemistry. One afternoon was given to a detailed review of the Brazil - U.S. Chemistry Program. In part, specific operational aspects of the program were considered. Details such as the importation of equipment and chemicals, orientation and relocation of Fellows, and administrative support for the Fellows were discussed. The question of extending the Chemistry Program into other research areas and to other Brazilian universities was also examined. Comments and observations, from the Brazilian committee responsible to CNPq for the Chemistry Program, are given in the remarks of Dr. Paschoal Senise in Annex B.

Agricultural Research - Agricultural Economics. Dr. Carlos Krug, an agricultural scientist and member of the CNPq Council, led a review of the agricultural research and agricultural economics activities. Because of the importance of the agricultural sector in the present Brazilian five-

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year economic development plan, the CNPq desires to focus Joint Study Group activities upon rather specific problems. Three activities that are to be given priority for the immediate future are (a) implementation of a plan to strengthen agricultural-economics research and analysis in Brazilian agricultural research stations, (b) undertaking a review of agricultural-engineering education and research, and (c) undertaking a review of research activities in the Brazilian cerrado (savanna) areas. A report on the Agricultural Research and Agricultural Economics Study Groups, as presented to the Workshop by Dr. Krug, is included as Annex C. A proposed program for research in agricultural-economics is Annex D.

Industrial Research. Professor Persio da Souza Santos from the Institute of Technological Research, University of São Paulo, and a member of the CNPq Council, spoke about the activities of CNPq to strengthen industrial research and promote communication of such research in Brazil. A specific example of an operating program in the iron and steel industry was presented by Dr. Miguel de Lima Bohomoletz from the Brazilian Ministry of Industry and Commerce. A summary report by Professor Souza Santos is given in Annex E.

Another session was devoted to a seminar on management and administration of research and development, for which the following were the principal speakers:

1. Dr. George Herbert, President of Research Triangle Institute of North Carolina. The Institute was formed by the University of North Carolina, North Carolina State University, and Duke University to promote industrialization in the Southeastern United States, a situation paralleling the Brazilian Government's efforts to increase industrialization in the Northeast, the Amazon region, and elsewhere. He spoke about the role

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of university-based research institutes and the way to link such institutes with industry.

2. Dr. Donald Collier, Vice-President for Research, Borg Warner Corporation. Dr. Collier spoke about the development of industrial research in the United States, how the emphasis has changed, and how industrial research in private, profit-making enterprises is distinct from research in government or nonprofit organizations. Formerly President of the U.S. Industrial Research Institute, an organization composed of American industries, he also discussed the role of such organizations in extending the benefits of industrial research.

3. Dr. Edward Roberts of the Sloan School of Management, Massachusetts Institute of Technology. Dr. Roberts discussed the training of research and development personnel. Methods and philosophies of training and education are of particular relevance to Brazil, where industrialization is growing at 10 to 12 percent a year.

The R & D management and administration seminar intended not to result in specific recommendations but to explore various aspects of a problem that is of growing importance to Brazil. It is expected that the subject of R & D management practices and training techniques will be considered again by the joint CNPq-NAS Continuing Committee.

Computer Science. Professor Carlos J. P. Lucena, Pontifical Catholic University of Rio de Janeiro and Chairman for CNPq Computer Science Programs, reported on the activities of the NAS-CNPq Joint Study Group on Computer Science. This Study Group has focused its attention on an analysis of manpower needs and training opportunities. In addition, the Study Group reported on its efforts to link the universities that are the trainers

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of computer specialists with industrial users of the specialized personnel. One objective of the Group is to understand the supply-demand picture for computers and for computer specialists in Brazil and make appropriate recommendations to CNPq. Because the work is not yet completed, a final report was not submitted to the Fourth Workshop. A progress report, presented by Professor Lucena, is given in Annex F.

Professor John M. de Albuquerque Forman, Chairman of the CNPq Geosciences Programs, summarized the present situation of postgraduate education opportunities in geochemistry, geophysics, and geology in Brazilian universities. The NAS-CNPq Joint Study Group recommended the strengthening of training in these fields because development of mineral resources has a high priority in Brazilian economic planning. A summary presentation by Professor Forman is given in Annex G.

Technological Innovation and Monitoring

A presentation was made by Dr. George Bugliarello, Dean of the School of Engineering, University of Illinois (Chicago), on the goals of the new NAS Advisory Committee on Technological Innovation and Monitoring. This Committee is endeavoring to uncover new technological approaches to specific development problems, such as (a) the potential of ferrocement for boat-building and other construction, (b) discovery of inexpensive and effective roofing materials and techniques, (c) non-food uses of protein materials, and (d) electrical power sources for remote villages in less developed countries.

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IV

AGENDA, PARTICIPANTS, OBSERVERS

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

November 1

Welcome and Introduction to the Workshop

Dr. Philip Handler, President, NAS
Dr. Harrison Brown, Foreign Secretary, NAS

"Science in Brazil: Advanced and Post Graduate Studies"

Dr. Amadeu Cury, Rector, University of Brasilia

The National Research Council of Brazil (A Strategy for Science and Technology Development)

Dr. Manoel da Frota Moreira, Scientific Director, CNPq

The CNPq Activities in the Area of Computer Science and the CNPq-NAS Study Group in Computing

Professor Carlos J. P. Lucena, Pontifical Catholic University of Rio de Janeiro
Dr. Bruce Gilchrist, Executive Director, American Federation of Information Processing Societies

NAS Project for Technology Innovation and Monitoring

Dr. George Bugliarello, Chairman, School of Engineering, University of Illinois, Chicago Circle Campus

November 2

CNPq Joint Cooperative Program with the NAS in the Field of Agriculture

Dr. Carlos Krug, Consultant to CNPq in Agriculture
Dr. Roy L. Lovvorn, Administrator, Cooperative State Research Service, U.S. Department of Agriculture

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CNPq Joint Cooperative Program with the NAS in the Field of Chemistry

Dr. Paschoal Senise, Chairman, Department of Chemistry, University of São Paulo
Dr. Carl Djerassi, Department of Chemistry, Stanford University

November 3

Report on the 1969 - 1971 Industrial Research Program of the CNPq

Professor Persio de Souza Santos, Institute of Technological Research, University of São Paulo

Technology Development and Transfer in the Brazilian Iron and Steel Industry

Professor Miguel de Lima Bohomoletz, Technology Advisor (Iron and Steel), Ministry of Industry and Commerce, Rio de Janeiro

Seminar on Research and Development Management in Industrial Research

Mr. George Herbert, President, Research Triangle Institute, North Carolina
Mr. Donald Collier, Vice President for Research, Borg Warner Corporation, Chicago
Dr. Edward Roberts, Sloan School of Management, Massachusetts Institute of Technology

November 4

Individual appointments for Brazilian panelists (National Science Foundation, National Bureau of Standards, U.S. Department of Agriculture Experimental Station (Beltsville), U.S. Geological Survey and U.S. Department of State)

November 5

CNPq-NAS Geosciences Program

Professor John M. de Albuquerque Forman, Chairman, Earth Sciences Commission, CNPq

Workshop Conclusions and Recommendations

Dr. Amadeu Cury, Rector, University of Brasilia
Dr. Manoel da Frota Moreira, Scientific Director, CNPq
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ANNEX A

THE NATIONAL RESEARCH COUNCIL OF BRAZIL: A STRATEGY FOR SCIENCE AND TECHNOLOGY DEVELOPMENT

Manoel da Frota Moreira

The National Research Council of Brazil (CNPq) played the major role in establishing on a government level a solid basis for the development of science and technology in Brazil.

Results of this work have been most rewarding: scientific and technological research hold an outstanding priority in the present "Program for Aims and Bases of Government Activities," drawn up by the Ministry of Planning of Brazil.

In this Program, in which fundamental national aims for the period 1970 - 1973 are set forth, the Government gives major priority to

1. Revolution in education and speedy development of a Health and Sanitation Program;
2. Revolution in the field of agriculture and food supply;
3. Acceleration of scientific and technological development; and
4. Strengthening of the competitive capacity of national industry.

The major role of science was further stressed by a substantial raise in the appropriations for scientific development to Cr$1,470 million for the 1970 - 1973 period, compared to a low Cr$43 million in 1967.

It was thus officially recognized that the only way to achieve global

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aims of development is by pooling decisions presented by scientists with political decisions concerned with the socioeconomic progress of the country; that scientific research and education are to be viewed as integrating elements in the process of advancing culture and raising the standard of living, and that technology and operational development are to be held as essential elements in promoting the material progress of the country.

A careful analysis of the growing activities of CNPq in 20 years of existence will furnish valuable data, including a set of priorities dictated by experience acquired along the way.

The CNPq, an agency subject to the Presidency and designed to promote and encourage scientific and technological investigation in every field of knowledge, is the Government's chief executive instrument for developing the part of the global plan pertaining to science and technology.

The Act creating the Council made specific provisions for budget funds of its own. In the last years the amounts have been those shown in Figures 1 and 2.

It must be pointed out here that other government agencies have been created meanwhile with programs parallel or complementary to the Council's. Their funds have contributed to the increase of financial support to science and technology in Brazil. In this category may be mentioned the National Fund for Scientific and Technological Development, of the Ministry of Planning; the Coordination for the Training of Personnel in Advanced Studies, of the Ministry of Education; the National Nuclear Energy Committee, of the Ministry of Mines and Energy; the Fund for Technical-Scientific Development, of the Bank of Economic Development.

After the groundwork of creating an awareness of science, the CNPq

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decided in favor of a support stage. Efforts were primarily concentrated on giving assistance to science researchers and institutions already at work in the country, and on setting up other centers that were indispensable to the framework of Brazilian research.

Along those years of steady and productive work, CNPq gained solid prestige in official circles, university communities, and the major areas of activity; and funds increased accordingly.

The Council was then ready to launch an intensive program for training able scientific personnel and to establish an effective system of scholarships and of grants to supplement the salaries for full-time scientific work. Scholarship recipients range from students working on a specific project under an able professor, up to head researchers or research-lecturers.

The main goal, then and now, has been to multiply the number of research people through what may be called a selective process of identification of, and support for, the most capable in the field. At the same time scholarships at the initial levels are meant to attract promising young people to the career.

As a complementary step, basic conditions have been improved in an effort to provide the indispensable facilities for research activities.

Increasing science personnel continues to be, perhaps, the Council's major concern, with the goal of obtaining a "critical mass" of highly competent people, from which will eventually emerge a "mass of talents" capable of producing creative work.

Scholarships

In 1970 CNPq's scholarships totaled 2,700, compared to 2,143 in 1969.

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(See Figures 3 and 4.) Last year 1,802 went for personnel formation: 666 at the initial level; 1,136 for postgraduate training and special courses at institutions officially recognized by CNPq as postgraduation centers. The rest were given to assistant researchers, researchers, heads of research, and research-lecturers whose work needs financial support.

Meantime, sholarships have also been granted, allowing research people to work on Ph.D. and postdoctorate levels in foreign institutions; 68 of these are now studying abroad in various fields, and 65 others will follow later this year.

Postgraduation Centers

In 1968, a decree came into effect providing for the establishment of Regional Postgraduation Centers and ordering CNPq to make a survey of the institutions in a position to hold postgraduate courses on a high level. For this purpose, the Council appointed a Postgraduation Committee, which has so far selected 81 institutions as meeting the requirements involved. These have been called "Centers for Excellence" and offer 156 M.Sc. and Ph.D. courses. (See Figure 5.)

CNPq granted 550 postgraduate scholarships last year, 750 in the present year; and 850 have been set aside for next year.

It should be explained here that some years back the Council brought together all the major federal and state agencies involved with science research and advanced studies. An overall coordinated plan for scholarship grants was drawn up then.

At present, approximately 4,000 postgraduate students are enrolled in various courses throughout the country, half of whom receive scholarship grants from those agencies.

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Of 156 postgraduate courses previously mentioned, 120 lead to a Master's Degree and only 36 to a Doctor's Degree. This seems to be an adequate distribution of M.Sc. and Ph.D. facilities to attend to the requirements of research work and technological development in countries like Brazil: a considerably larger number of people well trained for professional activities, and for adaptation and transference of technology; and a much smaller number qualified for creative work in science and technology, as well as for the training of a new generation in the field.

Simultaneously, the program to provide adequate conditions for research work has not been lost sight of. To that end, last year alone 500 grants were given, covering the acquisition of equipment and material, visits of foreign professors, maintenance of technical personnel, specialized training of Brazilians at institutions abroad, acquisition of scientific literature, etc. (See Figures 6 and 7.)

We now come to what might be called the converging state at which the qualifications of the scientist, the viability and intrinsic or extrinsic scientific value of the research project proposed, and its possible repercussions in other fields of science--or in the socioeconomic framework of the country--converge and strongly influence the decisions to be taken.

CNPq's Five-Year Plan for Science and Technology

After solving the problem of paying an adequate salary for research work on a full-time schedule, by 1967 the Council was in a position to launch a Five-Year Plan for the Development of Science and Technology. It defined the bases for an overall program and selected the fields to be developed in a rational and comprehensive order of priority, taking into

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account not only the country's scientific and technological needs, but also the operational viability in each case.

It was another significant step in the development of the Council's policy of science, taken with the assistance of the most outstanding members of the Brazilian scientific community.

Priority was given to what might be termed "reproductive" areas, such as physical-chemistry, inorganic chemistry, organic syntheses, and polymer chemistry, in which projects are now well advanced in the Universities of Rio de Janeiro and São Paulo. Now the fields of Agriculture, Geophysics, and Geochemistry, Computer Science, and Industrial Research which greatly benefited in the NAS-CNPq agreement are being implemented. The same can be said of Genetics, Biophysics, and Solid State Physics, which, since they operate in interdisciplinary areas, are expected to produce results of a "reproductive" nature.

These priorities have deserved special consideration in the agreements our Council has already signed with the U.S. National Academy of Sciences, The Royal Society (United Kingdom), the National Research Council of Canada, and the German Government, as well as in those it is about to sign with the United States, Japan, Israel, and Mexico.

In some cases, the Council has had to face chronological expediency, imposed by ecological or socioeconomic conditions of a transitory nature. This is the case of the so-called "natural laboratories," for which plans have been developed with a view to studying problems involved with social anthropology, linguistics, nutrition, man's adaptability to environment, zoology, botany, etc.

As the nucleus of a natural network of science and technology which

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has been growing and spreading for the last years, CNPq has also turned to programs of applied research, in collaboration with the Ministry of Planning, with a view to improving industrial and agricultural technology.

In this respect may be mentioned the overall evaluation of the Brazilian steel industry, with the participation of all the government agencies, private corporations, industrial associations, and research organizations involved in this field. As a result, measures have been taken to improve the technical know-how of the steel plants, so as to reach an annual production of 20 million tons by 1980. Likewise, the study for putting the campos cerrados to good use, is of particular interest to the Ministry of Agriculture.

Programs of applied research specifically designed to accelerate economic progress and improve the standard of living are drawn up in collaboration with the Ministry of Planning, to make sure they are not only desirable but opportune for implementing the National Plan for Economic Development.

From the point of view of the science administrator, careful attention must be given to technological research projects, in order to make sure the possibilities of their objectives' being reached have been properly evaluated.

It is well known that only about 5 to 10 percent of the overall cost with the process of innovation are applied on R & D.

Most likely, in developing countries, which as yet do not have an accurate system of economic evaluation, a great deal may be spent indefinitely on science-and-technology research with little or no chance of suc-

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cess. All the more so, when final results are likely to depend on the application of 9 or 10 times the resources available.

In view of the strengthening and extension in the various fields of research in Brazil, which we have tried to show here, CNPq judged conditions were ripe for expansion in the field of industrial technology.

To that end, a meeting was held at Itatiaia in 1967, under the joint sponsorship of NAS and CNPq. Discussions resulted in a basic project, published in 1968 under title "Industrial Research in Brazil as a Contributing Factor to Development," fundamental recommendations of which are being followed progressively.

Recently CNPq sponsored a meeting of representatives of the country's Technology Institutes to draw up a plan for organizing a National System of Technological Data.

In a coordinated action with the Ministry of Planning, CNPq has taken the initiative of submitting 12 projects in applied scientific research and industrial research to be developed with loans from the Inter-American Development Bank.

I hope to have given you here a true picture of CNPq's efforts not only to promote and accelerate the development of science and technology but, also to bring the results thereof to bear on the economic progress of the country, with a view to raising the Brazilian standard of living.

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FIGURE 1. CNPq budget, 1963 - 1970.

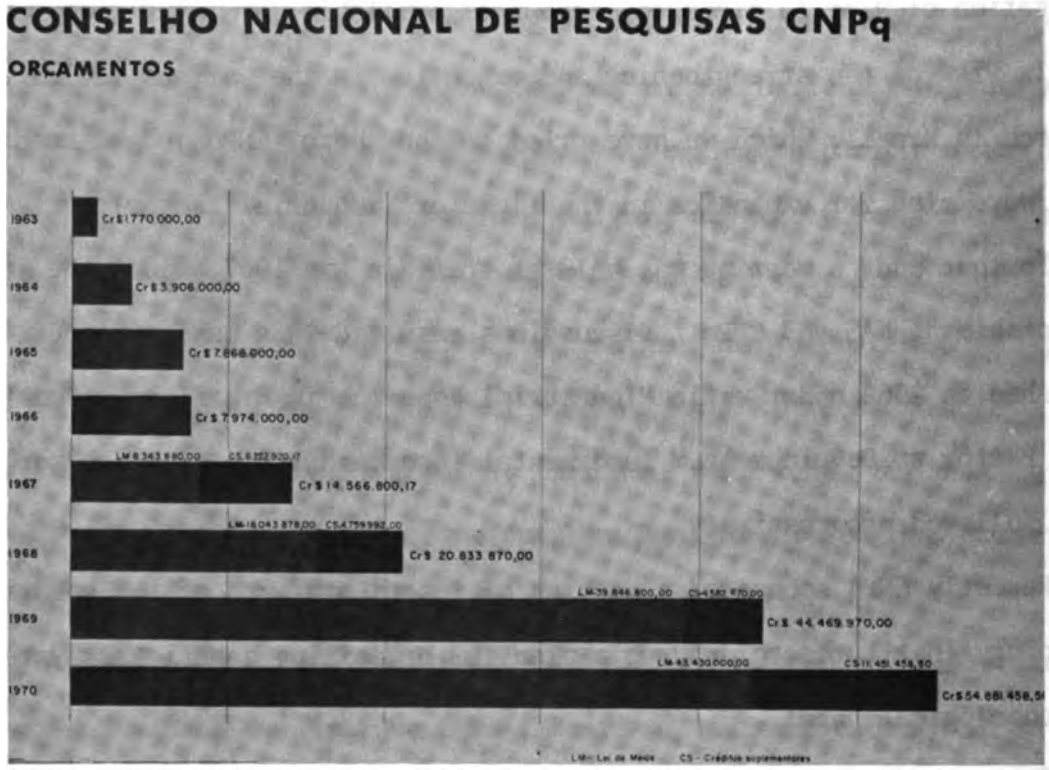

FIGURE 2. CNPq budget applications in 1970.

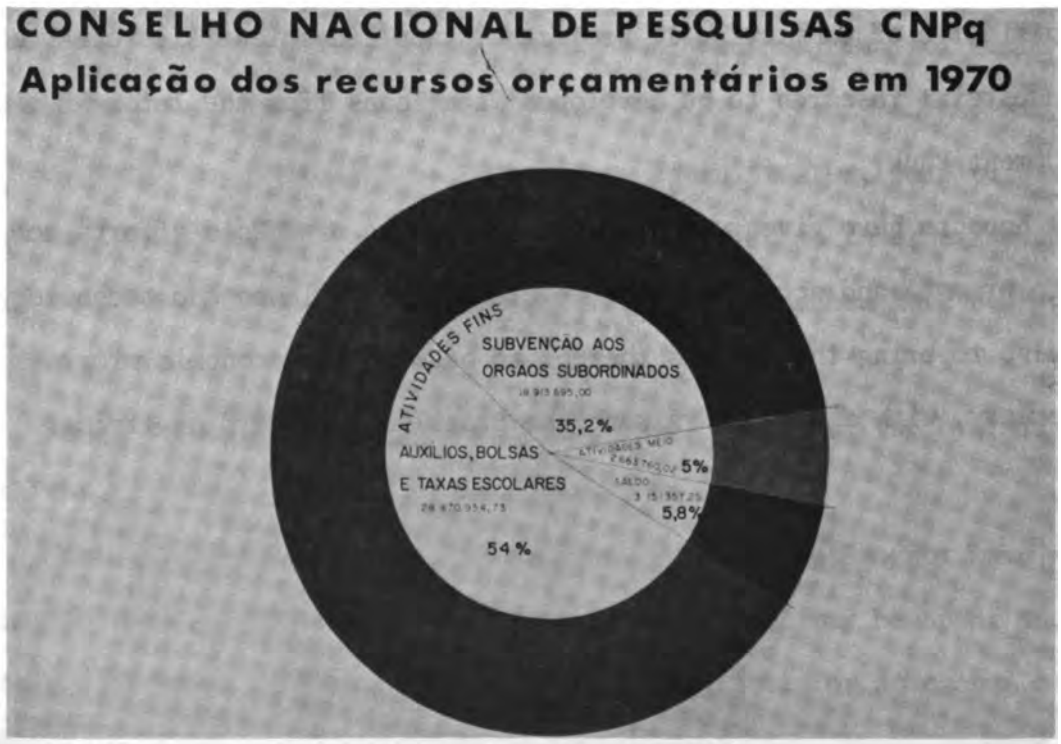

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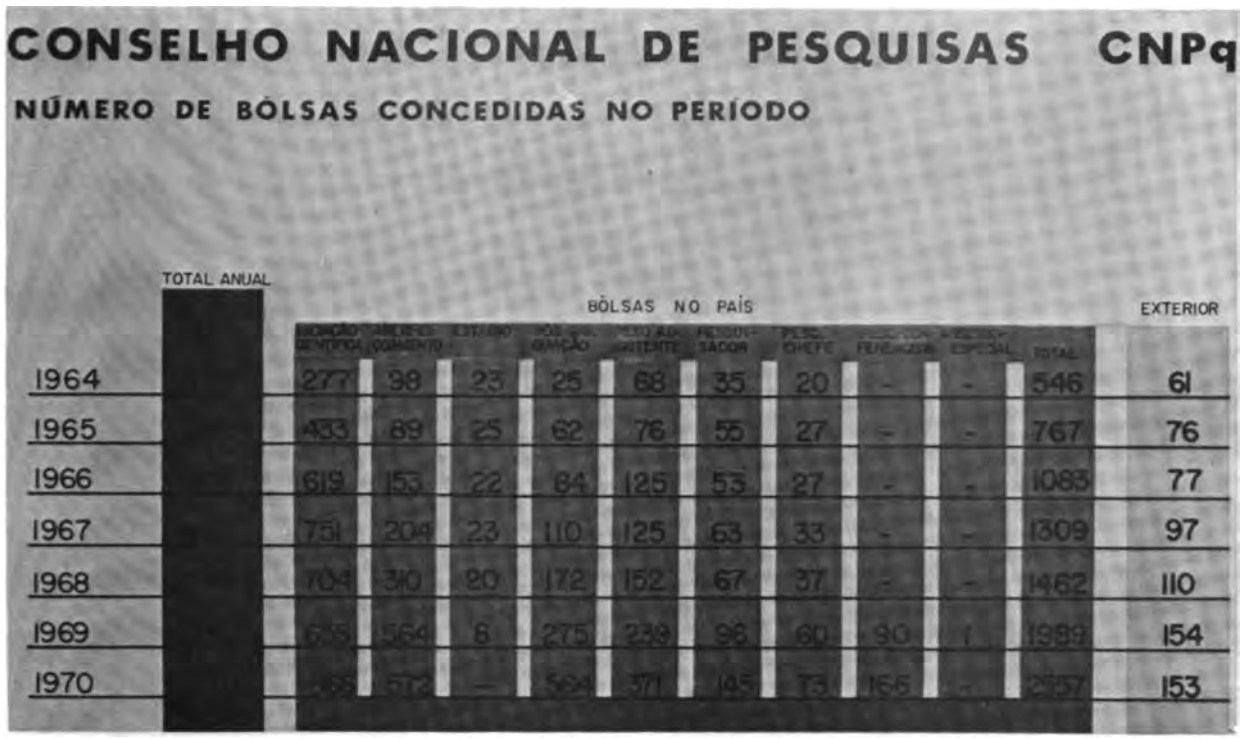
FIGURE 3. Number of CNPq scholarships awarded, by year.



CONSELHO NACIONAL DE PESQUISAS CNPq

NÚMERO DE BÓLSAS CONCEDIDAS NO PERÍODO

	TOTAL ANUAL	BÓLSAS NO PAÍS										EXTERIOR
		EDUCAÇÃO DE INTRODUÇÃO	AMPLIAÇÃO DE CONHECIMENTO	ESTUDO	POS-GRADUAÇÃO	PESQUISA AO AMBIENTE	PESQUISADOR	PESQUISA CHEFE	PESQUISA FENÓMENOS	PESQUISA ESPECIAL	TOTAL	
1964	[illegible]	277	98	23	25	68	35	20	-	-	546	61
1965	[illegible]	433	89	25	62	76	55	27	-	-	767	76
1966	[illegible]	619	153	22	84	125	53	27	-	-	1083	77
1967	[illegible]	751	204	23	110	125	63	33	-	-	1309	97
1968	[illegible]	704	310	20	172	152	67	37	-	-	1462	110
1969	[illegible]	635	564	8	275	239	96	60	90	1	1999	154
1970	[illegible]	[illegible]	572	-	564	371	145	73	166	-	2257	153

FIGURE 4. Number of CNPq scholarships awarded, by specialized sector.

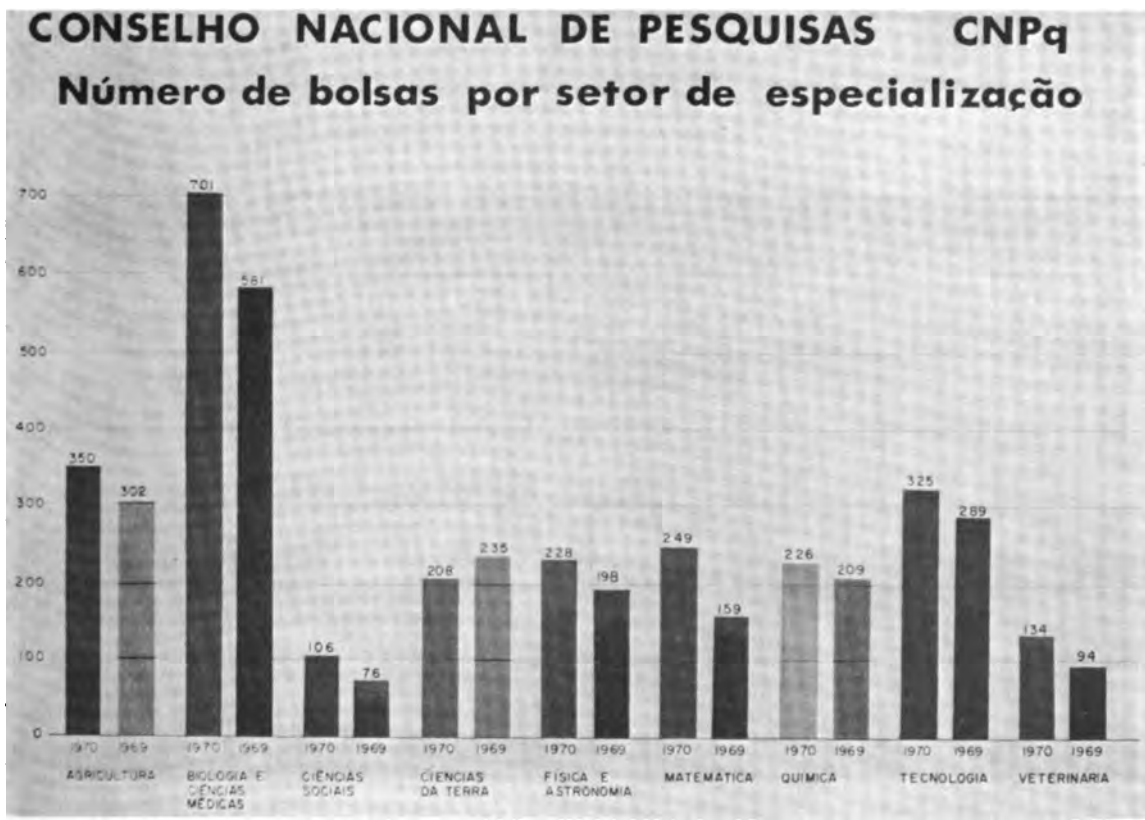


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FIGURE 5. CNPq report of centers of excellence.

CENTROS DE EXCELÊNCIA RELACIONADOS PELO CNPq.

SETORES	INSTITUIÇÕES CREDENCIADAS	NÍVEL DOS CURSOS: MESTRADO	DOUTORADO
AGRICULTURA E VETERINÁRIA	4	19	—
BIOLOGIA E CIÊNCIAS MÉDICAS	23	26	14
CIÊNCIAS SOCIAIS	8	8	1
CIÊNCIAS DA TERRA	4	6	4
FÍSICA E ASTRONOMIA	9	9	5
MATEMÁTICA	8	10	1
QUÍMICA	4	9	5
TECNOLOGIA	21	33	6
TOTAIS	81	120	36

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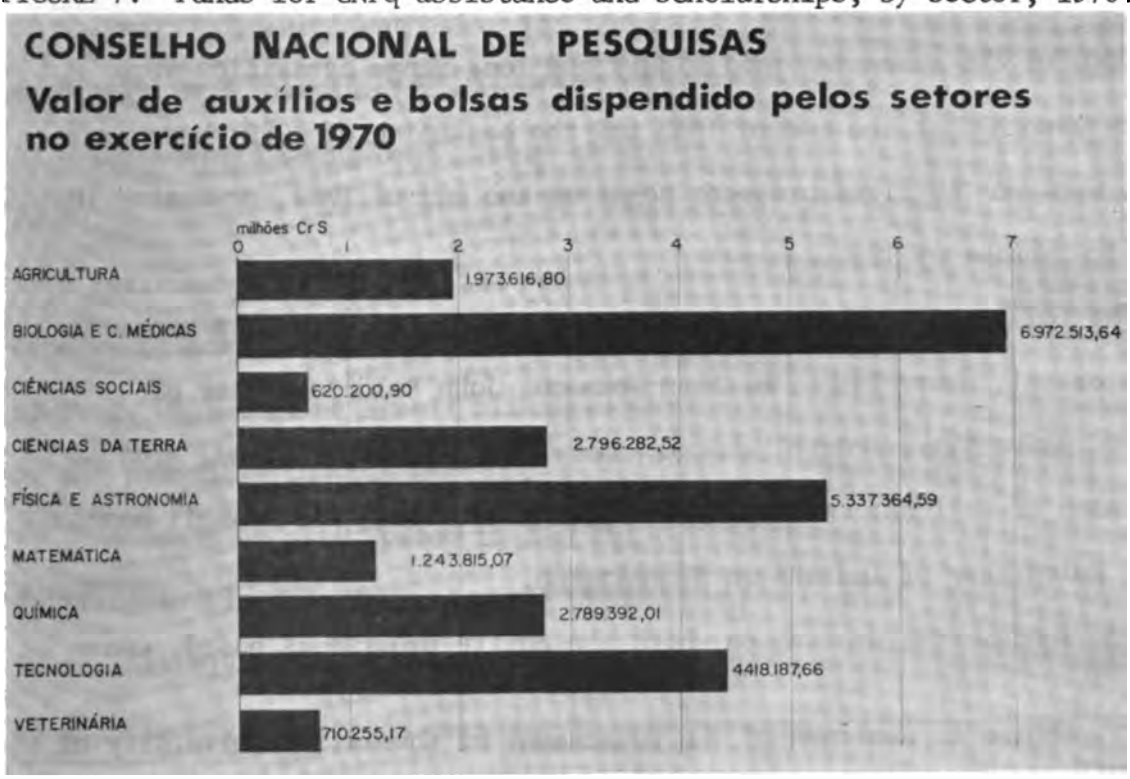
FIGURE 6. CNPq assistance and scholarships in force, 1969 - 1970.

FIGURE 7. Funds for CNPq assistance and scholarships, by sector, 1970.



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ANNEX B

PROGRAM FOR COOPERATION BETWEEN NAS AND CNPq: CHEMISTRY

Paschoal Senise

As a result of the joint meeting of the American and Brazilian groups of the National Academy of Sciences and the National Research Council in Washington, D.C., February, 1968, and the visit of outstanding American scientists to Brazil in August, 1968, a cooperative program in the chemistry sector was launched, aimed primarily at stepping up postgraduate and high-level research activities in Brazil.

The program is of very special importance, not only because it involves the direct collaboration of some of the most outstanding contemporary scientists in their special fields, but also because it was set up so as to guarantee continuity.

Some of the essential preliminary and long-range activities were already launched at the end of 1968 and the beginning of 1969; however, actual work on the first projects began at the end of 1969, or during the first few months of 1970.

The following professors are directly associated with this program: Carl Djerassi, Henry Taube, William Johnson, John Baldeschwieler of Stanford University, George Hammond, Harry Gray, Robert Ireland, Aron Kuppermann of Caltech; Charles Overberger of Michigan; and Russell Bonham of the University of Indiana in Bloomington.

One fundamental aspect, on which the entire program is based, con-

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sists of sending young postdoctoral fellows--who are students of these famous scientists--to Brazil for an average period of 2 - 3 years. Should a fellow return before the termination of the program, which is to run 5 years, he will be replaced by another young scientist having the same general qualifications. Each project involves association with a Brazilian professor, and, furthermore, every one of the American senior professors makes short visits to Brazil twice a year to get a closer look at the progress of the work and to hold seminars and deliver lectures.

The program has taken into account the current status of chemistry in Brazil. It is addressed to strengthening the scientific basis for developing the industrial and academic chemical sectors and includes the traditionally defined areas of physical chemistry, inorganic chemistry, and synthetic organic chemistry. Projects have been included in the fields of polymers, organic synthesis, ion resonance, electron scattering, photochemistry, and inorganic reaction mechanisms.

The work is being done partly in Rio de Janeiro and partly in São Paulo.

Periodic reports have been prepared and released by the National Academy of Sciences on the various phases of the program. This summary, however, will confine itself almost exclusively to a critical analysis of the present situation and some suggestions for the future.

As could be anticipated in the light of the diversity of conditions existing in Rio and São Paulo, the programs in each city had to be planned in an entirely different fashion and, more importantly, they were bound to be affected by conditions peculiar to each location.

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When the program began in São Paulo various graduate chemistry projects already were operating at the University, were located in the same building, and were in a natural process of integration and consolidation. This evolutionary process was given added impetus by the university reform measures adopted by the Government of Brazil for the entire university system and, in the case of the University of São Paulo, culminated in the establishment of the Chemistry Institute. The practice of exchanges with foreign professors through assistance from various domestic and foreign sources was well established, but the CNPq-NAS program opened a number of new teaching and research sectors, thereby giving a powerful stimulus to the extension of graduate chemistry programs at the University.

With the establishment of the Chemistry Institute, it was possible to make more efficient use of teaching personnel and thereby organize a full range of postgraduate activities in inorganic, analytical, organic, and physical chemistry. The new fellows who were attracted through the agreement between the NAS and the CNPq, are gradually participating actively in these postgraduate courses; they are having some difficulties which, of course, have not yet been completely resolved; but we think that they also found an environment which facilitated the exchange of ideas and personal contacts so that they do not feel completely isolated. We also wish to point out that the NAS-CNPq fellows and the permanent staff of the Chemistry Institute are mutually deriving benefits from the opportunity for close scientific collaboration. Although problems remain to be solved, the progress, as measured by the periodic reports, reveals results generally considered satisfactory by everyone.

As was anticipated from the beginning, it would have been desirable

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to have a larger number of postgraduate students in order to take better advantage of the presence of the NAS-CNPq fellows. In fact, there has recently been a gradual increase in the number of postgraduate students, even though there are still some difficulties along these lines. In absolute terms and mainly in terms of variety, the choices in existence can be noted in Table 1. We continue to publicize the opportunities for postgraduate studies in both the State of São Paulo and elsewhere in Brazil. We must, however, take care to maintain high standards in the selection process if we are to guarantee postgraduate research and education at the level consonant with our objectives. We have also instituted a refresher course or, more accurately, preliminary training for several months to assist those not quite prepared to meet the high entrance standards. We are making progress, although more slowly than we like in the recruitment of postgraduate students. We are firmly committed to the task of offering a program that is not limited to São Paulo but is emphatically national in its scope.

At this time, we have seven postgraduate students participating directly in projects connected with the program, plus three who are in their last year before graduation. Six new persons have already pledged to join the various groups, and they are scheduled to start their postgraduate work in 1972. Most are scholarship students sponsored by the Research Assistance Foundation of the State of São Paulo (FAPESP) whose material assistance to the Institute also indirectly contributes to the success of these projects. By virtue of its charter, the FAPESP cannot take care of scholarship students from other states, unless they are in an exceptional situation. Recently, however, it was possible for us to

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give financial assistance to individuals from other geographic areas of the country through aid we received from the National Economic Development Bank (BNDE). Through this bank, an appreciable contribution is also being made toward the procurement of equipment which will complete the already existing equipment that was furnished directly by the National Research Council. The same is true with regard to contributions received from the Inter-American Development Bank (IDB). Administrative difficulties have been largely overcome by the hard work and efficiency of Mrs. Hide Sugimoto Lafayette, who was hired with grant funds of the National Research Council. Next year we hope to alleviate the secretarial shortage by hiring other persons with our own money.

We also want to mention the bibliographic material, since the Institute Library--which also had to go through a process of integration when the libraries of the old departments at the University were combined--cannot receive the magazines necessary for work in various sectors, including those tied to the program, with the hoped-for regularity. This difficulty is primarily due to factors outside the administration of the Institute itself but can be almost completely resolved by next year. Already it has been possible to guarantee the renewal of subscriptions to all the periodicals for 1972 with in-house funds or with funds coming from the BNDE to provide for the airmail delivery of a certain number of magazines through a budget allocation from the Institute. In this way, we believe that we have taken an important step in supplying the means that we consider essential to the success of the program.

The situation in Rio de Janeiro was quite different. The more favorable conditions in São Paulo were largely due to a certain already existing

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TABLE 1. Graduate Enrollment in Chemistry, Institute of Chemistry, University of São Paulo

	1970		1971	
Subject Area	Masters Program	Doctorate Program	Masters	Doctorate
Analytical Chemistry	7	12	21	12
Inorganic Chemistry	6	11	15	11
Physical Chemistry	11	8	9	12
Organic Chemistry	11	17	14	22
Total	35	48	59	57
	83		116	

Origins of Students Enrolled, 1971

States in Brazil		Foreign Countries	
Bahia	3	Colombia	2
D. Federal (Brasília)	2	Egypt	1
Ceará	8	Ecuador	2
Guanabara	3	Israel	1
Minas Gerais	2	Mexico	1
Pará	1	Peru	1
Paraíba	1		
Paraná	4	Subtotal	8
Pernambuco	1		
Rio Grande do Sul	6		
Subtotal	31		
São Paulo (interior)	19		
São Paulo (city)	58		
Subtotal	108		
	Total: 116		

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research tradition which sprang from the pioneering activities of German instructors, and the fact that a reasonably full-time system has been in operation for many years.

We must, however, pay tribute to the most praiseworthy efforts with which some of the colleagues in Rio--imbued with a great spirit of personal sacrifice and idealism--managed, around 1963, to overcome the obstacles and, in isolated groups, to develop research activities and launch postgraduate courses. The results of the NAS-CNPq program in Rio and, particularly, the initial difficulties are an outgrowth of this situation. A major deterrent, furthermore, has been the lack of a concentration of research personnel at the new campus of the University City. Some key Brazilian counterparts to the foreign professors were not available.

On the other hand we must emphasize the extraordinary success obtained in the field of polymers by Professor Eloisa Mano. (This sector, by the way, is not yet developed in São Paulo.) The work in Rio, with the strong collaboration of Professor Overberger, illustrates the importance of the commitment of both parties to a program in its initial stages of operation. In particular, one can point to the fundamental necessity of a Brazilian senior associate, collaborating with the NAS-CNPq fellow, to ensure the success of the project.

Fortunately, the difficulties encountered in other sectors in Rio de Janeiro, particularly in inorganic chemistry, are being resolved; with the active participation of Dr. Aida Espinola, we believe that a way has been found which will lead to the hoped-for results. The management of the Chemistry Institute, at the Federal University of Rio de Janeiro, is giving every possible support. It must also be pointed out that Dr. Eloisa

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Mano and her group receive their largest financial support from the University and the National Economic Development Bank, both of which fully endorse her program.

Table 2 summarizes statistics for the program at Rio de Janeiro.

CNPq's great interest in the success of the program is revealed by an investment which, at this moment, totals US $541,103.02, excluding Brazilian personnel expenditures.

In continuing the program in the coming months, one of the points which we must also address ourselves to concerns the establishment and stimulation of exchanges between the centers in São Paulo and Rio. Already, we have had the pleasure of inviting Professor Eloisa Mano to São Paulo during the first half of 1971. She gave a postgraduate course on polymers which was attended by 15 regular students. She considered the result to be quite satisfactory, although about 10 of them did not really need credits. We were also able, for the first time, to offer a postgraduate course on this subject in São Paulo; and we had an opportunity to stimulate interest in polymer chemistry. Steps are now being taken to offer a portion of the postgraduate courses in São Paulo and then send the students to Professor Mano's laboratory in Rio for research and preparation of their dissertations. The Chemistry Institute in São Paulo recognizes the necessity of establishing a research group in polymers in São Paulo and looks to both Professor Manos' group in Rio and to Professor Overberger at Michigan for assistance in achieving this goal.

As initially intended, the NAS-CNPq agreement provides for the possibility of sending postgraduate students to the United States for varied periods of time, along with visits which might be made by the Brazilian

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TABLE 2. Graduate Enrollment, Institute of Chemistry, Federal University of Rio de Janeiro

	1970		1971	
Subject Area	Masters Program	Doctorate Program	Masters	Doctorate
Organic Chemistry	52	5	52	10
Inorganic Chemistry	0	0	2	0
Physical Chemistry	0	0	3	0
	52	5	57	10
Subtotal	57		67	
Biochemistry	26	2	34	4
Subtotal	28		38	
Total	85		105	

Origin of Students Enrolled, 1971[a]

State	No. of Students
Minas Gerais	1
Pará	3
Pernambuco	5
Rio Grande do Sul	1
Santa Catarina	1
São Paulo	1
Subtotal	12
Guanabara, including Rio de Janeiro	55
Total	67

a/ Does not include students in biochemistry.

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professors themselves who are involved in the program. This is one aspect to which we believe special attention must be devoted but we should not establish rigid conditions.

It has been found that the trips by the Brazilian professors prior to the actual launching of work were extremely fruitful. For example, Dr. José Riveros, at the end of 1968 and at the beginning of 1969, spent a period of time in the laboratory of Professor Baldeschwieler. Also Dr. Vicente Toscano, at the beginning of 1971, spent 2 months in the laboratory of Professor Hammond at Caltech to familiarize himself with work in the photochemistry sector. Another case is that of the Brazilian student Peter W. Tiedemann, who, after about 1 year in the laboratory of Dr. Riveros (São Paulo), spent about 3 months with both Drs. Riveros and Harry Blair in the laboratory of Professor Baldeschwieler (Stanford). This gave excellent results primarily because Tiedemann had considerable experience acquired previously in São Paulo. This method of sending postgraduate students abroad after a certain phase of their work in Brazil generally seems to us to be more desirable than the idea of sending them at the very beginning of their postgraduate studies. From the Rio group, Miss Eva Bierig spent 1 year of postgraduate studies at the University of Michigan and then returned to the Federal University of Rio de Janeiro to complete her master's work and to continue on to her doctorate.

This is the reason we feel that there must be a great deal of flexibility and each case will have to be examined separately. But there is no doubt that after getting their doctorates the good students should have an opportunity to spend some time abroad as post doctoral students to improve their knowledge. This type of fellowship support should not be

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overlooked in the NAS-CNPq cooperation program. Furthermore, we in Brazil are very much interested in providing good opportunities for the first Brazilian graduates from the program to return to university teaching and research careers. At the University of São Paulo, we are actively trying to get young people from states such as Ceará, Bahía, etc. to return to their universities of origin when they have completed their doctorates here. We also wish to attract those graduates who do not have any connections with any other universities, so that they may reinforce the nuclei at São Paulo and thus we may be able to guarantee the continuity of the work that the American scientists are now doing.

We have already taken the first steps along these lines by admitting Peter W. Tiedemann as instructor, and we are now offering an identical position to the student Henrique Eisi Toma, who is working under the guidance of Dr. John Malim. The same policy will be pursued in Rio de Janeiro.

Trips by Brazilian researchers directly associated with the program, such as that of Dr. Eduardo Peixoto in the United States for 45 days, are necessary. Also the trips by senior Americans are of major relevance, even though they come to Brazil for a shorter period of time and for a different purpose. Such periodic contacts have been highly stimulating and fruitful to our professors, the NAS-CNPq fellows, and to our students.

We also want to stress that in addition to the CNPq program with the NAS, we are trying to stimulate exchange through assistance from CNPq itself and from other organizations. The goal is to send young people from our universities abroad, especially to the United States, primarily as post doctoral students. We also want to attract qualified researchers to

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Brazil. Our desire is to promote such initiatives in as coordinated a manner as possible to ensure the best possible results. For example we would like to mention that Dr. Eduardo F. de Almeida Neves, of our laboratory in São Paulo is working with Professor Fred Anson at Caltech in electroanalytical chemistry. Expenses were financed entirely by the FAPESP. This is one example, but it is not the only one. Again we can point to the efforts of Dr. Eloisa Mano, who arranged that her first M.S. graduate, Luiz Antonio Alves, go to the University of Aberdeen, Scotland. This was financed by CNPq. Alves did research for 1 year along lines different from those explored in Rio; this work was the basis for his doctoral thesis.

Through visits with her students to the industrial area of São Paulo, Dr. Mano has tried to stimulate industry to become interested in the development of studies in the vast field of polymers.

We believe in the good results of coordinated work in chemistry, and above all we believe that it will enable us more easily to open other fields which are not yet completely developed--fields which we must not overlook in Brazil.

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ANNEX C

COOPERATIVE PROGRAM: AGRICULTURE

Carlos Krug

This document (1) summarizes activities carried out by the two Study Groups--on Administration of Agricultural Research and Agricultural Economics, (2) comments on their recommendations, (3) appraises the benefits so far derived from this international cooperation, and (4) proposes ways and means to pursue these activities.

I. Summary of Activities

A. Study Group on Administration of Agricultural Research

1. Members: CNPq: Glauco Pinto Viegas (Chairman)
Ady Raul da Silva
Mozart Teixeira Liberal

NAS: Roy L. Lovvorn (Chairman)
H. Rex Thomas (Vice-Chairman)
R. K. Frevert
James Turnbull (Alternate)

2. Visits. The American members of the team visited many Brazilian institutions where agricultural research is being carried out, to acquaint themselves with their achievements and problems.

3. Seminars on Administration of Agricultural Research. Two such seminars were held, in 1968 in Rio de Janeiro and in 1970 in Campinas, Sao Paulo. Numerous directors, teachers and research workers discussed important influences on the efficiency of research. These discussions are

Dr. Carlos A. Krug of the CNPq Governing Council presented the report based on this outline.

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expected to contribute toward basic improvements. Some of the recommendations, aiming at the elimination of serious bottlenecks, are already being implemented: the CNPq is supplementing salaries of numerous, selected research workers; new incentives will soon be offered them through adequate promotions; better, overall coordination of research is being promoted through National Research Committees; a great effort is being made to improve and expand postgraduate courses at selected institutions; and new national sources for the financing of research are now available. It is, however, recognized that much has still to be done to improve efficiency of research in Brazil.

4. Recommendations of the Study Group. The CNPq fully agrees with the recommendations in the Group's 1970 report that closer cooperation be established among federal and state research institutions and among these institutions and the universities; that teaching and research in agricultural engineering be encouraged; and that researchers in forestry be invited to future seminars on research administration.

B. Study Group on Agricultural Economics

1. This Group met three times, in 1968, 1969, and 1970, and presented their conclusions in three separate reports.

Members: CNPq: Victor J. Pellegrini (Chairman)
Constantino Carneiro Fraga
Helio Tollini

NAS: C. Edward Schuh (Chairman)
D. Woods Thomas
Lawrence W. Witt

2. Study Tours. A group of young Brazilian agricultural economists visited relevant institutions in Brazil and in the United States,

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primarily to acquaint themselves with ways and means to establish close cooperation among agricultural economists and research agronomists.

During its last meeting, the Group also discussed various alternatives for their continued activities. It was concluded that high priority should be given to the training of "research-oriented" agricultural economists, and a preliminary project dealing with this matter was prepared by Dr. G. E. Schuh. (See Annex D.)

II. Recommendations for Future Activities

A. Based on the suggestions in the reports of the above-mentioned Study Groups and also on recommendations of its Agricultural Committee, the CNPq proposes the following specific projects to be jointly carried out in the near future:

1. A Third Seminar on Administration of Agricultural Research. This should be held later, when the need may arise for the discussions of certain specific problems. The proposed short course on "R & D Management," proposed for industrial research directors in Brazil, should also be open to directors of agricultural research.

2. Project for the establishment of undergraduate teaching and research in agricultural engineering. An ad hoc committee of two Brazilians and two North Americans should be established at once to propose--after a 3-month investigation--ways and means to implement such a project.

3. Project to strengthen research in the CERRADO areas (savannas). Considering the following points:

a. the rapidly increasing use of these areas for food (both animal and plant) and forestry production, partly through special government incentives;

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b. the existence of several institutions already devoted to research in these areas;

c. CNPq's special interest in fostering and coordinating such research efforts through its Cerrado Committee; and

d. the need for speeding up such work through international cooperation.

The CNPq proposes that an ad hoc committee of four members--two from CNPq and two from NAS--be established at once to work out the details of such a project of scientific cooperation, possibly for a 5-year duration, which would contract the services of highly qualified researchers, particularly in the fields of soil fertility, plant physiology (soil/plant/water relations), animal nutrition, forage crops, and marketing, and would also include the postgraduate training of Brazilian technicians in the United States.

4. Project on training of agricultural economists, aiming at their integration in the field of agricultural research. Another ad hoc joint committee (a two-man team would be sufficient) should be nominated to further elaborate on Dr. Schuh's proposal. (See Annex D.)

It is also proposed that a qualified Brazilian institution be chosen to coordinate such a project and that it be started in the following places:

a. Brasilia (National Department of Agricultural Research and its Planaltina Experiment Station), or the Sete Lagoas Regional Agricultural Research Institute, both located within, or close to, vast cerrado areas.

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b. Belém (Regional Agricultural Research Institute). There is an urgent need in the Amazon area to apply agricultural research results in the implementation of large colonization projects along the "Transamazonica" road.

c. Curitiba (Regional Agricultural Research Institute) or the new Agronomic Institute at Londrina, North Paraná, where rapid changes are occurring in agricultural patterns, thereby causing social problems due to acute changes in labor requirements.

d. Campinas, São Paulo (Agronomic Institute). This is the country's oldest and largest agricultural research institution, with influence throughout the nation, and possibly, in some of Brazil's leading departments of agricultural economics.

III. Conclusion

The cooperative, scientific effort, jointly conducted by CNPq and NAS in the field or agriculture, has been a very fruitful one. Having so far dealt predominantly with generalities, the two Study Groups nevertheless have now been able to propose action on specific subjects as outlined above.

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ANNEX D

A PROPOSAL FOR STRENGTHENING

AGRICULTURAL RESEARCH AND ECONOMICS*

Brazil is making considerable progress in developing advanced training programs in agricultural economics. At present four institutions are offering graduate work at the Master of Science level. Two of these programs--at Vicosa and Porto Alegre--are almost 10 years old, and have trained approximately 130 people to the M.S. level. A third program--at Piracicaba--is almost 7 years old and has produced approximately 10 M.S. graduates. The fourth program--at Fortaleza--started in August, 1971; its capacity for training new M.S.'s is now estimated at between 35 - 40 per year.

*Formally titled "A Proposal to the Brazilian National Research Council, the U.S. National Academy of Sciences, and the U.S. Agency for International Development for the Strengthening of Agricultural Economics Research and Analysis in Brazilian Agricultural Research Stations," this proposal has evolved from the deliberations of the Joint U.S. - Brazil Study Group on Agricultural Economics, which has been part of the U.S. - Brazil Science Cooperation Program conducted by the National Research Council of Brazil and the U.S. National Academy of Sciences. (Activities of the Study Group are described in reports dated January 30, 1968; March 15, 1969, and October 31, 1970.)

The proposal began to take shape in a meeting of the Study Group in Washington, D.C., on May 1, 1970. The proposal was refined in discussions of the group in Campinas, São Paulo, July 27 - 31, 1970. After that meeting Dr. Schuh prepared the draft of a formal proposal, together with a preliminary budget, which was attached to the report of October 31, 1970. Both the report and the preliminary proposal were submitted to the Fourth CNPq-NAS Workshop on Science and Technology in Development, which was held in Washington, D.C., November 1 - 5, 1971. One of the recommendations of that Workshop was that the proposal be revised for formal submission for funding. Drs. Antonio Raphael Teixeira Filho of the Federal University of Vicosa, and G. Edward Schuh, Program Advisor to the Ford Foundation and Professor of Agricultural Economics at Purdue University, were requested to make that revision, and are responsible for the proposal in its present form.

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From this "middle-level" strength, training programs are extending both upward and downward. Two schools of agriculture--Vicosa and Piracicaba--are offering an undergraduate specialization in agricultural economics. On the upper side, Vicosa plans to offer a Ph.D. starting in 1972.

In addition to the growing number of training programs, several specialized research institutions are developing strong programs. The Institute of Agricultural Economics of the São Paulo State Secretariat of Agriculture was probably, until recently, the strongest center of research in agricultural economics in all of Latin America. It has been surpassed, at least in potential, in this past year by a planning-research group in the Ministry of Agriculture composed of 30 staff with the M.S. or better. In addition, the Department of Economic Studies for the Northeast (ETENE) of the Bank of the Northeast, the Department of Rural Studies of the Secretariat of Agriculture in Minas Gerais, and the Institute of Applied Economics Research in the Ministry of Planning are developing a growing research competence.

Two serious deficiencies remain, however. The first is the lack of research on farm-level production problems. More specifically, there has been little attempt to make an economic evaluation of the production technology developed by the agricultural research stations, or to synthesize production packages or systems of new technologies that could be adopted by the individual farms. Put somewhat differently, there is a lack of integration between agricultural economists and the agricultural scientists.

A second deficiency is the lack of research designed to orient the research programs of the technical scientists. One result of this deficiency

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is that most programs of technical research lack a sense of priority and relevance. Rather than concentrating on a limited number of critical products or production problems, they tend to run a gamut, attempting to do something on all products that might be produced in a given region, with some research on various aspects of the production problem. Equally important, technical research is undertaken with little recognition of the resource-saving or resource-using implications of successful breakthroughs. Given the serious employment problems in most of Brazil, and the rather badly skewed nature of its distribution of income, this is a serious omission.

The Joint U.S. - Brazil Study Group on Agricultural Economics strongly recommends that an effort be made to solve these problems. Procedures and approaches by which these problems might be solved have been an integral part of the discussions of the Study Group since its inception almost 4 years ago. With the present proposal the Study Group takes an additional step forward by suggesting a specific program of action. The proposed program will involve collaborative efforts between Brazilian and U.S. agricultural economists on the one hand, and the Brazilian and U.S. governments on the other.

Elements of the Proposal

The elements of the proposal are listed below:

1. The Brazilian government--through its Office of Research and Experimentation (EPE), Ministry of Agriculture--and selected state governments, would contract small cadres of agricultural economists to be an integral part of their agronomic research stations. For purposes of the

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present proposal* it is recommended that such professionals be located at the following sites:

a. Brasilia, at the National Department of Agricultural Research (DNPA) and its Planaltina Experiment Station, or Sete Lagoas, at the Institute of Agricultural Research and Experimentation of the Central-West (IPEACO).

b. Belém, at the Institute of Agricultural Research and Experimentation of the North (IPEAN).

c. Recife, at the Institute of Agricultural Research and Experimentation of the Northeast (IPEANE), or at the Institute of Agricultural Research (IPA).

d. Curitiba, at the Institute of Agricultural Research and Experimentation of Parana (IPEAPA), or at the Agronomic Institute at Londrina.

e. Campinas, at the Agronomic Institute (IAC).

A nucleus of 2 - 3 agricultural economists at each station is the target. These men should have an undergraduate specialization or an M.S. in agricultural economics.

2. The U.S. National Academy of Sciences would award postprelim dissertation fellowships to five outstanding young agricultural economists who have an interest in the problems of developing countries. These fellowships would be assigned to each nucleus indicated in 1. Each Fellow would do his own research, which will serve as his Ph.D. dissertation, and also

*The Study Group hopes that the concept of including a small group of agricultural economists will eventually be extended to each of the eight federal research stations, as well as to other state and autonomous experimental stations. The present proposal, however, is restricted to a program that seems feasible for implementation in the next 3 years.

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work collaboratively with their Brazilian colleagues on their respective research programs. In this collaborative role their primary objective will be to assist in developing relevant, high-quality programs of research.

3. A U.S. and a Brazilian coordinator will be appointed on a part-time basis. These two men will be senior agricultural economists and will have the following responsibilities:

a. Administer and coordinate the program during the 3 years of its expected life;

b. Participate in the screening and selection of Fellows; and

c. Provide program and advisory assistance to both the Fellows and their Brazilian colleagues.

4. The Joint Brazil - U.S. Study Group will provide policy guidance to the research groups, assist in identifying research priorities, and provide overall orientation to the program.

5. The major professors of the U.S. Fellows would make an on-site visit once each year, to provide assistance to their students, and to the Brazilian economists working with them.

Mechanics of the Program

1. The Brazilian economists would be recruited at the earliest date possible. Since the market for agricultural economists is rather tight at present, placing only one man with an M.S. at each of the five stations may be the only feasible solution for the short term. However, it is hoped that an effort will be made to place at least two men with the M.S. at each station by the end of the program, and preferably three. If recruiting

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efforts are not successful in obtaining the full complement of 10 men with the M.S., or equivalent, in the first year of the program, it is recommended that at least one such man be placed at each of the sites, with the rest of the cadre made up of staff with an undergraduate specialization in agricultural economics, or some experience in economic research.

2. Responsibility for providing the two coordinators could be given to two universities. In Brazil, the logical choice would be the Federal University of Vicosa, given its strength in agricultural economics and its continued participation in the binational Study Group. On the U.S. side, the choice might be Purdue University, since two of its staff members have been members of the Study Group since its inception, and the University has had a continuing involvement in Brazil over a rather long period.

3. Responsibility for the U.S. side of the program would be delegated to the U.S. university which provided the U.S. coordinator. (Jay Davenport of the NAS has suggested this as one means of implementing the program.) In this case the university would be responsible for dispersal of funds for dollar costs of the program. This would apply also to the stipends of the Fellows, even though the fellowships would be official NAS nominations and awards.

4. Recruitment of Fellows would be on a nationwide scale, and competitive. The coordinators would have responsibility for conducting the announcement and screening process. Selection of the Fellows would be the responsibility of the Study Group and the two program coordinators, or a subcommittee thereof.

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5. The Study Group would assist in establishing research priorities, and would establish program and policy guidelines as the need arose. To this end it is proposed that the Study Group meet once each year, preferably in Brazil.

6. The two coordinators are expected to work together rather closely. To this end, travel money should be provided for at least two trips each year to the counterpart country.

Justification

The proposed program can assist in making an important step toward integrating the technical and social sciences to solve some of the important development problems of Brazil's agricultural sector. In addition, it will provide important ancillary benefits.

The following are among the more important benefits of the program:

1. A vehicle will be provided for a social science input into the decision-making process regarding research priorities. This should improve the relevance of the research, assist in providing a more well-focused program thrust, and create conditions whereby agricultural research can make a larger contribution to Brazilian development.

2. The economic evaluation of new production technologies, and the synthetization of such technology into new production packages, can make for the more effective use of research produced by the agricultural research stations, and stimulate the process of technical change among agricultural producers.

3. Multiple sources of technical assistance will be provided to the new cadres of agricultural economists, which include

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a. The U.S. Fellows, who will be associated with each group for day-to-day collaboration and assistance;

b. The program coordinators, both of whom are expected to be experienced, well-trained researchers;

c. The Joint Study Group, which has a considerable amount of accumulated experience and should be able to provide perspective and program orientation as well as technical assistance on individual problems; and

d. The major professors of the U.S. Fellows, who should be able to provide important technical inputs into each of the research programs.

4. A substantial research output should result from the program over the 3-year period. This knowledge should contribute to our understanding of the agricultural development problems in Brazil, and provide an important input into developing more rational development policies.

5. The research programs will be focused on critical problem areas in Brazil. The following observations are pertinent:

a. Brasilia and Sete Lagoas are located in areas of the cerrado, which encompasses a vast area of the Brazilian interior. To date, it is underutilized. Some informed people believe that it has rather great agricultural potential if an adequate knowledge base can be developed and appropriate developmental policies implemented.

b. The experiment station at Belém is responsible for the large Amazon area. This region is the focus of a major development thrust of the Brazilian government, and is being opened up by the construction of the Transamazon Highway. The government is promoting colonization on a rather large scale.

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c. The experiment stations at Recife serve the semi-arid Northeast. This region has the largest concentration of poverty in the western hemisphere. The federal government recently committed itself to spend the equivalent of U.S. $800,000,000 to strengthen the agriculture of this region through the Program for Land Redistribution and Establishment of Incentives for the Agroindustries in the North and Northeast (PROTERRA).

d. The state of Paraná has until recently been rather poorly served by agricultural research of any kind. However, the state is a major source of agricultural output and is experiencing rapid changes in patterns of agricultural production. Moreover, it is experiencing social problems due to rapid changes in labor requirements.

e. The Agronomic Institute at Campinas is Brazil's oldest and largest research institution. Budget support by the state government is strong, and the station continues to make major contributions to the development of Brazilian as well as São Paulo agriculture.

6. An important fringe benefit of the program will be the experience and training provided the five U.S. Fellows. Such training and experience is not easy to come by and should assist in making these men valuable inputs into future development programs.

7. Finally, the opportunity for two national groups to collaborate on a common program should increase mutual understanding and assist in further stimulating an already effective dialogue between the two national professional groups.

Some Research Suggestions

The cadres of agricultural economists will work on two kinds of analyses:

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1. Research which can make a contribution to the establishment of research priorities for the technical research program.

2. Micro-analyses of production technology, with emphasis given to evaluating the economic viability of new production technology and the synthesization of viable production systems.

The following comments are designed to indicate with a bit more specificity the kinds of problems which come under each of these two headings.

Resources for agricultural research are scarce. This means that if research is going to make its maximum contribution to agricultural development, it must be directed to solving important problems and to maximizing its contribution to economic development. One of the first tasks in establishing research priorities for technical research is to determine what products should receive major attention. Here, the economists have a major contribution to make. Research will be required that estimates regional food and production balances, identifies production bottlenecks, and indicates where and in what products output and technical efficiency should be increased.

But establishing research priorities involves a consideration of more than product markets. Technical change typically involves major shifts in resource use. For example, it may be land-saving (fertilizers, new and improved varieties), or labor-saving (mechanization, improved varieties).

The second class of problems are those designed to facilitate the adoption of new technology at the farm level. The first important aspect is the evaluation of new production practices or technology in an economic context. It is not enough, for example, that fertilizer increase yields. If it is not profitable, the farmer will not use it. A careful analysis

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of this problem would determine the optimum level of application under a rather wide range of economic and physical conditions and in relation to complementary inputs such as water--as well as the optimum proportions in which various plant nutrients should be combined with each other.

At a somewhat more complex level there is the problem of combining "packages" of new practices. An example will perhaps best illustrate the point. One advantage of hybrid corn is that it has a larger response to fertilizer than do open-pollinated varieties. If the farmer does not use fertilizer, he will not realize this advantage and hence become disillusioned with the potential of the new variety. Similarly, if fertilizer is applied to open-pollinated or traditional varieties, the response will be small and the producer equally disillusioned. It is only when the two practices--hybrid seed and fertilizer--are combined that the complementarity is realized and the combined "package" becomes profitable.

At a still more complex level is the problem of synthesizing combinations of enterprises into profitable systems. Under tropical conditions there seems to be greater potential for double-cropping and other more complex production systems than in the temperate zones. Yet, this potential seems to be largely unexplored. Once modern inputs are used, with their rather heavy drain on cash expenditures, the need to make the most efficient use of the input becomes increasingly great. Hence, the synthesization of production systems is a potentially valuable area of research. The research program should be adapted to particular resource endowments and should avoid, when possible, the aggravation of existing resource problems such as unemployment.

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There are two dimensions to the problem, however. First, the resource-saving nature of the new technology should be identified and related to the existing resource base. Hence, research that will release large numbers of agricultural workers in the Northeast, for example, should be avoided. Similarly, research which is land-saving has less priority in a land-abundant economy.

Second, some crops or products are inherently labor-intensive or land-intensive. Given the nature of the existing resource problem or resource situation, the research program would be directed to one kind of product or the other. For example, in the Northeast technical-biological research should probably be directed to strengthening the comparative advantage of products that are inherently labor-intensive, such as tobacco, sugarcane, cocoa, cotton, and vegetables--with lesser attention being given (on this criterion) to more labor-saving products such as cattle.

A final aspect that might be considered in determining research priorities is the effect of the research on the distribution of income. It is increasingly recognized that new technology tends to worsen the distribution of income, since those that benefit from it tend to be the larger, more well-endowed farmers. Economic research can assist in identifying the nature of this problem, suggest products for which technical change would be more accessible to the small producer, and indicate the kinds of research that could help the disadvantaged. Economic research can ameliorate the deleterious effects of the technology, or actually make it a positive factor in improving the distribution of income.

In researching this problem, as well as in analyzing the appropriate packages of modern inputs, considerations of risk and uncertainty--whether

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they come from weather or market conditions--are a major issue. Hence, an important part of the micro-analyses should be cast in a framework of risk and uncertainty, which, of course, may require some micro-analyses as complementary studies.

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ANNEX E

COOPERATIVE PROGRAM: INDUSTRIAL RESEARCH

Persio da Souza Santos

The 1968 report of the Panel Group, entitled "Industrial Research in Brazil as a Factor in Development," was presented in Rio de Janeiro in 1969 at the Third Workshop, an English-language version of which was prepared by the NAS. The National Research Council of Brazil (CNPq) published the report and distributed it to Brazilian government agencies, research institutes, industrial organizations, and university institutions.

At the 1969 meeting, Council Member, and subsequently Minister of Planning, Paulo Veloso--who at that time was the representative of the Ministry of Planning in the Deliberative Council of the CNPq--announced that the Ministry of Planning supported the report and had adopted many of its suggestions.

The 1969 Workshop appointed Professors Richard Jordan and Persio da Souza Santos to follow up the work of implementing the recommendations from the industrial research report. The presentation that will be made today to the Fourth Workshop will be a listing of what was accomplished in terms of the suggestions made in that report, with emphasis on the contributions made by the CNPq. There are many other implementations that are the direct result of the suggestions and that demonstrate the penetration and impact

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of the report in Brazilian sectors where industrial research is carried on, or where there is a need for expanding it.

Implementation of the Industrial Research Report

Since 1969, the CNPq has carried out the following projects to implement the industrial research report:

1. Postgraduate Scholarship Students in Technology

In 1970 - 1971, the CNPq provided 140 and 210 graduate scholarships on the master's level in Brazil and 40 scholarships abroad for doctoral studies in various areas of engineering, thus making an objective effort to create a labor force in industrial research for the Brazilian universities, government institutes, and industrial organizations. In the scientific areas that serve as support for technological activities there was also a significant increase, which was demonstrated by Professor Amadeu Cury in his communication addressed to this Workshop.*

We must also stress the current effort in technological research institutes to increase the number of young researchers among their personnel, by encouraging master's-level and doctoral-level instruction during full working time. To give just one example, one institute had 15 master's candidates in 1969, 20 in 1970, and 70 in 1971.

The CNPq's support of graduate departments in various states of Brazil by giving scholarships and funds for research--directed to increase and polarize studies on national technological problems--is one way of imple-

*The numbers quoted by Professor Cury are from the National Plan for Development CPND-1972/1974, published in the Supplement to Diario Oficial da União, December 17, 1971.

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menting the explicit recommendations in the report of the Industrial Research Group.

2. Brazilian Technology Journal (Revista Brasileira de Tecnología)

The report recommended the creation of a high-level technical-scientific journal to provide a medium in Brazil for publication and dissemination of the results of industrial research projects and studies contained in graduate theses from university departments accredited by the CNPq--in the form of original articles on Brazilian technological problems.

The CNPq assumed all responsibilities involved in the publication of the new Revista Brasileira de Tecnología, selecting its editorial staff and launching, in 1969, the "call for papers" that announced the existence of the journal; at the same time scientific and technical papers were directly solicited from Brazilian organizations in the industrial research field, as well as Brazilian government agencies and universities. Volume I appeared in 1970 with 11 original papers and 24 abstracts of graduate theses; in 1971, 3 issues were published and the fourth is now in press, thus completing Volume II with 24 papers and 66 theses abstracts. The journal is distributed free of charge by the CNPq to 5,000 research people, university professors, industrial establishments, universities, and industrial research institutes, as well as to a large number (about 600) of professional people and foreign organizations who directly requested the journal.

3. Meeting of National Research and Technological Support Institutions

In May, 1971, the CNPq organized a conference at the IPT (Industrial Research Institute) in São Paulo between directors of industrial research institutes and government agencies that support technological research. The meeting lasted 3 days and consisted of 11 sections with 140 active members;

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94 came from 46 research institutions, and 46 came from 31 support organizations. The meeting included the following sections:

- Technology and Development--Objectives, General Policy, and Technology Transfer
- Mechanism of Interaction between Technological Research Institutes and the Country's Industrial Production System
- Structural Integration of a Technological Research System
- Relationship between Universities and Technological Research Institutes
- Study of Influence of CNPq Report, "Industrial Research in Brazil as Development Factor"
- Incentives for the Expansion of the Brazilian Scientific and Technological Community
- Use of Tax Incentives and Other Measures in Industrial Research
- National System of Technological Information, both Free and Patented
- System of Support for Civil Construction Industry in Various Regions of Brazil
- System of Support for Extractive Metallurgy and for Mineral Processing Industry
- Support for Basic Sanitation Technology

The papers at this conference, as well as the recommendations of the various groups, were collected by CNPq as working documents. They serve as a basis for the implementation work that the National Technological Support Panel Group, set up by the CNPq, is now beginning. One valuable aspect of the meeting was the opportunity for fruitful discussions among

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the participants from the research institutions, from technological-support institutions, and government agencies.

4. Panel Groups

To promote the development of specific sectors proposed in its 5-year program,* the CNPq has set up, since 1970, and is operating various high-level coordinating groups composed of professional people from industry, industrial research organizations, government agencies, and universities whose purpose is to orient the CNPq on current Brazilian industrial research problems in these specific sectors. Thus, the following specific groups were created:

Food Technology. By initiative of the CNPq, to establish a national network of research organizations in food technology, with coordinated research programs and training of specialized personnel, based on financial support allocated by the CNPq.

Ceramics. Resulting from proposals by representatives of the ceramic industry to identify the research problems in the ceramic industry that the CNPq could help in solving and to coordinate these research programs with the National Development Program, i.e., refractory materials for the Iron and Steel Development Plan and building materials for the Housing National Bank (BNH) Plan building program.

Iron and Steel Industry Studies. A proposal approved by the CNPq for a national system for the development and transfer of iron and steel technology; its essentials to be presented today to the Fourth Workshop

*CNPq - Plano Quinquenal para o Desenvolvimento Científico e Tecnológico apresentado pelo CNPq a Presidência da República (1968/1972), Rio de Janeiro, CNPq, Dezembro de 1967.

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by Dr. Miguel Bohomoletz of the National Steel Industry Development Council (CONSIDER) of the Ministry of Industry and Commerce.

Iron/Steel Technology Commission. Organized from the recommendation of the CNPq's Iron and Steel Industry Study Panel Group to work in coordination with the Brazilian Iron/Steel Industry Development Plan (to be executied by CONSIDER)--which is intended to increase Brazilian production to 20 million tons of iron and steel by 1980; and to support and coordinate iron and steel research programs in accordance with national priorities established by the National Steel Plan.

Commission for Support for National Technology. To implement, detail, and direct the recommendations of the CNPq's 1971 Meeting of Research Institutions and National Technological Support Institutions in accordance with the Report on "Industrial Research in Brazil as Development Factor."

Cellulose and Paper. In answer to a proposal by the cellulose and paper industry to help specific research on raw materials and processing problems to make Brazil self-sufficient in cellulose and paper and eventually an exporter of cellulose pulp and paper products.

Government Research Institutes. The high-level Joint Brazil - U.S. Industrial Research Panel Group suggested a model for an industrial research institute in its 1968 report. Specific efforts to adopt the organizational recommendations have been made by Food Technology Institute (ITAL), Technological Research Institute (IPT) of the University of São Paulo, the Technological Research Institute of Pernambuco (ITEP), and the National Technological Research Institute (INT). The Petrobras Research Center and the Minas Gerais Industrial Research Center (INDI) have contracted with

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foreign firms to make suggestions for their administrative reorganizations. By request from the Secretary of Industry of the State of Pernambuco, ITEP contracted IPT to make a reorganization study and a proposal for increasing its productivity in providing the necessities of Pernambuco. The collaboration of Dr. Lawrence Bass, made possible by the CNPq-NAS program, was extremely useful to IPT. It is hoped that further efforts will be successful, through the initiative of the Commission on Technology of deliverative Council of the CNPq. Toward this end, seminars on management research-and-development for Brazil are valuable and must be put in operation in the near future.

The panel groups just described were organized between July, 1969, and July, 1971. Internal reports were prepared for CNPq but have not been released to the public. One important fact to emphasize is the spontaneous initiative of industrial organizations and associations in approaching CNPq for this cooperation for improving research in specific areas and in forming working groups.

5. Other Examples of Implementation of Specific Suggestions in Report

As illustrations, the cases that involve the direct application of specific recommendations contained in the Industrial Research Report are listed:

- Creation and organization of the National Industrial Property Institute in the MIC (Ministry of Industry and Commerce), with the objective of establishing an efficient patent system and an information system on foreign patents, as well as studying new patent legislation.

- Visit, as part of the CNPq-NAS program, of Dr. Lawrence Bass to evaluate the organization and activities of Brazilian Technological Institutes: INT, ITERS, ITAL, and IPT.

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- Studies for the establishment of the National Scientific and Technological Information System.

- The National Industries Conference approval and recommendation in Rio de Janeiro in 1971 of a large number of suggestions contained in the Report on Industrial Research.

- Agreement between the National Industry Confederation and the INT on the creation of the Technological Information Center for the dissemination in Portuguese of information of technological interest.

- Studies of salary scales in institutes such as the IPT to help demonstrate the feasibility of a positive relationship between salary and productivity.

- Establishment of the Brazilian Pharmaceutical Industry Foundation and a research institute supporting the pharmaceutical industry, according to the model proposed in the Industrial Research Report. This Foundation has just asked the CNPq to establish a panel group for the pharmaceutical industry.

- Translation into Portuguese of the book by Dr. Lawrence Bass on Industrial Research Management.

- Meetings of a national character between universities and industry, promoted by the Roberto Simonsen Institute of the Federation of Industries of the State of São Paulo in the chemical industry sector and in the cellulose and paper industry sector, at which the Report on Industrial Research was analyzed in detail and many recommendations were approved and carried out.

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Conclusions and Suggestions

The number of recommendations in the report of the Panel Group on "Industrial Research in Brazil as Development Factor" that were implemented during 1969 - 1971 demonstrates the amount of activity of the CNPq in this sector. It also illustrates the broad dissemination of the report and its impact on industry and the industrial research institutes, as well as the universities, leading to a marked increase in the development of industrial research in Brazil. We might say that the report also produced an increasing general awareness in the industry-institute-university areas, creating a favorable atmosphere for implanting new ideas and research programs in agreement with the industrial development programs of the Federal Government, such as the Industrial Technology Program of the BNDE and the program in industrial technology (MINIPLAN-BID) of the Ministry of Planning with the CNPq and the Interamerican Development Bank.

This increasing awareness on the government level led to an increase in the annual funds allocated to the CNPq, which in turn led to an increase in the allocations for the technology sector, thus illustrating the objective effort made by the CNPq to expand the technological research sector within its sphere of coordination in Brazil, without interfering with overall scientific development. This increasing general awareness also made it possible during this time for the CNPq to identify certain areas of national interest in terms of industrial research development such as scientific and technological information; technology transfer; research-and-development management; iron-and-steel industry; refractory

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materials; machine tools; food technology; building materials; technology of cellulose; pulp, and paper; mineral technology; and nonferrous-metals technology. This entire complex of areas, as it is presented now to the NAS in this Workshop, represents the awareness of CNPq of its role in developing and coordinating industrial research in Brazil as a medium-term program, about 5 years, as technical-scientific support for the National Development Program. These areas could serve as specific objectives for an industrial-research-cooperation program between the CNPq and the NAS, the idea for which is suggested in this Workshop.

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ANNEX F

REPORT ON ACTIVITIES: COMPUTER SCIENCE

C. J. P. Lucena

Computing is a very recent interest in Brazil. The great majority of computer installations in the country were set up after 1967. Nevertheless, as a result of a number of complex factors and surely as a reflection of the rate of development of the country, the use of computers quickly acquired considerable importance for the economy of Brazil. At present Brazil has 630 computer installations, which is about 50 percent of the existing installations in Latin America. Further, the computer market in Brazil is one of the fastest growing in the world, with a rate of increase estimated at more than 30 percent a year.

These facts naturally came to the attention of CNPq, since most of the research in Brazil is still performed by universities and research centers. These institutions, which work in close contact with CNPq, very quickly became equipped with computing facilities for the development of their programs. Today a total of 40 installations can be found in 31 of these institutions.

The involvement of CNPq with computing, as related to research and teaching, is not new, although a systematic focusing of the problem dates only from 1968. CNPq cosponsored the first computer installation in the country (1959) and several others thereafter. They also supported the

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education of computer specialists both in Brazil and abroad. Today these specialists constitute the majority of the community related to computing in research and teaching in Brazil.

From the time the computer science field started to be addressed systematically, CNPq has acted principally along the following lines:

1. Selection and support of Centers of Excellence in the area of computer science, aimed at achieving high-level research and training in the country.

2. Selection and support of postgraduate students for study in Brazil and abroad.

3. Establishment of programs for the dissemination and integration of the activities in the country related to research and teaching in computing (seminars, congresses, etc.).

4. Establishment of interchange programs with several countries, aimed at exchanging experiences and resources for the development of computer science.

Among the interchange programs in progress, one of the more effective is that conducted in association with the NAS. (Members of the Brazil - U.S. Computer Science Study Group are listed at the end of this section of the report.) Although it is a very new program, its effects can already be felt in the regular activities of CNPq. Among the results already achieved by this recent program, the following ones merit mention:

1. Elaboration of a preliminary diagnosis of the present situation of computer science in Brazil.

2. A set of basic recommendations which are currently being used by CNPq in various activities in the area of computing.

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We are sure that the continuation of the program, from now on as a consulting instrument for specific projects, will be of great help for the development of computer science in both Brazil and the United States. Brazil will be able to avoid mistakes that occurred in the development of computer science in the United States, and the United States in its turn will be able to appreciate a project for systematic implementation of computer technology in a modern economy.

Members, Brazil - U.S. Computer Science Study Group

Brazilian National Research Council	National Academy of Sciences
Carlos J. Pereira de Lucena	Harry D. Huskey
Fadigas Torres	Barry Boehm
Denis Leite	Bruce Gilchrist
A. C. Olinto*	Michel A. Melkanoff
Celso Renna e Souza	

*Resigned, September 1971

Computer Science Study Group: Proposed Activities, 1971 - 1972

OBJECTIVE

To develop an interchange program that will utilize U.S. experience where it is applicable to the Brazilian computer field, in particular in the area of education, and that will examine strategies for the implementation of new technologies in modern developing economies.

PROCEDURES

. To establish panel of members with wide academic and industry experience in U.S. or Brazil.

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. To meet frequently enough for current situations to be understood and addressed.

. To carefully preplan meetings and to address specific topics.

. To arrange for extensive exchange of background information before meetings.

SPECIFIC PLANS

. To maintain awareness of industry and academic personnel requirements (skills and numbers). U.S. experience has indicated a dearth of, but a great desirability for, such data. The U.S. Panel Report stressed this point following the August, 1970, meeting in Brazil. The October, 1971, Brazilian Panel Report indicated that CNPq and the Association of Users of Electronic Computers and Subsidiary Equipment (SUCESU) have made surveys of academic and industry areas.

. To concentrate initially on the training of university teachers and high-level personnel (Ph.D. level). August, 1970, meeting and subsequent discussions emphasized importance of this area. Improved training must start at a high level and percolate downwards. The U.S. Panel Report stressed this area, and the Brazilian Panel Report in October 1971 detailed the actual plans of three major universities.

. To encourage and help arrange exchange visits of professors and graduate students. A difficulty brought out in the August, 1970, meeting was that of identifying appropriate candidates in the United States for visits to Brazil. A significant number of Brazilian students are currently studying in the United States.

. To encourage exchange of technical information. Two problem areas were discussed at the August, 1970, meeting: getting the latest technical

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information available to Brazil without undue delay, and the need for a greater awareness in Brazil of practical applications and programs that have been developed in other countries. (These problems are not unique to Brazil.)

. To study ways of improving training of computer specialists for industry. Although the Panel regards this as an important area, it has had little time to address the problems. More extensive contacts with industry representatives are necessary to develop plans in this area.

IMPLEMENTATION

Panel Meeting	August, 1970
Exchange of Documents	1971
Panel Meeting	December, 1971
Exchange of Documents	1972
Panel Meeting, and Rio Symposium on Computers for Development	August, 1972

PRODUCTS

. Recommendations on programs of three major universities for effective complementation of strengths and meeting of rational needs.

. Recommendations for further analysis of collected data and for future data collection efforts for improved understanding of rational needs in computer science.

. Establishment of procedures for organizing and maintaining a register of appropriate candidates in the United States for visits to Brazil, and appropriate location for advanced study by Brazilians in the United States.

. Establishment of procedures for improved transfer of technical information in the computer sciences from the United States to Brazil.

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. Specific guidelines and groundwork for activities which will maximize short-term and long-term advantage to Brazil of hosting August, 1972, Symposium on Computers for Development.

Draft Agenda

Panel Meeting
(December 10 - 15, 1971)

Day 1	AM	Visit to Federal University of Belo Horizonte
		RIO
Day 2	AM	Review of available Data--Surveys, etc.
	PM	Constructive review of the Catholic University (PUC) program in computer science Constructive review of the Federal University of Rio de Janeiro (COPPE) program in computer science
Day 3	AM	Constructive review of São Paulo program in computer science Overview of three major universities' program in computer science
	PM	Planning and writing report on three major universities
Day 4	AM	Group visit to a major user
	PM	Interviews with key industry people
Day 5	AM	General discussion of computer specialists for industry Plans for August, 1972, Symposium
	PM	Summarization and report preparation Arranging for subsequent information exchanges

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ANNEX G

REPORT ON ACTIVITIES: GEOSCIENCES

John A. Forman

The importance of earth sciences to any country is well established and need not be elaborated upon in this paper.

Brazil, a country with an area of 8,500,000 kms. has at present about 1,500 geologists, and of these about 600 are engaged in mineral exploration. The country has a small mining industry that only in the recent years has gone into the quest for new deposits. The government has taken measures to prepare basic geological maps of the country and also, through fiscal and financial incentives, encourage exploration and mining.

To develop mineral resources of the country a much greater number of specialists is needed.

A well-known fact about the development of geology in Brazil is that regular courses at universities were started only in 1957. Before that, geology was done by mining engineers, civil engineers, etc. In 1957 the Ministry of Education established the "Campanha de Formação de Geólogos" which initiated geology courses within the universities of Rio Grande do Sul, São Paulo, Ouro Preto, and Recife. The following year courses were started in Rio de Janeiro and Salvador.

Later geology courses were introduced in Belém, Fortaleza, Brasilia, Florianopolis, and Juiz de Fora.

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When the five original courses began, the schools received assistance from several foreign countries including the United States, through a contract with the U.S. Geological Survey (USGS) and the Agency for International Development (AID). In the early years foreign professors stayed for periods up to 3 years and from about 1961 were replaced by Brazilian graduates of the geology programs, some of whom went abroad for training but very few to get advanced degrees.

From what is briefly described above three conclusions can be drawn:

1. The "experienced" Brazilian geologists have, at most, 10 years of experience.

2. With the increasing number of geology courses offered throughout Brazilian universities, the need for qualified professors has also increased sharply.

3. To develop the mining industry in accordance with national goals, a greater number of geologists is needed. From 1961 to 1967, with funds from CNPq, Council for Advanced Training of University Level Personnel (CAPES), AID, and other agencies, about 250 geologists were sent abroad for training periods of 3 months to 1 year.

Aware of these problems, the CNPq in 1967-68 made an evaluation of the several universities that had geology courses, and in 1969 graduate courses were started in Porto Alegre (M.Sc.), São Paulo (M.Sc.-Ph.D.), and Rio de Janeiro (M.Sc.-Ph.D.). The universities of Brasilia and Bahia were encouraged to obtain the necessary equipment and staff so that by 1972 graduate courses could be offered. It should also be noted that the University of São Paulo gave the doctorate in geology following the

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European system whereby a dissertation and period of special studies qualified the candidate for the degree.

The graduate programs have already given their first M.Sc. degrees and will soon produce the first doctorates (Ph.D.'s), following the system usually adopted in the United States. It is recognized that there is still room for improvement in both undergraduate and graduate teaching of geology in Brazilian Universities.

Although there are a number of fields in geology that need development, the CNPq chose to concentrate resources on three areas: geochemistry, geophysics, and mathematics applied to geology (geomathematics). These areas were selected because of their interdisciplinary character and importance to long-term development of the mineral industry within the national goals of the Brazilian government.

In all three areas two objectives should be taken into account:

1. A short-range objectives to train geologists and other specialists in exploration techniques to be applied to the mining industry, and

2. A long-range program to develop expertise on interpretation and creation of new techniques, as well as formation of a critical mass of qualified professors.

The following universities can join this program:

- Universidade Federal do Rio Grande do Sul
- Universidade de São Paulo
- Universidade Federal do Rio de Janeiro
- Universidade de Brasilia
- Universidade Federal de Bahia

The ongoing programs at these universities are listed as follows:

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Universidade Federal do Rio Grande do Sul. A M.Sc. program on paleontology, sedimentology, and stratigraphy. There is a nucleus of a sedimentary geochemistry laboratory. There also exists a Coastal Studies Institute which is carrying out programs on Brazil's southern continental shelf and coastal lagoons.

Universidade de São Paulo. There are M.Sc. and Ph.D. programs on petrology, economic geology, and structural geology; also a small geophysics group, well equipped for teaching purposes, which concentrates its activities on electrical methods. A small but well-equipped geo-chemical laboratory and a geochronology laboratory are also working. The geophysics program has received assistance from French and German agencies. The geochronology laboratory was begun and still collaborates very closely with U.S. universities, particularly the University of California at Berkeley. A theoretical geophysics group is being established, and there is a small group working on application of mathematics to geological problems.

Universidade Federal do Rio de Janeiro. There are a M.Sc. and a Ph.D. program on engineering geology. A major research project on the formation of soils under tropical conditions was started in 1970. There is a very good analytical laboratory; the first electron microprobe of Brazil is already installed, and is receiving help from England's Manchester University. There are undergraduate and graduate courses on exploration geophysics.

Universidade de Brasilia. Graduate courses are to begin in 1973. There is an array station, the only one in eastern Latin America to register and analyze seismic data, started with the help of the Geological Institute of England and the U.S. Coast and Geodetic Survey. The laboratories are

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now being equipped by the CNPq to broaden their coverage in geophysics. A geochemistry unit is also under study.

Universidade Federal de Bahia. A major effort in geochemistry and geophysics teaching and research is underway. These efforts are again financed by the CNPq and the Technical-Scientific Development Fund (FUNTEC) of the National Economic Development Bank (BNDE). The geochemistry unit is adapting exploration techniques to Brazilian conditions, and the geophysical group is developing courses and research on exploration techniques and theoretical subjects. A carbon-14 unit will be in operation soon. The University of Bahia has been helped by UNESCO, the British Council, and French agencies.

Proposed CNPq-NAS Program

The joint CNPq-NAS program could be developed along the following lines:

1. High level specialists on geochemistry, geophysics, geomathematics.

2. A minimum of one specialist and a maximum of two for each area, for a period from 1 to 6 months in 1972.

3. These specialists would visit all the centers mentioned above, and help to outline a long-range program.

4. The specialists would keep in mind the two aspects--the immediate and the long-range formation of Brazilian specialists.

5. Depending on the field of the specialists who go to Brazil, one of the universities would serve as base for courses and operation.

6. In the coming years, after the first assessment, a program similar to the one being developed for chemistry could be established.

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7. Several American professors have been to Brazil or have worked there and have shown interest in participating in the program. They come from Stanford University, the University of Georgia, and Syracuse University. The University of Georgia already has a Brazilian program underway and is very keen on participating in the area of geomathematics and exploring ways to cooperate in geochemistry and geophysics.

8. Other fields might be chosen to be developed in the future.

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