

AGENCY FOR INTERNATIONAL DEVELOPMENT WASHINGTON, D. C. 20523 BIBLIOGRAPHIC INPUT SHEET	FOR AID USE ONLY <i>Batch 32</i>
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1. SUBJECT CLASSIFICATION	A. PRIMARY	TEMPORARY
	B. SECONDARY	

2. TITLE AND SUBTITLE
 Science and Brazilian development, report

3. AUTHOR(S)
 (101) Workshop on Contribution of Science and Technology to Development, Washington, D.C., 1968

4. DOCUMENT DATE 1968	5. NUMBER OF PAGES 113p.	6. ARC NUMBER ARC BL330.981.N277
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7. REFERENCE ORGANIZATION NAME AND ADDRESS
 NAS

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)

9. ABSTRACT
 Science & technology R&D

10. CONTROL NUMBER PN-AAB-850	11. PRICE OF DOCUMENT
12. DESCRIPTORS	13. PROJECT NUMBER
	14. CONTRACT NUMBER GSD-1122 GTS
	15. TYPE OF DOCUMENT

SCIENCE AND BRAZILIAN DEVELOPMENT

**Report of the Second Workshop on
Contribution of Science and Technology to Development**

**Washington, D. C.
February 5 - 9, 1968**

CONTRACT

**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
Washington, D. C.**

This report records the issues discussed and the conclusions reached at the Second U.S.-Brazil Workshop on Contribution of Science and Technology to Development held in Washington, D. C., February 5-9, 1968. It is compiled from reports of session chairmen and rapporteurs, as well as staff notes. The workshop is part of a science cooperation program between the National Academy of Sciences - National Research Council and the Brazilian National Research Council (CNPq), under contract AID/csd 1122. The report will be presented to the Science Organization Development Board of the National Academy of Sciences and to the Agency for International Development and will be made available to interested institutions in Brazil. It is part of a continuing study of science organization and development in a number of countries.

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Second U.S.-Brazil Workshop on
CONTRIBUTION OF SCIENCE AND TECHNOLOGY TO DEVELOPMENT

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Note:

Special appreciation and thanks are due to Dr. Paulo de Góes and Mr. Tony Cermeño of the Brazilian Embassy for their valuable assistance in the preparation for this workshop.

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A G E N D A

Second
U.S.-BRAZIL WORKSHOP
on
CONTRIBUTION OF SCIENCE AND TECHNOLOGY TO DEVELOPMENT
February 5-9, 1968

February 6 (Monday)

Chairman: Dr. Harrison Brown

9:00 a.m.
Session I

Opening Statements

- Dr. Harrison Brown
- Dr. Amadeu Cury
- Dr. Aristides Leão

Special Presentations: "Nuclear Agro-Industrial Complex"

- Dr. Alvin Weinberg

Discussion

2:00 p.m.
Session II

Review of U.S.-Brazil Program: Interim Reports of Study Group

- Industrial Research - Dr. Pêrsio de Souza Santos (Read by Dr. M. da Frota Moreira)
Dr. Richard Jordan
- Mineral Resources - Dr. Annibal Alves Bastos
Dr. William Johnston, Jr.
- Norms, Measurements and Testing - Mr. Julien Engel

Evaluation of current programs, discussion of future plans. Procedural questions relating to study group reports and recommendations.

February 6 (Tuesday)

Chairman: Dr. Aristides Leão

9:00 a.m.
Session III

Interim Reports of Study Groups (continued)

- Agricultural Research - Dr. Glauco Pinto Viegas
Dr. Roy L. Lovvorn
- Agricultural Economics - Dr. M.G.C. McDonald Dow

Discussion

1:00 p.m.
Session IV

Presentation: Special problem area in Brazilian science and technology -- Scientific Manpower Development (including particularly the development of post-graduate programs and technical assistance)

- Dr. Manoel da Frota Moreira
- Dr. Carl Djerassi
- Dr. Paulo de Góes

Discussion

SPECIAL SEMINAR ON SCIENCE POLICY

Chairman: Prof. Carroll L. Wilson

February 7 (Wednesday) Part I: Consideration of Brazil's science and technology goals, plans, institutions, procedures, etc.

9:00 a.m. Science and Technology and Brazil's National Goals

Introduction - Dr. Amadeu Cury
(Elaboration on CNPq's five-year plan)

Specific Area Presentations

- Agriculture - Dr. Glauco Pinto Viegas
- Geology - Dr. Annibal Alves Bastos
- Physics & Chemistry - Dr. Oscar Sala
- Biology & Medical Sciences - Dr. Aristides Leão

Discussion with Guest Panelists and Participants

2:00 p.m. Brazil's Science Policy Decision-Making Process

Introduction - Dr. Amadeu Cury

Discussion with Guest Panelists and Participants

February 8 (Thursday) Part II: Consideration of U.S. science and technology problems, practices, policies, etc., as relevant to Brazil

9:00 a.m. The Status of U.S. Science Policy

Guest Panel discussion of major themes especially relevant to Brazil

Questions by Brazilian participants

2:00 p.m. Continuation of morning discussion and questions

February 9 (Friday)

9:00 a.m. Preparation of report and recommendations

12:00 Adjournment

Summary Report
of the
Second U.S.-Brazil Workshop on Contribution of Science and
Technology to Development
February 5-9, 1968

The second in a continuing series of workshop meetings, co-sponsored by the U.S. National Academy of Sciences-National Research Council (NAS-NRC) and the Brazilian National Research Council (CNPq), was held in Washington, D.C. February 5-9, 1968.

These binational meetings are convened for the purpose of bringing together representatives from the scientific community, government and private institutions to discuss informally problems relating to science and economic development. More specifically, the participants in these meetings consider mechanisms for facilitating and accelerating scientific progress as well as using science and technology in the development process.

The initial workshop in this series was held in Itatiaia, Brazil, in April 1966. This meeting resulted in the formulation of specific recommendations for continuing joint U.S.-Brazil activity in several problem areas considered to be of priority significance. Subsequently, a program of five joint U.S.-Brazilian study groups was elaborated to consider (1) industrial research, (2) norms, measurements and testing, (3) agricultural research, (4) agricultural economics, and (5) mineral sciences. These groups have been meeting during the course of the past year and their final reports are anticipated for the next U.S.-Brazil workshop planned for Brazil in April 1969.

The present workshop focused attention on an evaluation of the direction and work of the existing joint study groups and a consideration of science policy development in the United States and Brazil.

Following opening remarks and greetings from Drs. Cury, Leão and Brown, Dr. Alvin Weinberg presented a special lecture on the subject of nuclear-powered agro-industrial complexes. This presentation was arranged in the belief that new technological developments should be brought to the attention of workshop participants for their consideration. Future workshops may well take up other important and interesting technical innovations relating to development problems.

The workshop then received informal progress reports from each of the joint study groups, following which discussions took place regarding both the organizational and substantive matters raised in

the reports. Considerable concern was expressed regarding possible mechanisms for implementation of recommendations coming from the study groups. Workshop participants felt that preparations must be made to insure that organizations which might be involved in implementing any study group recommendations be involved in some way in the earlier deliberations. In many cases it was pointed out that this concern has already been satisfied through the inclusion of representatives of relevant organizations as participants and observers in the study groups.

It should be noted that the study groups are utilizing different approaches in the achievement of their objectives, thus the industrial research and norms, measurement and testing groups meet periodically for relatively short meetings in the United States and Brazil while the two agriculture groups have met for a longer period initially to define a program of work to be carried out by the Brazilian component, and are not to have another joint meeting for about a year. The mineral resources group, in view of the rather active long-term involvement and association of its participants, meets formally but once a year to consider and evaluate ongoing activities and to consider new possibilities.

These differences in approaches of the study groups are reflected in the character of the reports presented to the workshop and appended to this workshop report.

In general, the workshop participants were greatly impressed with the progress made thus far and expressed their hope that the work of these groups be completed as soon as possible so that their recommendations might be evaluated by the next workshop.

The participants further noted their pleasure at the very efficient and productive way in which this truly cooperative program has developed. The study group program is not only binational in participation but in organization and funding as well.*

Two days of the workshop were devoted to a seminar on the subject of science policy. A panel of high-level U.S. government agency representatives under the chairmanship of Professor Carroll L. Wilson, Massachusetts Institute of Technology, discussed with the Brazilian and U.S. workshop participants the development, structure, and dynamics of science policy in the United States and with particular attention to aspects relevant to Brazil. The discussion of Brazilian science policy was based largely on the document "Scientific and Technological Development" (The 1968-1972 Five-Year Plan), completed by the Brazilian

*Up until February 1968 the NAS contribution to the joint study group program was funded by AID/LA, the Brazilian contribution by CNPq. The present NAS contribution is being funded through a contract with USAID Rio as part of a formal U.S.-Brazil Program Agreement.

Research Council in December 1967 for the President of the Republic. It should be noted that this document, yet unpublished, was made especially available to the panel and the U.S. participants.

The five-year plan for the development of science and technology in Brazil made a significant impression on the participants and panel members for it clearly represented an attempt to bring the scientific community of Brazil into the future planning for science and technology, an effort which seems without parallel in Latin America and most other parts of the world. The participants were pleased to note that many of the concerns of the various joint study groups are already receiving attention in this document.

Although the discussion of the evolution and structure of U.S. science policy brought out clearly the differences in the particular circumstances existing in the United States and Brazil, points both positive and negative emerged which will be of possible use to the Brazilians in their future policy planning. U.S. science policy panelists and the Brazilian participants considered at some length the need for more effective and simplified means of access by Brazilian researchers to U.S. and international agencies supporting research abroad.

At the special request of the Brazilian participants one session was devoted to urgent problems in Brazil's science and technology, in particular to scientific and technical manpower development. Much attention was given to possible mechanisms for cooperative programs with the United States and other countries to help satisfy Brazil's immediate and future needs in this area.

The fields of chemistry and computer science were singled out for continued attention in the context of the existing study group program.

In closing, the workshop participants agreed to concentrate on the completion of the study group programs in progress and the creation of two new ones in the areas noted above. The participants further agreed on the desirability of continuing the workshop meetings with the next gathering to be held in Brazil probably in April 1969. This meeting will concentrate on an evaluation of the final reports of the various study groups and a consideration of mechanisms for implementation of possible recommendations.

Specific Recommendations

The workshop recommended that:

1. In view of their fruitful work these groups remain in existence beyond the completion of their reports until the next workshop at which time their efforts will be evaluated and consideration given for their possible continuation or termination;

2. A joint study group in chemistry be established to pursue efforts to strengthen the chemistry program in Brazil;
3. In view of the importance of computer science in the future development of science and technology, that a joint study group be formed to consider program development in this field. It was pointed out that the time is particularly appropriate as computer facilities and training programs have already been initiated in Rio de Janeiro and Sao Paulo. Initial activity would involve the sending of one U.S. computer scientist to Brazil to discuss the planning of a program;
4. That an effort be made to create mechanisms to stimulate U.S. professors and researchers to go to Brazil to assist in its scientific development

Progress Report of the Joint U.S.-Brazil Study Group
on Industrial Research

by
Pérsio de Souza Santos
Head of the Brazilian Group on Industrial Research
(Read by F. Moreira)

The group for industrial research was organized according to a recommendation approved during the Itatiaia workshop in 1966. In March 1967, the Deliberative Board of CNPq appointed a certain number of people as members of the CNPq's group for Industrial Research. Similar invitations were made in the United States by the National Academy of Sciences. The first meeting of the U.S.-Brazil panel was agreed to be in Rio de Janeiro in April 1967.

Rio de Janeiro Meeting

The Brazilian group plus ten invited guests from different branches of industrial activities had a preliminary meeting with Mr. Julien Engel from NAS and coordinator of the U.S. group. Literature was distributed by Mr. Engel about the qualifications of the ten U.S. members of the group and a broad definition of industrial research was offered in order to define the work of the panel.

One week later, April 10, the U.S. group arrived and three full-day meetings took place in Rio de Janeiro at the Brazilian Academy of Sciences and CNPq. During these meetings, twenty verbal reports, about 20 minutes long, were presented by Brazilians in order to give a general outlook of the Brazilian situation on industrial research. Free discussion was established and several decisions were made, as follows:

(a) A model was approved for the final report to be written by the group, aiming to impress and influence the decision-making organizations in Brazil in order to increase industrial research in quantity and quality.

(b) The Brazilian group agreed in writing a series of papers covering information and data on research, educational and industrial activities to serve as a background to the final report.

(c) The papers, in English, were to be ready in July 1967, to be reported by their authors in August 1967, during the second meeting of the panel at the Battelle Memorial Institute in Columbus, Ohio.

The panel then went to São Paulo, visiting Instituto de Pesquisas Tecnológicas, Instituto de Tecnologia de Alimentos, Instituto Tecnológico da Aeronáutica and had a meeting with the directors of U.S. industrial organizations in São Paulo; some of them also visited other states of Brazil.

The Brazilian group had afterwards 15 full-day meetings in Rio de Janeiro to discuss and organize the following reports:

- A. André Tosello (Instituto de Tecnologia de Alimentos, Campinas)-
Primary Sketch on Industrial Research in Brazil.
- B. George S. Moraes (SINVAC, Governador Valadares)-
Profile of Industrial Research System with Case Studies of
Successful and Unsuccessful Industrial Research Programs.
- C. Remolo Ciola (Refinaria de Petróleo União, São Paulo)-
Utilization of Human Resources.
- D. Antonio Seabra Moggi (Petrobrás, Rio de Janeiro)-
A National Information System.
- E. Pêrsio de Souza Santos (IPT e EPUSP)-
CNPq Role in Industrial Research in the Past Five Years.
- F. Pêrsio de Souza Santos (IPT e EPUSP)-
Industrial Research Output in the Past Five Years.
- G. Joaquim F. de Carvalho (Ministério do Planejamento, Rio de
Janeiro)-
International Cooperative Activities in Industrial Research:
Technical Assistance.
- H. Kurt Politzer (Universidade do Brasil)-
Industrial Research - Fiscal Incentives, Tax Legislation and
Effect of General Business Conditions.
- I. Juvenal Ozorio (CEIQUIM, Ministério da Indústria e Comércio)-
Sources and Levels of Finance for Industrial Research.
- J. Pêrsio de Souza Santos, Nelson Gutheil, Abrahão Iachan-
Technological Institutes: A Comparative Analysis.

Columbus Meeting

The U.S.-Brazil panel had three full-day meetings (August 14-16) in Columbus, Ohio, at the Battelle Memorial Institute. The papers were presented by their authors and fully discussed by the panel. A list of suggestions and recommendations was written. The form of presentation of the final report of the group was approved. A third meeting of the panel was ascertained to be in Belo Horizonte, Minas Gerais in the third week of February 1968. The suggested draft of the recommendations to improve industrial research is going to be discussed in this Belo Horizonte meeting.

After the Columbus meeting, the members of the Brazilian group visited 65 organizations for research in industry, universities and government. A report of the activities of the Brazilian group was presented at a meeting of the Deliberative Board of CNPq.

Eight meetings were made in Rio de Janeiro for the suggestions to be presented in Belo Horizonte, which were sent, in the middle of January 1968, to Mr. Julien Engel for distribution to the U.S. group.

Supplementary Remarks to the
Progress Report of the Joint U.S.-Brazil Study Group
on Industrial Research

by

Richard C. Jordan

Chairman of U.S. Study Group on Industrial Research

Following completion of the First Brazil-U.S. Workshop on the Contributions of Science and Technology to Development, held in Itatiaia, one of the first Joint Study Groups proposed for implementation of the recommendations of the conference was that on industrial research. Agreement to proceed in the formation of this committee was consummated in early 1967. Shortly thereafter the U.S. panel was selected.

The broad charge to the Committee concerned the formulation of recommendations for promoting the development of Brazil's industrial research capabilities and their application to general economic development. Therefore, the U.S. panel was selected with a view toward competences from the three sectors engaged in this activity, namely, industry, university, and research institutes. Personnel selected initially were as follows:

Dr. William Bollay, Professor, Department of Mechanical Engineering, Stanford University; former President, Aerophysics Development Corporation; former Head, Aerophysics Laboratory, North American Aviation; Project Manager and Leader, Peru-Chile Team on Training of Industrial Leaders and Industrial Development of Latin America Council for International Progress in Management.

Dr. Jesse Hobson, Heald, Hobson and Associates, New York City; former Director, Armour Research Foundation; former Director, Stanford Research Institute; former Director of Research, United Fruit Company.

Mr. William A. W. Krebs, Vice-President, Arthur D. Little, Incorporated, Cambridge, Massachusetts, in charge of economic development activities in developing countries; Senior Lecturer, Sloan School of Management, Massachusetts Institute of Technology; former General Counsel, National Science Foundation; former Associate Counsel, U.S. Atomic Energy Commission; former Counsel, Office of Naval Research.

Dr. Anthony Leeds, Associate Professor of Anthropology, University of Texas, Institute of Latin American Studies.

Mr. Robert W. Olson, Vice-President in Charge of Special Projects, Texas Instruments Incorporated, Dallas.

Professor Eugene P. Pfeider, Institute of Technology, School of Mines and Metallurgy, University of Minnesota; former chief engineer, mining companies in Bolivia, Cuba; formerly associated with Freeport Sulphur Company; consultant to mining companies in South America.

Dr. Bertram D. Thomas, President, Battelle Memorial Institute, Columbus, Ohio; member, Executive Committee, Division of Engineering and Industrial Research, NAS-NRC; member, National Council, National Planning Association.

Dr. Richard C. Jordan (Chairman), Head, School of Mechanical and Aerospace Engineering, University of Minnesota; former Chairman, NAS-NRC Division of Engineering and Industrial Research; member of Brazil Science Workshop; member of State Department Science Survey Mission to the CENTO countries.

Thus the initial competences of the group drew broadly from research institutes, universities, and industry, and, in many cases, these competences were overlapping in the three areas. In addition, more recently, Dr. Werner Bahr, on leave of absence from Vanderbilt and currently in São Paulo on temporary assignment, has been added to the Committee as an economist with broad experience in Brazil. Dr. Stephan Robock, a member of the workshop group, has served as consultant to the Committee and met with the group during the Columbus Conference, reported later.

Mr. Julien Engel, Professional Associate, Office of the Foreign Secretary, National Academy of Sciences, was appointed as Staff Officer for the U.S. group and has proven to be an excellent selection. He has rapidly gained broad knowledge of the industrial research picture, particularly as it applies to Brazil, has acted both effectively and efficiently in supplying the U.S. panel with pertinent publications relative to U.S. industrial research and has supplied this to the Brazilian panel in behalf of the U.S. group.

First Joint Meeting, Rio de Janeiro

Prior to the time of the first joint meeting of the U.S.-Brazilian panels in Brazil, the U.S. panel met twice in this country: once in Washington and once in Chicago. During these preliminary meetings, the U.S. panel drafted suggestions to be sent to the Brazilians for their consideration for the first meeting. Following this, the first joint meeting of the two groups was held in Rio de Janeiro and São Paulo on April 17-19, 1967.

At this time it is interesting to recollect the first relatively strained meeting of the groups with neither knowledgeable of the other's competences or intent. However, after the first day's meetings, this

probing approach dissipated into a warm and mutual respect for the high competences represented in the two panels. Dr. Hornig has said, "Scientists talk easily to each other." This proved to be so in this case and the U.S. panel on several occasions voiced its high respect for the competences which the Brazilian group brought into the discussions. The U.S. panel fully recognized the unreality of suggesting that there could be any direct transfer of science and technology from an economy such as the United States possesses to the Brazilian economy, but rather, that differences historically, politically, and economically, must be taken into consideration in attempting to structure the place of industrial research in the Brazilian nation.

This first joint meeting in Brazil had as its objective (1) the establishment of mutual rapport between the two panels, (2) a gathering of knowledge by the participants of the industrial research environment in Brazil, and (3) an initial draft outline for the final report.

All three objectives were accomplished. The purposes of the initial draft outline were principally to establish initial, possible goals for the findings and recommendations which would eventually stem from the committee. It was recognized that the first rough document would be modified many times before final consummation. This draft outline had sections on (a) background, (b) current state of industrial research in Brazil, (c) major problems and difficulties, (d) recommendations, and (e) documentation. Since the details of the outline have been modified several times since that time, any relating of them at this point would serve only superficial purpose.

Second Joint Meeting, Columbus, Ohio

The second joint meeting of the study group on industrial research occurred in Columbus, Ohio, on August 13-16, 1967. The meeting was hosted by Battelle Memorial Institute as a representative research organization in the United States. Prior to this meeting a series of semi-research studies had been conducted by the Brazilian panel, and these were reported upon at the meeting. These included, "Brazil's Industrial Research Output" (Santos), "Brazil's Industrial Research System" (Moraes), "Utilization of Human Resources" (Ciola), "Role of the CNPq in Industrial Research" (Santos), "Brazil's Institutes of Technology" (Gutheil), "International Cooperative Activities" (Carvalho), "Fiscal Incentives and Tax Legislation" (Politzer), "Primary Sketch of Industrial Research in Brazil" (Moggi for Tosello), "Recent Developments in U.S. Research Institutes" (Hobson), and "International Information System" (Moggi). Following the presentation of these papers and general comment provided by all members of the U.S. panel as well as joint discussion between members of both panels, an action summary for the study group's next phase was prepared.

Additional Visits of Panels

In attempts by both panels to gain better understanding of the industrial research picture in the two countries, a number of additional individual trips were taken, both at the time of the first and the second joint meetings and between the time of the first joint meeting and the present. At the time of the first meeting, all members of the American panel spent some time in São Paulo and Campinas on side visits. Further, following the regular formal meeting of the U.S. panel in Brazil, several members of the U.S. panel took additional trips. Professor Pfleider visited Minas Gerais and Ouro Preto. Dr. Bert Thomas spent some time in the northern areas of Brazil. Since that time Dr. Thomas has also made two additional trips to Brazil. Mr. Weber spent time following the first meeting at Volta Rodonda and more recently has made an extensive visit to the northeast of Brazil in the company of Dr. Iachan. Dr. Jordan spent a month during the last summer in Rio de Janeiro, São Paulo, São Carlos, Recife, and Salvador, much of it in the company of Dr. Frota Moreira and Dr. Tolmasquim. Prior to the Belo Horizonte third joint meeting scheduled to occur later this month, Dr. Bollay plans to visit Porto Alegre and São Paulo and Rio de Janeiro again before journeying on to Belo Horizonte.

In turn, the Brazilian panel, following its meeting in Columbus, made various visits to parts of the United States ranging from upper New York to Texas and from New York City to California. All these additional visits have served to acquaint the two groups with the problems, strengths and weaknesses of the industrial research patterns in the two countries.

Third Joint Meeting, Belo Horizonte

The third joint meeting of the study group is to occur in Belo Horizonte on February 17-21, 1968. Toward the end of the Columbus meeting a series of questions were posed to the U.S. panel and since then, information concerning these has been collected and submitted to the Brazilians. Further discussions on these questions will occur at Belo Horizonte.

This meeting will also be preceded by a meeting of a subcommittee on industrial research institutes consisting of Drs. Thomas, Krebs and Hobson from the U.S. panel, and Drs. Moggi, Moraes, and Politzer from the Brazilian panel. Prior to this time Dr. Hobson will spend some time in Porto Alegre, São Paulo, and Rio de Janeiro, and this six man group are to study the possible patterns for the establishment of an industrial research institute in Brazil.

Much of the time of the Belo Horizonte meeting is planned for discussions of items intended for inclusion in the final report. In addition a group of Brazilian industrialists will meet with the joint study group to permit a strong input from this segment of the Brazilian community.

Final Report

One additional joint meeting of the study group is planned for the United States sometime later this year, and we foresee that by that time it should be possible to collect all materials and complete all studies necessary for the final report. Some inevitable delays were entailed in the formation of the joint panel and the total eighteen months period as originally envisioned as needed for study and preparation of the report still holds true but the completion of the report will probably be accomplished by late fall or early winter (Northern Hemisphere).

At this time the U.S. panel would like to express its sincere appreciation to the Brazilian panel for the volumes of time, effort and sincere friendliness which they have injected into the activity. The U.S. panel recognizes that the final report must have its origins from the Brazilian group and that the U.S. panel can only provide knowledge and information, advice and discussion. The U.S. panel feels strongly that Brazil as a nation has all of the potential to become one of the leading world industrial powers, if research and resulting industry are properly nurtured. Brazil now appears to be in the stage where its principal manufacturing relates to the development of equipment in substitution for current imports. To a great extent the United States went through this same phase early in this century, and Japan has done so in a much later time context. At the present time Brazil is on the verge of developing the needed synergism between industrial research, university research, and federally sponsored research which can result in an eventual flow of creative products and pass from the phase of adoptive research to the development of new products and achievements for export to other parts of the world. The U.S. panel and their associates hope to aid this potential development which, in the long view, can only mean greater hemispherical strength and friendship.

Progress Report of the Joint U.S.-Brazil Study Group
on Norms, Measurements, and Testing

by

Julien Engel
National Academy of Sciences

In its discussion of the assistance that science and technology can render industry, the Itatiaia Workshop made a couple of recommendations which led to the creation of the Joint Study Group on which I have the pleasure of reporting this afternoon. The rapporteur's summary of that Itatiaia discussion indicated that

"the participants ... recognize the importance of the establishment of an expanded standards activity formed around the present Bureau of Weights and Measures as a nucleus."

Later on, in a summary of the principal recommendations, the Workshop concluded with this statement:

"The participants of the workshop recognize the importance of the establishment of a Brazilian National Bureau of Standards. In order to aid the long-range development of such a bureau of standards, it is recommended that a joint subcommittee... be established."

Despite this rather specific charge, the Study Group now in existence operates under the name of Joint Study Group on Norms, Measurements, and Testing, and by implication remains rather silent on the matter of a Brazilian NBS. There is an explanation for this which needs to be stated here. As we began giving effect to the Itatiaia recommendation, and on both the Brazilian and U.S. sides selecting the specialists who were to constitute the membership of the group, it became quite evident to both sides that to take the workshop's recommendations explicitly as a point of departure would be to prejudge the very outcome of the inquiry that needed to be made. Furthermore, the U.S. members--largely drawn from our NBS--were not at all sure that their institution was a particularly apt or useful model for emulation in the Brazilian context; and the Brazilian members were not at all sure that the most pressing Brazilian needs would be usefully or efficiently met by an institution given to the pursuits of the U.S. NBS.

In short, after due consultation with the CNPq and the NAS, the Group decided to start with a clean slate and, broadly within the intent of the original charge, to formulate its own terms of reference, which are to consider and make recommendations with respect to these five questions:

- (a) the present organization, programs, personnel and equipment related to norms, standards of measurement, and testing in Brazil;
- (b) the role of government, industry, educational institutions, and technical societies in their fields;
- (c) the associated interrelationships between technological institutes, universities, industry, state and federal governments, science related institutions with regard to financing, direction, and control;
- (d) the adequacy of relationship between organizations and activity relating to codes and specifications covering products and commodities;
- (e) the present and anticipated requirements of measurement standards and techniques in relation to Brazil's economy, its development plans, and its relations with international markets.

The Study Group can be said to have been in effective operation for about nine months. During this time each national panel has met several times, and the two panels have come together for joint meetings twice. A third joint meeting will take place early next month.

The first joint meeting took place in the United States, at the NBS, last May, with the participation on the Brazilian side of a nucleus team of two persons under the chairmanship of Admiral Geraldo Maia, the U.S. panel of six members under the chairmanship of Dr. Ralph Sawyer, plus a dozen consultants from various divisions of our NBS. It was then that the two groups decided that they should address themselves to a set of problems substantially different from, though related to, the one identified at Itatiaia (that is the establishment of a Brazilian NBS), and which would include consideration of the following factors among others: development of industrial norms and related standards of measurement, performance testing of products and materials, quality controls, voluntary and mandatory system for certification and compliance with standards or specifications, and so forth. In the United States, these various functions and activities are carried out by a loose and quite unrational complex of agencies and institutions, public and private, largely outside of, but working in friendly collaboration with, the NBS.

The particular relevance of this aspect of the problem should be quite obvious: Brazil has undertaken a marked industrialization effort; its changing economic conditions away from a highly protected, import substitution oriented economy make for increased industrial competition at home and for increased pressures to expand its exports of manufactured goods. Thus, the two panels concluded that Brazil's priority needs were for a system custom-tailored to Brazilian realities able to undertake

essentially the same activities and perform the same services as the mixed complex of private-public, voluntary-mandatory operating in the United States (and, incidentally, not to excessive satisfaction on the part of a good many Americans!).

The Group came to a second basic conclusion: the magnitude of the problem and the multiplicity of industrial sectors to be affected by whatever scheme would ultimately come about--and this coming about would be directly dependent on the active collaboration of the industrial sector--required for sheer reasons of practicality that this task be approached on a sector by sector basis.

The electronic-electrical sector was to be given initial attention and with satisfactory progress there and the acquisition of experience applicable to other sectors, the Group would move on to consideration of (in this order) the mechanical, steel, non-ferrous metals, automobiles, and ship-building industries. Implicit in this approach, of course, is the assumption that the relationship being established would extend well beyond the eighteen months initially projected and would go on for as long as the job required or the money lasted.

In the course of the second joint meeting, in Brazil this past August and September, the U.S. panel had opportunity to visit Brazil's principal institutes of technology, many of which have delegated responsibility for metrology, the Brazilian Institute of Weights and Measures, the Brazilian Association for Technical Norms (ABNT), as well as a broad range of Brazilian and foreign-owned industrial enterprises. These visits, combined with extended discussions between the two panels, produced general agreement on several points among others:

1. need for certain changes in the structure, procedure, staffing, and missions of institutions like the Brazilian Institute of Weights and Measures, and the Brazilian Association for Technical Norms;
2. need for more active and broader involvement of Brazilian industry in the formulation of Brazilian standards, which in number and coverage are grossly inadequate for Brazil's requirements;
3. need for more aggressive campaigns to educate Brazilian Government and industry on the advantages of standardization;
4. need for the development of institutional, legal or financial devices to motivate compliance by industry with recognized standards.

The third joint meeting of the Study Group is scheduled for early March here in Washington. In preparation for it, the Group had agreed in Rio to undertake the following "homework" tasks, which would constitute the basis for the next round of discussions and also serve as

the basis after proper consideration, for a first statement and recommendations of the Group:

The U.S. panel was to formulate a model plan for an integrated Brazilian system covering norms, testing and means for promoting compliance; this plan to be inspired by all relevant experience, indeed perhaps more European than American.

The Brazil panel was to formulate a plan for a model system of weights and measures with emphasis on both technical and legal aspects of metrology, taking into account existing institutions and legislation.

Both of these homework tasks have been completed, but they are very tentative exercises, rough approximations of what is desirable and feasible. The two plans need considerable discussion and refinement, and furthermore the two plans must be meshed into a single system before they can be unveiled to the hard glare of public inspection, and this, of course, is what the Group intends to do next month.

The Brazil panel is also expected to formulate a project for the establishment of a pilot government and industry-supported standards control facility for electronic components, in line with the sector approach alluded to earlier. The proposed unit would undertake the drafting of standards in the electronics fields for submission to ABNT's formal approval procedures, would establish measuring methods, and perform certain other services.

In view of the fact that the two panels have thus far had opportunity only to exchange working papers on the issues under consideration, without yet the extensive discussion which will bring their respective views within a sound and realistic perspective, it would be premature--and indeed quite out of place--for me to go into the substance of their thinking. This the Joint Study Group should be in a position to reveal shortly after their forthcoming meeting.

Progress Report of the Joint U.S.-Brazil Study Group
on Agricultural Research

by

Brazilian Members

Ady Raul da Silva, Chairman
Roberto Meirelles de Miranda
Glauco Pinto Viegas

U.S. Members

Roy L. Lovvorn, Chairman
R. K. Frevert
H. Rex Thomas

The Joint Study Group was created through a recommendation made at the Itatiaia Workshop of the U.S.-Brazil science cooperation program between the Brazilian National Research Council (CNPq) and the U.S. National Academy of Sciences (NAS) in April 1966. In January 1968 the U.S. members of the Study Group visited Brazil for the first meeting with the Brazilian members at which the following objectives and methodology for the study were agreed.

Objectives

The main objective is to develop recommendations to the CNPq and NAS on the improvement of agricultural research in Brazil. These recommendations will indicate priority areas which may receive attention from national, bilateral, and international technical assistance programs.

Introduction

The first visit to Brazil of the U.S. members of the group enabled them to become acquainted with the problems of research at the federal, state, and university levels by visits to a number of selected institutions (Appendix 1) and to hold discussions with their Brazilian colleagues to agree on the objectives, scope and future activity of the Study Group. Recognizing the importance of making meaningful suggestions regarding agricultural research in Brazil, based on considerably more detailed information than could be covered in a three-week visit, the group proposes that studies detailed below should be carried out by the CNPq and other appropriate organizations over a period of approximately twelve months, with further joint meetings of the group in the United States and Brazil as are feasible and appropriate. A report based on these studies will be presented to the 1969 Science Workshop of the Cooperative Science Program.

The Group also held joint meetings with the Study Group on Agricultural Economics, and proposes to work closely with this group during the period of the studies. A section of their preliminary draft as relates to this report is attached (Appendix 2).

The continuation of the activities of the Group after the completion of the initial studies is advisable for counseling during implementation of the recommendations.

Throughout the two weeks of visits made to institutions the Group was impressed with the following general observations:

1. Lack of funds at the time they are needed.
2. Application of a disproportionate amount of funds for maintenance as opposed to actual research projects.
3. A large number of institutions operating under different administrative authorities and systems of administration.
4. A shortage of well-trained senior research personnel and a lack of capacity to train them.
5. Limitations in the system of promotion, particularly relating to merit and incentive.
6. Disparity between salaries for research and teaching, and the small difference in pay scale between capable junior and senior technical personnel.
7. Lack of connection between research, teaching and extension institutions.
8. Difficulties of communication between institutions, organizations, and individuals conducting agricultural research
9. Lack of economic interpretation given to the experimental results.
0. Under-utilization of building, equipment, and personnel.

These impressions from a short visit and other points should be evaluated critically through studies which it is proposed should be carried out by, or under the auspices of, the CNPq before the next meeting of the Group. The data will assist the Group in arriving at proper definitive conclusions and recommendations.

Basic Information Necessary for the Study of the Improvement of
Agricultural Research in Brazil

It is proposed that the analysis of agricultural research in Brazil and the problems of increasing its value and effectiveness be undertaken with emphasis on a number of broad areas described in this section.

A. Research Institutions

In order to arrive at suggestions for improving agricultural research the present situation must be described and possible alternatives indicated. It is therefore proposed that:

1. An inventory be made of the number, location, physical facilities, equipment and personnel of the present research stations, including their branch stations.
2. The same data as required under 1 be provided for institutions doing research on forestry and rural economics. (This will enable the Group to consider the advisability of combining these disciplines with plant and animal sciences, soil science, rural engineering, and processing of plant and animal products in the different institutions.)
3. An examination be made of the administration of research institutions, under the following headings:
 - a. Control at national, regional and state levels, and the degree of autonomy.
 - b. Administration of funding--time of funding, flexibility, and sources, including federal, state, taxation, endowment, income from produce, and contracts.
 - c. The desirability of preparing a five or ten year development plan for individual research institutions with annual review.
 - d. The need for a national and/or regional agricultural research advisory committee, composed of representatives from various institutions.
 - e. The training of research administrators.
 - f. A mechanism for the planning and evaluation of research projects.

B. Scientific Manpower

One of the principal problems facing agricultural research is the provision of adequately trained technical and administrative personnel in the appropriate geographic locations to carry out the required research. On the basis of information collected the following topics will be considered in greater detail:

1. The discovery and stimulation of interest by undergraduates in research as a vocation.

2. Selection and training of personnel:
 - a. Graduate training
 - b. Further training and research
 - c. Exchange of personnel between institutions for training purposes
3. Salary policy:
 - a. Special salary for research
 - b. Recognition of merit
 - c. Difference between salary at beginning and end of research career
 - d. Salary differential for personnel with higher degrees or qualifications
 - e. Careers in research recognized through honorary degrees
4. Dual position in teaching and research.
5. Participation in graduate teaching by research institute personnel.
6. Tenure.
7. Supporting personnel:
 - a. Medium education
 - b. Personnel
8. Perquisites:
 - a. Free housing
 - b. Other non-salary benefits
9. Twin systems of career:
 - a. Equal salary
 - b. Recognition for administrative and technical responsibilities
10. Training for administration of research.

11. Scientific recognition through academies, professional societies, prizes, awards, etc.

C. Support of Agricultural Research

The total amount of funds used in Brazil for agricultural research has not as yet been precisely estimated. It is suggested that an inventory of these funds available to each institution in the different regions be prepared. This inventory will provide elements for judgment on the distribution of resources for different institutions and will allow the group to make suggestions on new sources of funds:

1. Present sources of funds:

- a. Direct federal and state appropriations from budget
- b. Special taxes
- c. Income from institutions
- d. Contracts from agencies requiring research; such as

IBC - Brazilian Coffee Institute

IBFD - Brazilian Forestry Development Institute

IAA - Alcohol and Sugar Institute

IBRA - Brazilian Agrarian Reform Institute

INDA - Brazilian Agricultural Development Institute

SUDENE - Superintendency for Development of the
Northeastern Region

SUDAM - Superintendency for Development of the
Amazon Region

SUVALE - Superintendency of the Sao Francisco
River Valley

- e. Loans from banks
- f. Grants from foundations

2. Other possible sources of funds:

- a. Tax deductions as incentive to application of private money on agricultural research
- b. Grants from private industry
- c. Research by private industry

D. Research Priorities

There is need of a study of the mechanism of establishing and ranking priorities in agricultural research in Brazil:

1. The following criteria for establishing and ranking research priorities may be considered:
 - a. Governmental policies
 - b. Current economic and social importance
 - c. Market potential
 - d. Availability of institutions personnel and funds
 - e. Scientific importance
 - f. Use of natural resources
 - g. Occupation of less developed territories
 - h. Benefits in relation to cost of research
 - i. Urgency of research
 - j. Feasibility and likelihood of successful completion in a reasonable period of time
 - k. Likelihood of similar research being undertaken elsewhere
 - l. Likelihood of results being adopted and implemented on a wide scale
2. Research priorities already established may be considered:
 - a. Five-year plan of the CNPq
 - b. Ministry of Agriculture National Plans
 - c. Plans of other institutions

E. Coordination of Research

Research activity in Brazil is the responsibility, through different laws, of many types of institutions, including:

1. CNPq.
2. Ministry of Agriculture.

3. State Secretariats of Agriculture.
4. Universities.
5. Regional organizations, such as SUDAM, SUDENE, Bank of North East.
6. Miscellaneous, such as the Institute of Sugar and Alcohol, the Bank of Brazil (cocoa research), and private institutions.

Having this activity under so many administrations calls for a system to bring their programs together with a view to planning complementary actions towards higher efficiency and better use of investments made in research.

It is therefore proposed that the CNPq prepare a study of the alternative methods through which coordination might be achieved and the degree and amount of coordination which might be desirable between these organizations.

F. Linking Agricultural Research Institutions with Associated Organizations and Institutions

In Brazil agricultural research is carried out principally by research institutes. The teaching, extension and related functions are, with notable exceptions, carried out independently by different institutions. An analysis of this situation should cover the following points:

1. Relationship between research and education. A study should be made of the most desirable administrative relationship:
 - a. Research and medium-level education
 - b. Research and professional education
 - c. Research and graduate education (centers of excellence)
 - d. Research and short-course training
 - e. Research and extension
2. Providing research results for others:
 - a. Teaching institutions
 - b. Extension
 - c. Credit
 - d. Farmers

- e. Industry and commerce
- f. Scientific institutions
- g. Economic institutions
- h. Government ministries, planning, etc.

G. Responsibility For Agricultural Research

A study should be made of alternative mechanisms for administering agricultural research:

- 1. Ministry of Agriculture and other ministries.
- 2. State Secretariats.
- 3. Universities.
- 4. Autonomous research.

H. International Scientific and Technical Assistance

A variety of agencies are providing inputs into Brazil's agricultural development. This should be examined within the context of the national problem in relation to the objectives of this study:

- 1. The relationship of international technical assistance to the system of research coordination to be developed.
- 2. The programs of the agencies:
 - a. International agencies including
 - UN - FAO, UNESCO, UNDP
 - OEA - Inter-American Institute of Agricultural Sciences
 - b. Bi-lateral agreements between governments
 - c. Private organizations
- 3. Technical cooperation with mutual benefits for the countries involved:
 - a. Exchange of personnel - profession and student
 - b. Exchange of documentation
 - c. Exchange of material - plants, animals, etc.
 - d. Meetings, congresses, seminars, workshops, etc.

4. Exchange of international scientists among institutions in Brazil. This study should include the feasibility of utilizing the unique talents of international technicians for specific short-term assignments at institutions other than those to which they are assigned.

I. National Technical Assistance

The possibility of the more advanced Brazilian research institutions giving technical assistance to the less developed should be explored in detail. This cooperation has the attractions of common language, low cost, easier adjustment of the technical personnel, etc.

The ways and means of carrying this out would be an appropriate area for the Group to examine under the following headings:

1. Funding agency or agencies.
2. Method of conducting research at advanced institutions for less advanced while simultaneously training personnel for the latter.
3. Cooperation and counseling.

J. Documentation

Need for coordination in this area is particularly great where the resources available are limited. Particular areas which might be examined are:

1. Libraries - exchange of material, cards, abstracts, specialization.
2. Releasing information and printing material.
3. Development of Brazilian journals covering large fields with subscription in sections.
4. Cost of printing.
5. Assistance with subscription to foreign journals.

K. Dissemination of Research Results

This topic should be examined as a limiting factor in the utilization of research results:

1. Methods of dissemination of research information among scientists:
 - a. Journals and technical bulletins, books

- b. Meetings, symposia, conferences, seminars and professional societies
2. Specialized dissemination to associated organizations:
 - a. Extension agencies
 - b. Government ministries
 - c. Credit agencies
 - d. Private industry and commerce
 3. General information for public - radio, TV, magazines, newspapers.

Implementation

It is obviously impossible for the Group to carry out the activities indicated above in the three weeks available. Therefore, it is suggested that the CNPq assume the initiative in organizing appropriate committees and/or staff personnel and funding for this purpose, in collaboration with other agencies. Special consideration should be given to DPEA (Ministry of Agriculture Research Department), USAID contract personnel and some regional institutions.

These studies would provide the bases for the next report of the Joint Study Group. This information is obviously of value independently of the Group's activities.

In view of the magnitude of the task it is recommended that action should be taken in the following sequence:

1. Inventory of Brazilian agricultural research.
2. Establishment of a committee to study alternative mechanisms for assessing and ranking research priorities, with representation from CNPq, Ministry of Agriculture, State Secretariats of Agriculture, universities, and members at large.
3. Establishment of a committee to examine alternative methods of collaboration between the various agencies in a systematic attack on agricultural research priority problems.
4. Establishment of a committee to consider manpower problems.
5. Establishment of committees to implement other studies not included in items 1-4.
6. It is recommended that Brazilian personnel experienced in agricultural research administration who might be assigned staff responsibility for supervising the preparation of an

agricultural development plan, be sent as soon as feasible to the United States for training in the procedures used by the U.S. Department of Agriculture and the Land Grant Colleges in developing its recent report, "A National Program of Research for Agriculture." Personnel to have responsibility for research evaluations should also have training in the new techniques being used in the planning, programming, and budgeting system.

7. It is recommended that experts from the U.S. Department of Agriculture familiar with developing research inventories be sent to Brazil for a short period to work with the Brazilian scientists sent to the United States for training.
8. Brazilian members of the group should continue getting information together, forwarding information to the U.S. members to keep them informed of the progress being made in the studies.
9. Time table.
 - a. Examination of the progress report by the Workshop, February 4-10, 1968
 - b. CNPq study of the organization of subcommittees, budget and funding
 - c. Organization of the subcommittees. (These items should be completed by March 31 1968.)
 - d. Inventory should be prepared between March 31 and September 30, 1968
 - e. The subcommittee should present their report by October 31, 1968
 - f. Each group member will study the reports of the subcommittees and present their suggestions up to December 31, 1968
 - g. The draft of the first report should be discussed at meetings of the national groups held in January or February 1969
 - h. The draft of the report should be ready by February 28, 1969
 - i. Meeting of the joint study group for the conclusion of the report should occur in the middle of March 1969
 - j. The report will be presented to the Workshop in middle of April 1969

Appendix "1"

Visit of the Agricultural Group of Cooperation Between
the Brazilian National Research Council and
U. S. National Academy of Sciences

Period: January 7 to 26, 1968

Group from NAS

Roy L. Lovvorn
R. K. Frevert
H. Rex Thomas
M.G.C. McDonald Dow

Group from CNPq

Glauco Pinto Viegas
Ady Raul da Silva
Roberto Meirelles de Miranda

1. Arrival at Belem, Para, January 7.
2. Visit at Belem, January 8:
 - a. Institute of Agricultural Research of Ministry of Agriculture (IPEAN)
 - b. College of Agriculture
 - c. Secretary of Agriculture
3. Drs. Frevert and Miranda visited on January 9 the College of Agriculture of the University of Ceara.
4. The other members traveled to Recife, Pernambuco, and visited the Agricultural Research Institute (IPA), January 9.

All members visited on January 10 the Institute for Agriculture Research of the Ministry of Agriculture for the Northeast (IPEANE) and the SUDENE (Government Agency for the Development of the Northeast).

5. The group traveled to Rio and was received by the President, Vice-President and the staff members of the Brazilian National Research Council on January 11.
6. On January 12 the group visited the Rural University and the Institute of Agriculture Research (IPEACS) at km 47, State of Rio de Janeiro.
7. Preliminary meeting of the group for the outline of the progress report was held on January 13.
8. The group visited the headquarters of the Department of Agriculture Research of the Ministry of Agriculture and its Divisions of Soils and Food Technology, I.R.I. Research Institute, and USAID Offices.

9. Meeting was held at National Research Council for discussion of the information at hand and planning for future inquiries on January 16 traveling to Campinas, São Paulo in the afternoon.
10. The Institute for Agriculture Research of the State of São Paulo, Campinas, the Tropical Center for Research on Food and Technology, the Research Center of Animal Nutrition at Nova Odessa, the Division of Specialized Technical Assistance (DATE), the College of Agriculture of the University of São Paulo, Piracicaba and the Biological Institute of the State of São Paulo were visited in January 17, 18, and 19.
11. A meeting with the general coordinator for Agricultural Research at the State of São Paulo and the directors of research of the visited institutions was held on January 19.
12. The Institute for Agriculture Research of the Ministry of Agriculture (IPEACO) at Sete Lagoas, Minas Gerais, in the region of "cerrado" was visited on January 20.
13. The Rural University of the State of Minas Gerais, Vicosa, was visited on January 21 and 22, and the group returned to Rio de Janeiro.
14. A joint meeting with Agriculture Economics Group was held on January 23 at the Brazilian Academy of Sciences.
15. Discussion, recommendations and final draft of the progress report were made, in meetings on January 24, 25, and 26.
16. Presentation of progress report to the President of the Brazilian National Research Council, January 26, and return to the United States.

Appendix "2"

The Economic Dimension of Agricultural Research
Needs to be Given More Emphasis*

Agricultural economics has been relatively neglected as a discipline in Brazil. As a consequence, there are only a couple of reasonably strong centers of agricultural economics in the country. This results in the almost complete lack of agricultural policy research, and the failure to have an economic interpretation of utilization of agricultural physical research.

As first steps to improve this situation, the following recommendations need to be considered:

1. Research in agricultural economics should be considered an integral part of agricultural research

It is recommended that the CNPq, the Ministry of Agriculture, secretariats of agriculture, universities, and other agricultural research institutions clearly recognize that a comprehensive agricultural research program which will best serve Brazilian agriculture must include, as an integral part, an appropriate staff and program of work in agricultural economics. It is further recommended that national, state, and private research policies, programs and budgets be developed in a manner such that this aspect of the agricultural sciences receives adequate financial resources on a continuing and timely basis.

As suggested below, agricultural economics can contribute in the detailed planning and interpretation of results for various technical research projects, in applying such information for improved farm management, as well as in conducting research on marketing and policy problems. Some part of this task can be accomplished by placing economists in close cooperation with other technical research workers in agriculture. Other parts of the task require research agencies specialized in agricultural economics. Both types of organization are essential if agricultural economics is to make its maximum contribution to the effectiveness of agricultural research.

* Partial text of this appendix is contained in section "Goals and Strategy"-Part A of the Progress Report on Agricultural Economics.

2. Agricultural economics should be established as a permanent component of the six regional Institutes that make up DPEA and in such other research institutions where viable.

New discoveries and new technologies are of little use to the farmer if they are not profitable. Moreover, the farmer wants to know more than whether fertilizer will increase yields, for example. He wants to know, given that fertilizer is profitable, how much should be used, and in what proportions.

In addition to this, he needs information on how different products fit together to make a profitable system of farming. This involves not only some knowledge of the physical relationships involved, but also the economics of how the various inputs and enterprises fit together. For this reason, the output of the physical research will be more useful to the farmer if it is synthesized and analyzed in the context of a total farm organization.

As agricultural research institutions develop their programs, agricultural economics can contribute to the establishment of priorities. These priorities are based on such things as the availability of human resources, the probability of success in the research venture, and some notion of the economic viability of the respective crop or product. It is important that economic consideration be considered in establishing these priorities. Recommendation should be considered at two levels:

- a. It is recommended that a team of at least three agricultural economists (with at least the M.S.) be placed in each of the regional institutes and in other research centers where viable. These economists would have the following functions:
- (1) Help in designing the experiments and research so that economically meaningful results can be derived from them.
 - (2) Interpret the results of the physical research from an economic standpoint. This is especially important in fertilizer and animal nutrition research, but even such things as disease and insect control have an economic dimension.
 - (3) Develop a program of farm management research. This will involve the synthesization of the results of the physical research into economically profitable systems, and the conduction of farm management surveys which will indicate what is taking place in the rural sector and serve as a basis for developing the new systems.

- (4) Conduct studies of the general agricultural economy of the region to provide economics information essential to the establishment of biological research. Considerations which must be taken into account in this are the relative economic importance of the product, the relative income elasticity of demand, market potential, etc.

The field of agricultural economics as a discipline encompasses much more than these four functions. However, such things as price analysis, detailed analyses of the marketing system, the evaluation of agricultural policy, and work on more basic economic development and resource allocations problems should be left to institutions that specialize in agricultural economic research. An attempt should be made to integrate the economists located in the research stations with the specialized agricultural economics centers.

- b. It is recommended that a small advisory group of agricultural economists also be established at the decision-making and planning level to help in establishing priorities for biological and physical research.

In addition to the decisions at the regional level it is also important that priorities be established at the national level. This group would assure that economic considerations will be included in establishing these priorities. This group would draw on the centers of agricultural economics for advice and the necessary analysis.

Several agricultural economics research and teaching institutions need to be added to complement those already existing in São Paulo and Minas Gerais. This can be done by encouraging the growth of small units in one or two other regions and one on a national basis. The existing centers, which are reasonably strong, warrant continued support.

The existing graduate programs need to be continued and strengthened. They furnish numerous opportunities for both research and training, with systematic and reasonably secure sources of support.

More elaboration of these comments and issues will be developed in the report of the Agricultural Economics Committee.

Progress Report of the Joint U.S.-Brazil Study Group
on Agricultural Research

by

Glauco Pinto Viegas
Brazil Study Group on Agricultural Research
(Summarized by M.G.C. McDonald Dow)

Dr. Viegas reported that as a result of their discussions and supplemented by visits to agricultural research and teaching institutions in various parts of Brazil the group had reached certain tentative conclusions about the nature of its future activity, subject to workshop approval, and which principally required the assembly of information relating to certain specific areas of activity. These are:

1. Research institutions - their number and type, including details of facilities, personnel, equipment, administration, funding, and evaluation of their effectiveness.
2. Scientific manpower - particularly education and training, research, salary policy, tenure, administration, and recognition.
3. Funding of agricultural research - direct federal and state appropriations, special taxes, income, contracts, loans, etc.
4. Priorities of research - particularly the need for a study of the mechanism of establishing and ranking priorities in agricultural research in Brazil, including the CNPq's five-year plan and other plans.
5. Coordination of research - it is proposed a study be made of the alternative methods by which coordination might be achieved in agricultural research.
6. Linking of research with education and extension - in Brazil the responsibility for these three functions lies with separate organizations.
7. Alternative methods of administering agricultural research.
8. An examination of international scientific and technical assistance providing assistance to agricultural development.
9. National technical assistance - the possibility of more advanced institutions giving technical assistance to the less developed should be explored in detail.
10. Coordination in the area of documentation.
11. Problems in the dissemination of research results as a limiting factor.

The group suggested that the CNPq assume the initiative for organizing appropriate committees for this purpose in collaboration with other agencies, particularly the Ministry of Agriculture Research Division, USAID and some regional institutions. It is also proposed that an inventory of agricultural research be carried out, similar to that undertaken by the USDA and the Land Grant Colleges in developing "A National Program of Research for Agriculture" with the assistance, both in the United States and in Brazil, of USDA personnel. A time-table of stages was suggested.

Supplementary Remarks to the
Progress Report of the Joint U.S.-Brazil Study Group
on Agricultural Research

by

Roy L. Lovvorn

Chairman of U.S. Study Group on Agricultural Research

Dr. Glauco Viegas has given an excellent report on the activities of our committee during our recent three weeks in Brazil and I fully concur in everything he has said. Perhaps a few additional comments would be appropriate.

On behalf of the U.S. component of the study group, I want to thank our Brazilian counterparts for arranging our schedule in such manner that allowed maximum use of our time while in Brazil. Certainly everything possible was done to allow us to see, hear, and learn the maximum about Brazil and its agricultural research. We were also cordially received wherever we went as a part of our mission.

During our group discussions we had many points of view and impressions but the differences between members of the U.S. group were just as great as were the differences in points of view between the two national groups. To me that was most significant. Our progress report, therefore, as given by Dr. Viegas is a unanimous one.

The ten general observations are repeated for emphasis. They are as follows:

1. Lack of funds at the time they are needed.
2. Application of a disproportionate amount of funds for maintenance as opposed to actual research projects.
3. A large number of institutions operating under different administrative authorities and systems of administration.
4. A shortage of well-trained senior research personnel and a lack of capacity to train them.
5. Limitations in the system of promotion, particularly relating to merit and incentive.
6. Disparity between salaries for research and teaching, and the small difference in pay scale between capable junior and senior technical personnel.
7. Lack of connection between research, teaching, and extension institutions.

8. Difficulties of communication between institutions, organizations and individuals conducting agricultural research.
9. Lack of economic interpretation given to the experimental results.
10. Under-utilization of building, equipment and personnel.

As Dr. Viegas has pointed out, we have identified eleven points for further study by subcommittees in Brazil prior to the next meeting of our joint study group. Emphasis is to be placed on obtaining an inventory of agricultural research, on studying mechanisms for assessing and ranking research priorities, on research coordination, and on a consideration of scientific manpower needs. We feel that these in-depth studies are needed in order for us to make our most objective contributions in developing a position paper on making agricultural research more effective in Brazil.

We feel we have made only a beginning in a study that should enable the Brazilian government to do a more effective job in organizing and administering its agricultural research program.

Progress Report of the Joint U.S.-Brazil Study Group
on Agricultural Economics

by

Brazilian Members

Rui Miller Paiva, Chairman
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Introduction

This report has its origin in a meeting of the U.S.-Brazil Science Cooperation Program held in Itatiaia in 1966. This meeting was jointly sponsored by the Brazilian National Research Council and the U.S. National Academy of Sciences.

One result of that meeting was an agreement to establish three binational agricultural study groups, each of which would make recommendations in specific areas. These three study groups were:

1. Study Group on Agricultural Research
2. Study Group on Agricultural Economics
3. Study Group on the Establishment of Germ Plasm Banks and the Development of Plant Collections

It was intended that the first two of these groups would work together in making suggestion for the improvement of agricultural research in Brazil. The original terms of reference given to the Study Group on Agricultural Economics indicated that it was to establish priorities for agricultural technical research based on the relative supply and demand conditions for food products in Brazil.

Later discussion led to an expansion of the terms of reference to include the following:

1. Establish priorities for agricultural technical research based on the relative supply and demand conditions for food products in Brazil;
2. Serve as a review-board for economic analysis and policy recommendations of the (proposed) USAID-Brazil internal economic analysis group;
3. Review the results of economic studies in order to appraise and revise policy recommendations for agricultural development in Brazil;

4. Consider and make recommendations on establishing research priorities for research in agricultural economics."

This revision in the terms of reference seemed desirable in view of the particular needs of Brazil and the experience of the men chosen to make up the committee.

The Study Group was to carry out its work over an 18-month period. In this period, meetings were to take place in both the U.S. and Brazil.

The Study Group on Agricultural Economics met for the first time in Rio de Janeiro from January 22-30, 1968. Preliminary discussions led to a decision to broaden further the focus of the Study Group, and led to a recommendation that certain of the assignments might better be carried out on a continuing basis rather than as a once-for-all set of recommendations.

As a result, the objectives of the group became the following:

1. To suggest ways in which agricultural economics could be integrated with the physical and biological agricultural research.
2. To suggest ways in which economic analysis could be brought to bear in establishing research priorities on a continuing basis.
3. To suggest steps to be taken which will strengthen agricultural economics as a science and discipline in Brazil. Special emphasis is to be given to:
 - a. Strengthening teaching programs in agricultural economics.
 - b. Strengthening research in agricultural economics generally, but most specifically, that useful for policy purposes.
4. To suggest ways in which a permanent council of Economic Advisors for Brazilian Agricultural Development could be established which would guide the development of the growing profession, advise on national agricultural policy, and advise on programs of international assistance to the agricultural sector of Brazil.

The present report represents the first step in attaining these objectives. The suggestions for objective one were attached to the report of the Agricultural Study Group.

Status of Agricultural Economics in Brazil

Agricultural economics, as a profession and as a field of study, is of recent origin in Brazil. Prior to World War II, there were no formally-trained agricultural economists actively involved in research, teaching or public service. In the universities, undergraduate instruction in this subject matter was limited to one course, at most two, as part of the Engineer Agronomo Curriculum. Formal programs of graduate study were non-existent. Useful programs of systematic scientific inquiry were almost completely absent. Nobody of scientific knowledge relative to the agricultural economy was available. The situation in public entities at the national and state levels was equally dismal.

During the 1940's and 1950's, some growth in the profession took place. This was characterized by the gradual evolution of a small group of agricultural economists with advanced scientific training abroad. Equally, a few agricultural economics programs took root. Notable among these were the Division of Agricultural Economics in the Secretariat of Agriculture in São Paulo and the Department of Agricultural Economics in the Superior School of Agriculture of the Rural University of the State of Minas Gerais. Still, as late as 1960, the profession was clearly in its infancy with but a handful of well-trained and experienced professionals. The state of knowledge relative to the Brazilian agricultural economy continued relatively low. With few exceptions, the profession was not in a position to make meaningful contributions to rational public decision-making at national and state levels, nor at the farm and agricultural business firm level.

The late start and slow growth of the profession in Brazil is attributable to a number of factors. First, it has evolved in the environment of the Brazilian school of agronomy. Such schools, with some exceptions, have been modeled after European schools and universities. They have been highly theoretical and isolated from the problems of Brazilian agriculture. Their limited concern for contemporary problems did not provide much opportunity for agricultural economics to come in play. Second, the schools of agronomy have tended to be autonomous, with little or no relation to other academic faculties, where intellectual interaction with other social sciences and other disciplines could take place. Third, the discipline of economics itself, until recently, has not developed in Brazilian faculties, and provided no base for the development of agricultural economics as the applied field.

In 1960, Nicholls* appraised the status of the agricultural economics profession in Brazil. In commenting on undergraduate teaching, he indicated:

*Nicholls, William H. (Vanderbilt University). Confidential report to the Ford Foundation entitled "An appraisal of Brazilian agricultural economics," July 1960.

1. The American concept of the "major field" was wholly absent in the undergraduate curriculum of Brazilian colleges of agriculture.
2. Unlike at least some of the technical fields of agriculture, agricultural economics had not yet won in Brazil a place in institutionalized research or extension. As a result, the few professional job opportunities for agricultural economists did not encourage undergraduate or postgraduate specialization in this field.
3. In Brazil's technically-oriented Faculties of Agronomy, the field of "rural economics" represented a distinct minority interest, making its internal expansion extremely difficult and sometimes impossible.
4. Brazil's catedráticos in Rural Economics had not yet produced an intellectual leader whose powers of intellect, personality, and leadership were sufficient to gain a position of respect for this unfamiliar and somewhat suspect field.
5. Brazil's professors of Rural Economics had not yet found that happy combination of theory and application needed for fruitful and effective demonstration of the value and importance of their field.
6. As a subject which cut across two important fields, agricultural economics in Brazil suffered unusually severely from almost absolute separation, both physically and intellectually, between the faculties of agriculture and the faculties of economics.

During the 1960's, interest in and growth of the profession accelerated, albeit from a narrow base. Currently, undergraduate specialization in agricultural economics is possible at two institutions--Viçosa and Piracicaba. Graduate programs leading to the Master of Science degree are available at three institutions--Viçosa, Piracicaba and Rio Grande do Sul. The number of Brazilian agricultural economists with advanced training at home and abroad has increased sharply. It is estimated that there are approximately 90 agricultural economists with Master of Science or higher level of training active in Brazil at the present. Additionally, there are some 40 students currently pursuing graduate programs at the M.S. and Ph.D. levels in this country and abroad, plus others who have advanced level training without obtaining the degree. The total number of people with some graduate level training is therefore approximately 150.

These professionals are rather highly concentrated in a few states. Minas Gerais has approximately 30, Sao Paulo approximately 15, Rio Grande do Sul approximately 20, Guanabara approximately 10, and Ceara and Pernambuco approximately 12. The remainder are distributed almost singly throughout the country.

Significant research programs are being developed in conjunction with the graduate programs in the three superior level teaching programs. The research capacities of the agricultural economics divisions of the secretariats of agriculture in the states of São Paulo and Minas Gerais are substantial and growing. Similarly, a few national entities, e.g., the Ministry of Agriculture, and in the Ministry of Planning, IPEA, are beginning to develop scientific research capacity of note. A national system of market news is evolving, as such activities in five states (São Paulo, Minas Gerais, Rio Grande do Sul, Guanabara, and Paraná) are linked through the Ministry of Agriculture. A national system of crop forecasts has already been developed, plus a monthly agricultural situation report for the Central and South producing areas of Brazil.

Institutional arrangements for the conduct of effective agricultural economics work have improved materially in a few significant cases. With the reorganization of the UREMG some two and half years ago, the Institute of Agricultural Economics was given the freedom and responsibility to develop undergraduate programs, research, and extension education programs. The creation of responsibility for graduate programs in agricultural economics at Piracicaba and Rio Grande do Sul is having similar effects in these institutions. The implantation of the economics and statistics project in the Secretariat of Agriculture in Minas Gerais has created an institutional vehicle with significant potential for bringing economics to bear on state government policy.

Despite the positive changes that have characterized the agricultural economics profession in recent years, it is clear that this branch of the agricultural sciences continues to be relatively weak, both in absolute and relative terms. It does not have the capacity to provide the kind and magnitude of scientific and intellectual inputs essential to the sustained growth of Brazilian agriculture. The major weaknesses of the profession, at this time are:

1. The lack of adequate numbers of well-trained agricultural economists in the several sub-disciplines of the field. In a relative sense, this problem is most serious in the macro-analysis and public policy areas.
2. Incomplete and imperfect integration of viable agricultural economics units in (a) the university system, (b) the non-university physical and biological agricultural research system, (c) the agricultural policy and action program agencies of state and federal governments.
3. The lack of an adequate conceptual and empirical knowledge base relative to the economics of Brazilian agriculture.
4. The lack of institutional capacity and adequate public support to expand the supply of agricultural economists and knowledge of the economics of agriculture at a rate consistent with national needs.

5. Imperfect recognition in both the public sector and the private sector of the potential contribution of economic analysis to more rational decision-making.

Brazil's Needs for Economic and Social Analysis of Agriculture

The national government daily makes important economic decisions affecting agriculture. Some of these decisions are being made within the several ministries, especially in Agriculture, Education, Planning, Treasury, and Commerce. Other national level decisions take place in various autarchies concerned with a specific commodity, such as coffee, sugar, and alcohol institutes. Still other decisions, sometimes applicable to specific regions, are made in institutes dedicated to particular functions, such as INDA (National Institute for Agricultural Development), IBRA (Brazilian Institute for Agrarian Reform), and SUDENE (Superintendency for the Economic Development of the Northeast). This substantial influence of the national government occurs without the benefit of analysis relative to the economic impact of these policies on agriculture, in general or upon specific sections of it. Also, there is little knowledge of the environment of agriculture, that is, the actual on-farm and farm-to-market situation in which the programs operate.

Similarly in the states, many public agencies make economic decisions on a wide variety of issues, but with little information on the consequences of their actions. Many of these actions appear to be inconsistent, often short term, and less effective than they might be. Private individuals too, make decisions important to them, to their suppliers, and to their customers with too limited a flow of timely economic information which could assist them in their farming or business ventures.

The Committee is concerned that important analyses of the economic problems in agriculture, that can lead to better public and private decision making, are not available or appear only on rare occasions. These concepts lead to an emphasis on applied research, but certainly also include basic studies on the operation of the agricultural economy, and its interrelation with the rest of the economy. Similarly, the social and other human relationships within agriculture and between rural people and the rest of society receive little research attention. Though much social and economic data which can contribute to understanding does not now exist, it is not necessary to develop an inventory of the data and information needed for relevant economic, social, and statistical research. Rather, the Committee wishes to focus on problems and how better understanding can be brought to the decision-making processes through systematic study.

A great variety of problems and subjects challenge the attention of rural social scientists. Criteria and priorities for selection among them need to be developed. This Committee has discussed this problem and can suggest some areas meriting serious attention, but cannot

possibly specify a "Master Plan," nor does it seem desirable to do so. Moreover, the importance of a specific project will change over time as new problems emerge. In the remainder of this section a number of Brazilian problems which applied social science research can help clarify are suggested. No priorities are implied by the order of listing.

In very broad terms, the methods by which the Brazilian government supports national economic objectives have impacts upon agriculture. Few of these effects are understood, and not enough attention is given to them. The efforts to increase the industrialization of the Brazilian economy often imply higher prices for agricultural inputs and for farm people as consumers. Import substitution policies, international trade policies, the ways in which foreign exchange is allocated and the adjustment of specific commodity prices during inflation have particular impacts on commodities important to agriculture. Modern inputs, such as tractors, fertilizer and insecticides have substantial potential in expanding the production and increasing the productivity of agriculture, yet frequently, the effect of the policies listed above is to make these inputs more expensive to Brazilian farmers than to competing farmers in other countries, and to discourage the modernization of traditional agriculture. Modern inputs do not receive adequate attention as potential strategic inputs, and as one result, Brazil has difficulties in competing in world markets.

Decisions at this broad level of policy, even with perfect understanding, will not and should not always be resolved for the benefit of one group of people, be they agricultural and rural people, consumers, business groups, or laborers. But information and analyses are needed which will provide an understanding of the consequences of such policies upon rural people with some analysis of alternative courses of action. This Committee believes that studies of this type, at an adequate level of quality, would be utilized in a significant way to improve the quality of Brazilian national decisions and development plan implementation.

The need is even clearer when examining the specific programs in agriculture of the several ministries, autarchies, functional institutes, and commodity organizations. This includes such programs as minimum prices, taxation on products important to agriculture, land settlement and migration, agricultural credit, land tenure, community development, extension education and research services, road construction and improving the marketing infrastructure. The administrators of such programs would be able to make their decisions with more confidence and with more appropriate choices among alternatives if they had access to a flow of studies appropriate to the problems they face.

But the analyses discussed so far will be more adequate and more accurate if supported by and related to specific studies of farms, marketing firms and the functioning of rural communities. Moreover, the problems of public and private agencies in the states, and of the farmers themselves require the results of economic and social studies as they make decisions appropriate to their situation. Brazilian

agriculture consists of millions of operating units, each of them allocating the resources at their disposal. In the aggregate, these decisions determine the volume of farm products available to the Brazilian economy. The suppliers of inputs, the marketers of farm products, and the public agencies seeking to influence the farm and market decisions need analyses that can help them understand the process by which such production decisions are made.

One of the important problems in this area is to use presently known technology to synthesize improved farm organizations which can expand production and increase the income of the farmer and the agricultural sector. Such studies can provide a stimulus and guide to individual farmers as they attempt to improve their own situation. They can also suggest the types of loans, extension programs, and other activities that public agencies might sponsor.

The agricultural research institutes functioning in various parts of the country are seeking new technologies applicable to agriculture. The creation of such technologies may not be very meaningful unless their application is profitable to the individual farmer or marketing firm. The questions as to whether the proposed innovation is profitable, and the level of use at which it is most profitable are both relevant. Recent advances in agricultural economics have developed scientific procedures which should be incorporated into the design of physical and biological research, and into the analysis of the results. This procedure can provide information for answering many of the economic questions at the same time that the technical results are obtained. Moreover, as innovations are identified, there is a need to study how they relate to existing patterns of production and to possible new patterns of farming with new combinations of inputs and enterprises. As economists work cooperatively with agricultural production scientists, both will gain knowledge which will enable them to help assess priorities and establish criteria appropriate in choosing among alternative technical research projects--a process by which the very limited scientifically trained people and financial resources are more effectively utilized.

Other social sciences can also contribute to a better understanding of Brazil's rural problems. Attitudes toward innovation and the process by which new technology is learned and adopted need to be understood, so that the technical and economic advances by the agricultural research institutes and the specialized agricultural economic research organizations are communicated to farmers in forms and patterns that facilitate adoption.

Food production does not end when the products are produced. The commodities must be transported from the farm, perhaps processed, packaged, stored and moved into the retail trade or into international markets. Brazil's population is increasing rapidly, and an increasing proportion is living in cities and towns. More products are required as population and real per capita income increases, and more must be marketed into urban centers as the urban proportion of total population

increases. Quite possibly, these combined will require substantial changes in the structure of markets and marketing practices.

An examination of these forces can provide insights useful to marketing firms, to the banks which finance them, and to public agencies called upon to help provide the marketing infrastructure that tomorrow's population will require. For example, with higher incomes the demand for meat, fruits, and vegetables is likely to increase more rapidly than the demand for wheat, rice, and mandioca. Or, regional changes in population and income will expand the size of one market relative to another.

Marketing also benefits from the availability of data on current production, current prices, and crop conditions. The system for collecting data on Brazilian agriculture does not function as well as it might. Systematic research is needed on new procedures leading to more reliable and timely data.

Such analyses of agricultural production and marketing provide basic information useful in contributing to the solution of policy questions raised at the beginning of this section. For example, the analysis of the changing demand for various farm products coupled with studies of farm organization and production permit a more accurate perception of the impact of minimum prices (or price callings) upon the production of the affected and competing commodities, and upon the income of various types of farms producing such products. As another example, studies of farm organization and the most profitable combination of traditional and modern inputs can suggest the most appropriate uses of agricultural credit. Credit organizations can draw on such studies periodically to identify loan needs and loan programs most likely to be effective in developing agriculture.

Finally, as Brazilian and international agencies make decisions among possible loan and technical assistance programs, there is much uncertainty and imperfect knowledge relative to the productivity of alternative investments, in developing the infrastructure or investing in operating programs, in supporting or creating one or another type of institution. The skilled economist can better contribute to such decisions when he can examine and draw on a flow of research results from agricultural economic research--research which provides more understanding of the way in which the agricultural economy functions, and the productivity which various inputs have in the farm business, in marketing firms, and in public programs. With a combination of micro and macro level studies ranging from the farm and the community to the nation as a whole, even to the nation in world economy, the loan and assistance programs that are chosen will likely make a larger contribution to expanding the levels of living of the Brazilian people.

Goals and Strategy

Specific goals to be sought and strategies which might be followed to strengthen agricultural economics as a science, to maximize the contribution of agricultural economics to technical agricultural research, and to improve decision-making in the formulation of national economic policy are presented in this section.

A. The economic dimension of agricultural research needs to be given greater emphasis.*

Agricultural economics has been relatively neglected as a discipline in Brazil. As a consequence, there are few reasonably strong centers of agricultural economics in the country. This has resulted in the almost complete lack of agricultural policy research, and the absence of essential economic interpretations of physical and biological research.

As first steps to improve this situation, the following recommendations need to be considered:

1. Research in agricultural economics should be considered an integral part of agricultural research

It is recommended that the Brazilian National Research Council, the Ministry of Agriculture, secretariats of agriculture, universities, and other agricultural research institutions recognize that a comprehensive agricultural research program which will best serve Brazilian agriculture must include, as an integral part, an appropriate staff and program of work in agricultural economics. It is further recommended that national, state, and private research policies, programs and budgets be developed in such a manner that this aspect of the agricultural sciences receives adequate financial resources on a continuing and timely basis.

As suggested below, agricultural economics can contribute in the detailed planning and interpretation of results for various technical research projects, in applying such information for improved farm management, as well as in conducting research on marketing and policy problems. Some part of this task can be accomplished by placing economists in close cooperation with other technical research workers in agriculture. Other parts of the task require research agencies specialized in agricultural economics. Both types of organizations are essential if agricultural economics is to make maximum contribution to the effectiveness of agricultural research.

*This section is based on the report attached to the Study Group on Agricultural Research, which also includes a statement about the need to strengthen specialized centers of agricultural economics.

2. Agricultural economics should be established as a permanent component of the six regional Institutes that make up the Department of Agricultural Research and Experimentation (DPEA, the Ministry of Agriculture) and in such other research institutions where viable

New discoveries and new technologies are of little use to the farmer if they are not profitable. Moreover, the farmer wants to know more than whether fertilizer will increase yields, for example. He wants to know, given that fertilizer is profitable, how much should be used, and in what proportions.

In addition to this, he needs information on how different products fit together to make a profitable system of farming. This involves not only some knowledge of the physical relationships involved, but also economics of how the various inputs and enterprises fit together. For this reason, the output of the physical research will be more useful to the farmer if it is synthesized and analyzed in the context of a total farm organization.

As agricultural research institutions develop their programs, agricultural economics can contribute to the establishment of priorities. These priorities are based on such things as the availability of human resources, the probability of success in the research venture, and some notion of the economic viability of the respective crop or product. It is important that economic factors be considered in establishing these priorities. Recommendations should be considered at two levels:

- a. It is recommended that a team of at least three agricultural economists (with at least the M.S.) be placed in each of the regional institutes and other research centers where viable. These economists would have the following functions:
 - (1) Help in designing the experiments and research so that economically meaningful results can be derived from them.
 - (2) Interpret the results of the physical research from an economic standpoint. This is especially important in fertilizer and animal nutrition research, but even such things as disease and insect control have an economic dimension.
 - (3) Develop a program of farm management research. This will involve the synthesization of the results of the physical research into economically profitable systems, and the conduct of farm

management surveys which will indicate what is taking place in the rural sector and serve as a basis for developing new systems of farming.

- (4) Conduct studies of the general agricultural economy of the region to provide economic information essential to the establishment of biological research. Considerations which must be taken into account in this are the relative economic importance of the product, the relative income elasticity of demand, market potential, etc.

The field of agricultural economics as a discipline encompasses much more than these four functions. However, such things as price analysis, detailed analyses of the marketing system, the evaluation of agricultural policy, and work on more basic economic development and resource allocation problems should be left to institutions that specialize in agricultural economic research. An attempt should be made to integrate the economists located in the research stations with the specialized agricultural economics centers.

- b. It is recommended that a small advisory group of agricultural economists be established at the national decision-making and planning level to help in establishing priorities for biological and physical research.

In addition to decisions at the regional level, it is also important that priorities be established at the national level. This group would assure that economic factors will be considered in establishing these priorities. This group would draw on the specialized centers of agricultural economics and the regional economics groups for advice and necessary analyses.

- B. The profession of agricultural economics needs to be further developed.*

Agricultural economics, as a science, has been largely ignored in the development of Brazilian agricultural sciences. It remains one of the major gaps in the agricultural research-teaching-extension

*This and the following section draw heavily on a 5-year program paper developed for the Ford Foundation, which gives considerable emphasis to developing agricultural economics. The program paper for the Foundation was prepared by Dr. G. Edward Schuh, one of the members of the Study Group on Agricultural Economics.

infrastructure. As short a time ago as 1960, there were in Brazil only five or six men with the M.S. in agricultural economics, departments of agricultural economics in the schools of agronomy were weak, and only one institution (the Divisão de Economia Rural of the Agricultural Secretariat of São Paulo) was doing any serious agricultural economics research.

Since that time, the Rural University of Minas Gerais with the combined efforts of the Ford Foundation, USAID, Purdue University has developed a graduate training program. Some sixty M.S.'s have been produced, and some valuable empirical research based on field data has been completed.

A small graduate program has been started at the Federal University of Rio Grande do Sul. A somewhat more ambitious program has been initiated at the Agronomy School in Piracicaba. Both have been developed with support of USAID and North American universities. An economic analysis and statistics group in the Agricultural Secretariat of Minas Gerais has been developed with the assistance of the Ford Foundation and Purdue University.

Despite the above, much remains to be done to develop a strong scientific discipline. The graduate programs turn out only a rather limited number of professionals. Some six to eight students are now in the U.S. working toward the Ph.D.; only one Ph.D. has returned to Brazil.

On the other hand, the Divisão de Economia Rural in São Paulo has continued to develop, albeit slowly, and a critical mass of young M.S.'s have been assembled in the Agricultural Secretariat of Minas Gerais. In addition, increased emphasis is being given to agricultural economics in the Institute of Applied Economic Research (IPEA) of the Ministry of Planning.

High priority must be given to further development of this sorely neglected profession. Development efforts should concentrate on both the demand and supply side of the market. That is, the capacity for providing graduate training within the country should be increased at the same time as viable institutions, in which critical masses of agricultural economists can work effectively, are developed.

It is recommended that the development of the agricultural economics profession in Brazil, in the next five years, be guided by the following set of minimal goals or targets:

1. To have 30-40 men with the Ph.D. degree or well along in their doctoral studies. A realistic target is to have some 20 completed Ph.D.'s working in the country by 1972.
2. To have 250-300 men with the M.S. degree working in the country. (A top-heavy structure with numerous Ph.D.'s

and no underlying base should be avoided. Efforts should be made to develop specialization at the undergraduate level, and to increase substantially the number of men trained at the M.S. level.)

3. To develop at least four strong regional centers or complexes in agricultural economics. Each of these should have a strong training component plus a strong research component through which economists are seeking to solve regional problems (See below.)
4. The development of at least one viable Ph.D.-level training program in Brazil.
5. To develop comprehensive research programs that are more than just the by-product of ongoing graduate programs.

C. Capacity for policy analysis and research must be expanded.

In part because of the lack of trained manpower, very little research and analysis for policy decisions is done. The Division of Rural Economics in São Paulo is by far the strongest and has accumulated a great deal of experience. The Economics and Statistics Group in the Agricultural Secretariat of Minas Gerais is in a position to do some good work, but was only recently organized. Capacity for policy analyses at the national level is limited despite the fact that the Ministry of Agriculture has an Economics Department, and the Ministry of Planning has a small group of agricultural economists.

The scarcity of qualified technicians to do development planning or to provide guidance to public policy-makers is a serious problem. For example, one of the serious shortcomings of the Alliance for Progress was the very unrealistic view it took of the available stock of technical competency and empirical knowledge available to implement such far-reaching programs. Exhortations to provide plans and programs were at best hollow sounding when there was neither the technical competency, the basic data, nor the knowledge of the economic system to do a rational planning or analysis. High priority should be given to further developing this important capability. It is a means of capturing the payoff from investments in trained people, and requires the development of viable institutions where well-trained technicians can work effectively. Specific targets which should be considered are as follows:

1. The development of at least one policy-research group for work at the national level

The location of this is not clear at the present time. The Fundação Getúlio Vargas is a logical choice, but to date has expressed little interest. The resource base in the Ministry of Agriculture is extremely limited. Perhaps the logical choice is in IPEA within the Ministry of Planning, where some strength exists and attitudes are good. An

alternative would be an inter-ministerial committee involving the Ministry of Agriculture, the Ministry of Finance, and the Ministry of Planning.

An advisory group provided by the University of California at Berkeley now functions in the Ministry of Planning. However, their work is primarily concerned with budget programming, and not with policy making and policy research per se. What is needed is at least one institution, somewhat removed from the decision-making process, dedicated to the research on which public policy decision-making can be based. This national research institution will constitute one of the major sources of economic knowledge produced through in-depth research.

2. The development of four policy research groups that could influence regional economic policy

One such group (Divisão de Economia Rural of São Paulo Agricultural Secretariat) exists as one of the two strong points of agricultural economics work in Brazil. Its involvement in agricultural policy matters at both the state and federal level is continuous and positive.

A second center (Secretariat of Agriculture, Minas Gerais) is being developed. After the short span of three years it has developed data sources, a data collection capacity, and gained some much needed experience in policy studies. In addition, a critical mass of eight agricultural economists with M.S. level training has been assembled.

A third center should be developed in the Northeast. The Banco do Nordeste has some twenty technicians working as agricultural economists in two sectors of the Bank. These men need to be provided with advanced training which would enable them to develop strong programs of agricultural policy research.

The fourth center should be located in the South. The base for this center exists in the Institute of Economic Studies and Research (IEPE) of the Federal University of Rio Grande do Sul. This institution has been doing research in agricultural economics for a number of years. With this experience, a strong program could be developed which would provide the analysis for the southern part of the country.

Efforts should be made to link these four regional centers together as much as possible, and to make their regional analyses relevant to national policy making.

D. A permanent advisory committee for agricultural economics should be established.

The state of the agricultural economics profession and science in Brazil has been explored earlier in this report. The systematic strengthening of this scientific field is clearly in the national interest.

The strengthening of a discipline such as this will require substantial resources. Some resources are being directed to this end already. It appears that additional resources will be available through the loan currently being negotiated between USAID and the CNPq. It is important that additional resources be obtained. One possibility of funds for this purpose has come to the attention of this Study Group. It appears possible that a fraction of the annual interest to be paid on the agricultural sector loan currently being negotiated could be earmarked for research on agricultural policy and related matters. If used appropriately, these resources could strengthen the profession of agricultural economics at the same time that research results are obtained. It is proposed that the Joint U.S.-Brazil Study Group on Agricultural Economics of the National Research Council of Brazil and the National Academy of Sciences of the United States be constituted as a permanent Joint Commission on Agricultural Economics. It is recommended that this permanent Commission be responsible to the Brazilian National Research Council and the National Academy of Sciences of the United States through the U.S.-Brazil Science Cooperation Program. The general responsibilities of this Commission will be:

- (a) to provide intellectual guidance and leadership to the development of the agricultural economics profession in Brazil;
- (b) to assist in the creation of stronger and more viable internal programs of research and education in agricultural economics;
- (c) to expand opportunities for professional interactions among Brazilian agricultural economists and their colleagues in the United States and other nations.

Were the additional funds suggested above actually attained for the development of the profession, the Commission could advise on the use of these resources for the strengthening of the profession. The immediate tasks before the Commission in this next year are three-fold:

1. Explore alternative ways in which a permanent Council of Economic Advisors could be established to advise on national agricultural policy and on programs of international assistance to the agricultural sector of Brazil. The possible structure, mechanics, organization, function,

and procedures of such an organization needs to be examined.

2. Devise ways in which agricultural economics can be strengthened and the recommendations of this report can be implemented.
3. Identify ways in which continuous support can be provided to research for policy purposes.

Summary of Progress Report of the Joint U.S.-Brazil
Study Group on Agricultural Economics

by

M.G.C. McDonald Dow
National Academy of Sciences

The original terms of reference, established at the Itatiaia Workshop were

"to establish priorities for agricultural technical research based on the relative supply and demand conditions for food products in Brazil."

It was envisaged that the group would work closely with the Joint Study Group on Agricultural Research in establishing agricultural research priorities.

It was evident, when the groups met in Rio de Janeiro in January, that the rather narrow limits of the original terms of reference, if strictly adhered to, would not lead to a lasting solution of the priority problems, and all agreed that the root of the problem should be squarely faced--the expanded objectives now being:

1. To suggest ways in which agricultural economics could be integrated with physical and biological agricultural research.
2. To suggest ways in which economic analysis can be brought to bear in establishing research priorities on a continuing basis.
3. To suggest steps to be taken which will strengthen agricultural economics as a science and discipline in Brazil, special emphasis to be given to:
 - a. Strengthening teaching programs in agricultural economics
 - b. Strengthening research in agricultural economics generally but most specifically in that used for policy purposes
4. To suggest ways in which a permanent council of economic advisors for Brazilian economic development could be established which would guide the development of the growing profession, advise on national agricultural policy, and advise on programs of international assistance to the agricultural sector of Brazil.

The report represents the first step towards attaining these objectives.

Status of Agricultural Economics in Brazil

Agricultural economics as a subject is of recent origin in Brazil. It has been restricted in growth by a number of factors inherent in the university system, and principally because economics itself has only recently become developed within the system. In the 1960's the situation has altered somewhat, and graduate courses are available at Vicosa, Piracicaba and Rio Grande do Sul. Even so, it is estimated that there are only at present some 150 persons with some graduate level training in the subject, and these are concentrated in a few areas. Some institutional changes have taken place, notably in the secretariats of agriculture of the states of São Paulo and Minas Gerais, the Ministries of Agriculture and Planning, to develop scientific research capacity in this field. Nevertheless this branch of the agricultural sciences continues to be relatively weak, and cannot make the scientific and intellectual contribution essential for the sustained growth of Brazilian agriculture.

The major weaknesses are:

1. Shortage of numbers.
2. Limited acceptance and integration of agricultural economics in the universities, the institutes of agricultural research and the policy and action program agencies of the state and federal government.
3. Inadequate information.
4. Inadequate institutional capacity and public support for the growth of the subject consistent with Brazil's needs.
5. Imperfect recognition of the potential contribution of economic analysis to more rational decision making.

The report then goes on to examine the problem in detail as the basis for the recommendations. It gives as its goals and strategy:

1. The economic dimension of agricultural research needs to be given greater emphasis; and it is recommended that:
 - a. Research in agricultural economics should be considered an integral part of agricultural research
 - b. Agricultural economics should be established as a permanent component of the regional institutes of DPEA, and such other institutes as are viable (at least three agricultural economists should be placed in the institutes--their tasks are spelled out)
 - c. A small advisory group of agricultural economists should be established at the national planning and decision-making level.

2. The profession should be developed--specific goals are detailed.
3. Capacity for policy analysis and research must be expanded (at least one policy-research group should be developed for work at the national level, and a number at the state level).
4. A permanent advisory committee for agricultural economics should be established.

This would have as a primary objective the systematic strengthening of the field. For this purpose considerable resources are necessary; the possibility of earmarking a fraction of the annual interest on the agricultural sector loan currently being negotiated for research on agricultural policy and related matters is suggested as a source worth investigating.

Report Conclusion

It is proposed that the Joint U.S.-Brazil Study Group on Agricultural Economics of the National Research Council of Brazil and the National Academy of Sciences of the United States be constituted as a permanent Joint Commission on Agricultural Economics. It is recommended that this permanent Commission be responsible to the Brazilian National Research Council and the National Academy of Sciences of the United States through the U.S.-Brazil Science Cooperation Program. The general responsibilities of this Commission will be:

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1. Explore alternative ways in which a permanent Council of Economic Advisors could be established to advise on national agricultural policy and on programs of international assistance to the agricultural sector of Brazil. The possible

structure, mechanics, organization, function, and procedures of such an organization needs to be examined.

2. Devise ways in which agricultural economics can be strengthened and the recommendations of this report can be implemented.
3. Identify ways in which continuous support can be provided to research for policy purposes.

The School of Geology of São Paulo, due to the fact that it already has a Master's Course, did not make any immediate requests. Nevertheless, it is possible that it will present its program in the second semester of this year or no later than the beginning of 1969.

Even though the conditions existed to start a graduate course (already approved), the third school, that of Porto Alegre, Rio de Grande do Sul, was forced to delay the start of such a course as the activities of its organizers were taken up by the Gondwana Congress.

2. Study of the Formation of Tropical Lands in Brazil

Because of its importance, this problem (of interest to geology, mining, and agriculture) deserves special consideration. Without the detailed knowledge of the soil, its characteristics, behavior of its elements, and its geochemical functions, the needs of agriculture will not be attended to since other professionals, who are not geologists or geochemists, are hardly in a position to carry out such studies.

The Geochemical Laboratory in the State of Bahia represents a base that could be extended to include facilities for the training of personnel in this specialty.

In Rio de Janeiro, the interest in this problem is demonstrated by the accord reached with a professor from the University of Manchester, who is a specialist in this field.

3. Geology and Paleontology

These two areas, lacking in technico-scientific support, and presently not in a position to accompany the national development, are about to demand means that will permit a rapid updating of knowledge, so that they will constitute real elements of progress.

According to what had previously been established, and which has the same validity today, it would be advisable to make available to the DNPM two geologists: one a specialist in sedimentology and the other in geochemistry.

To attend to the needs of the Section on Paleontology of the DNPM, a specialist in ostracods and another in foraminifers is highly recommended. It is essential to put the Laboratory for the Preparation of Fossils in a position that will enable it to handle a new phase of intensified research, which is the objective of the support we are asking for now.

4. Mineral Research Laboratory

The preoccupation of increasing the number of researchers, of attending to the needs of the existing laboratories, and of creating conditions so that new laboratories can be installed is clearly expressed in the Five-Year Plan of the CNPq.

The lack of research in mineral resources is being felt and for this reason we should add another item to the program now being discussed, that is the creation of a mineral research laboratory in the DNPM.

The training of specialists is imperative for the execution of this plan on a short-term basis. Here, as in other programs, it would be advisable to train a "Head of Research" as well as a sufficient number of assistants for the start of its activities.

The right action to be taken should be to send to the United States three fellows or grantees, for a period of time still to be decided upon, to be trained in specialized laboratories, and to send to Brazil one or two technicians to program, project, and orient those grantees returning to Brazil from their internships in American laboratories.

Resume of the Mineral Research Program

1. Master's Course

Professors to come to Brazil: a specialist in the mechanics of rocks in the second semester of 1968 to Rio de Janeiro; a specialist in geophysics in the second semester of 1968 to Rio de Janeiro; and a specialist in mineral economics in the second semester of 1968 to Rio de Janeiro.

2. Study of the Formation of Tropical Lands

Researchers to come to Brazil: to the Geochemical Laboratory of the Federal University of Bahia in the second semester of 1968 or the first semester of 1969.

3. Geology and Paleontology

Technico-scientific support: two geologists, one a specialist in sedimentology and one in geochemistry; two paleontologists, and a specialist in ostracods and one in foraminifers.

4. Mineral Research Laboratory

Specialists to come to Brazil: one "Head of Research" in the second semester of 1968 to Rio de Janeiro.

Specialists to go to the United States: one "Head of Research," three fellows and two researchers.

Supplementary Remarks to the Progress Report
of the Joint U.S.-Brazil Study Group
on Mineral Resources

by

W. D. Johnston, Jr.

Chairman of the U.S. Study Group on Mineral Resources

Dr. Bastos recalled the discussions of the Workshop at Itatiaia in 1966. He expressed his pleasure in the progress that had been made in the mineral resources program since that meeting. Brazil's needs in the mineral field were coordinated with the CNPq's plan for scientific and technological development (1968-1972). Under the general headings of research, teaching, and technology he called attention to urgent needs in the fields of geology and mineral development.

He listed the following four areas of immediate need:

1. Specialists are needed to teach soil mechanics, geophysics, and mineral economics during the second semester for the Master's program in earth sciences, just being started at the University of Rio de Janeiro.
2. Research workers are needed for the Laboratory of Geochemistry at the Federal University of Bahia on the broad subject of tropical soils (which includes the types of tropical weathering that produces such seasonal deposits as lateritic iron and manganese ores, nickel and cobalt-manganese ores and bauxite).
3. The National Department of Mineral Production (DNPM) needs geologists specializing in the fields of sedimentology and geochemistry, and paleontologists specializing in ostracods and foraminifers.
4. The DNPM needs to rehabilitate its ore dressing laboratory in Rio de Janeiro. A chief metallurgist is needed for this laboratory and three scholarships for study in the United States should be established.

Dr. Johnston, in reply to Dr. Bastos, called attention to the wide flexibility of the pending development program of the DNPM and the National Department of Water and Energy (DNEA) which involved an AID loan of 8.5 million dollars and the investment of Brazilian funds to a total of 20 million dollars over a 10-year period. Graduate training of geologists and other scientists and engineers to staff those institutions fell within the objectives of the loan; Dr. Johnston felt that the agreement has sufficient latitude to encompass items 2, 3, and 4 on Dr. Bastos' list. The directors of DNPM and DNEA have

the authority to specify their needs in both people and equipment, and all that would be required is their concurrence. Dr. Johnston suggested that Dr. Bastos, on his return to Rio, work out such a program with Dr. Francisco Moacyr de Vasconcelos, Director of DNPM, and Max White of the U.S. Geological Survey, now assigned to AID in Rio de Janeiro. He also expressed the belief that at least some part of item 1--professors for Rio de Janeiro--might be obtained under the dollar development loan if the DNPM ruled that the Master's program at the University of Rio de Janeiro was properly contributory to the upgrading of the DNPM.

As an alternative, in filling the teaching positions, it might be possible to find suitable specialists who might devote sabbatical leave from their own institutions (encompassing the second semester at the University of Rio de Janeiro) if the CNPq could provide transportation and subsistence in Brazil. Dr. Frota Moreira thought this could be done. It was agreed that the matter should be further explored with the American Geological Institute.

SUMMARY REPORT OF SESSIONS I AND II

Rapporteur: Dr. Oscar Sala

After opening statements by Dr. Brown, Dr. Cury and Dr. Leão, Dr. A. Weinberg presented his paper on "Nuclear Agro-Industrial Complexes."

Following his presentation, the paper was open for discussion. The problem of energy production and food production, in terms of Dr. Weinberg's paper, was debated with particular reference to the various areas of Brazil.

Dr. Brown proposed that a study group be created for the problem raised by Dr. Weinberg, with the participation of the NAS, AEC, CNPq, and CNEN (Brazilian Atomic Energy Commission).

Dr. Cury suggested that this subject should be taken up again for discussion during this meeting, when experts on agriculture and water supply would be present.

The afternoon session started with a review of the interim report of the Study Group on Industrial Research presented by Dr. Frota Moreira (in place of Dr. Souza Santos, who could not come for the meeting), and Dr. Jordan.

Information was given that the final report with the recommendations should be ready by the end of the year or early 1969.

Dr. Keville brought up the question of what should be done with the final report. He suggested a similar procedure as the one followed for the OECD reports, namely, a confrontation.

Dr. Robock pointed out that although the final report is not ready, some of the recommendations contained in the preliminary draft are already guiding some actions of the Brazilian government and that the five-year plan of the CNPq already reflects some of the discussions of this study group.

Dr. Brown pointed out that in the final report the group should make suggestions for implementation but that the report should be submitted to the workshop for a critical revision.

Dr. Bastos and Dr. Johnston, Jr. presented the Interim Report on Mineral Resources. The progress of the group was largely discussed and emphasis was placed on the fact Brazil still needs a much larger number of geologists.

Finally, Mr. Engel presented the very preliminary report on norms, measurements and testing, pointing out that in about two months a first draft of the report and recommendations should be ready.

Dr. de Góes mentioned that the Brazilian Ministry of Industry is very much interested in this report.

SUMMARY REPORT OF SESSION III

Rapporteur: Dr. Stefan H. Robock

A. Agricultural Research

Reports by: Dr. Glauco Pinto Viegas
Dr. Roy L. Lovvorn

A written progress report as of January 1968 of the Joint Study Group was distributed to the Workshop. The Group first convened in Brazil on January 7, 1968, and after visiting many parts of Brazil and meeting with representatives of many organizations prepared and presented its progress report to the President of the National Research Council on January 26.

Dr. Viegas briefly described the Group's recommendations for a series of activities (see page 33 of report), and a sequence to be followed. A number of committees were proposed to undertake these activities ranging from a research inventory to developing mechanisms for establishing priorities. A time table was proposed that would result in a draft report being ready by February 28, 1969.

Dr. Lovvorn added that the report was truly a joint product of the U.S. and Brazilian participants with as much variation in views presented by the Americans as the Brazilians.

It is hoped that the research inventory, depending on the criteria used for the inventory, will begin to develop information on research needs.

The general picture is one of a research field that has been recognized and supported for a number of years. However, there is a tremendous dilution of effort over many sub-fields, a great need for coordination, and for establishment of an order of priorities. Dr. Christopher Wright emphasized that the setting of priorities must be separated from the mechanisms of coordination and that priorities must be the responsibility of a group not involved in operations.

Certain aspects of the operation plan were clarified. The problem of how the group will establish priorities was mentioned briefly.

The subcommittees are expected to proceed with the work program and the National Research Council has appointed a full-time staff member, Dr. Ady da Silva, to work with the Joint Study Group.

Although some impressions of the problems in agricultural research were mentioned and discussed in a tentative way, it appears that detailed discussion of substantive questions will have to await the results of the Joint Study Group work program. The time table of the Group assumes that the next meeting of the Workshop will be held in April 1969. Dr. Cury suggested that such a meeting could be held most conveniently between April 1 and May 31, 1969.

B. Agricultural Economics Study Group

A written report of the Joint Study Group was presented to the Workshop with brief explanatory remarks by Dr. Dow. The Group met for the first time in Brazil from January 20-30, 1968, and no members of the Group were present at the Washington meeting. The report of the Group has recommendations as to goals and strategies for strengthening agricultural economics as a science, for maximizing the contribution of agricultural economics to technical agricultural research, and for improving decision-making in the formulation of national economic policy.

Professor Robock noted that the Study Group appears to have revised the objectives of the Group from those originally recommended at the Itatiaia meeting so as to minimize the macro questions of the relationship of agriculture to the rest of the economy to an almost exclusive concern with the micro issues of agricultural economics within the agricultural sector. The Workshop participants appeared to agree that the broader contribution of agricultural economics should continue to be a part of the scope of the Group's work, along with the recommended goals and strategies for including agricultural economists in agricultural research programs and in the staff or regional institutes and similar organizations.

With the above caution, the issue of utilizing more agricultural economics expertise to identify priority areas for agricultural efforts, based on future demand and supply perspectives, should also continue to receive the attention of the Joint Group; it was recommended that the work of the Joint Group should be continued as part of the U.S.-Brazil Science Cooperation Workshop, subject to the availability of financing.

Dr. Christopher Wright suggested that the Group may have to go beyond the traditional approach of considering agriculture as the predominant source of food. New views and developments may not fit into present subject matter divisions, and non-agricultural ways of producing food may become an important part of the future supply of food.

SUMMARY REPORT OF SESSION IV

Rapporteur: Mr. Christopher Wright

Scientific Manpower Development

In order to implement basic plans for scientific manpower development, it is necessary to know the sources of manpower and of available means for supporting them. This has been done in Brazil and it was suggested that it might be useful to consider comparable studies in other countries.

1. Universities. There are 42 universities in Brazil of widely varying quality. Some are federal, some are state universities and some are private. There are 200,000 students of whom 17,000 are at the University of São Paulo and 16,000 at the University of Rio de Janeiro. Major and much needed university reforms are underway to permit full-time study, research programs (with full-time research workers), and graduate studies. Discussions of university conditions continued on the following themes:

- a. Centers of excellence. It is important to concentrate research and graduate studies so as to create a "critical mass" of quality work in selected areas which attract outstanding persons and have multi-disciplinary aspects. The activities of such centers should be coordinated with related work elsewhere. Whether or not these fields of work can and should also be selected because of their likely usefulness to the economy is debatable. It seemed generally agreed, however, that these centers must have an advanced training, as well as research, function and must be part of a university with the senior research personnel also serving in professional capacities. It must be recognized that the accommodation of university academic and administrative procedures to the needs of such research centers is not easy and appears to require special attention. Full programs of graduate study must be available in some universities, as an alternative to study abroad. Some universities must become recognized for the outstanding quality of their graduate programs in particular fields.
- b. Professional staffing. This is the key to graduate and research programs. It may be best to have no such programs in an area until they can be staffed by top-quality personnel. The system of university appointments does not, as yet, seem well-adapted to recognize and reward quality, especially among younger scientists. Whether or not students and researchers go abroad for further work, it may be

desirable in many cases to find and attract foreign scientists, perhaps well-trained younger scientists who are starting their careers and who will come and help build viable centers for scientific work. When doing so, there is an opportunity to exercise some policy choice as to which science subjects should be emphasized as likely to contribute the most to national goals.

- c. Careers in science. The viability of a science center depends upon arrangements which not only make it possible for students to begin studying a subject but also make it advantageous to him to complete the full course of formal studies.

At present there appears to be a large demand for technicians with less training and a relative lack of demand for holders of the Ph.D., as reflected in the salaries offered. Whether or not the salaries of advanced research workers could or should be raised because of their qualifications or when and if they demonstrate their economic or social value is a question. In any case, it was noted that an experienced research worker in Brazil may only receive a stipend three times that of a student. It was suggested that a ratio of five or eight to one would be better and that certain non-monetary recognition (such as annual prizes for outstanding work by young scientists) could be very important for the development and evaluation of scientists.

- d. Scientific instruments. Centers of science engaged in advanced frontier research are likely to require increasingly expensive pieces of research equipment. It is unlikely that these should be produced locally. In some cases it may even be possible to send material and problems to be processed with instruments located elsewhere. Maintenance may be a problem and in any case it was suggested that the continued efficient and appropriate use of the equipment may not be possible unless the equipment is owned and loaned, as appropriate, by a central organization such as the National Research Council (CNPq).

2. Sources of Support for Scientists and Facilitating Organizations. There are now about 6,000 research workers, defined as individuals who are continuing in research and have published at least one paper in a recognized journal. Thus not all persons with advanced degrees may be included and some without such degrees are included. Biographical directories of these researchers are being prepared. In discussion it was suggested that if the Brazilian research community is to be part of the world science community, research should be reported in one of the internationally recognized languages for science.

The Brazilian National Research Council (CNPq), has been instrumental in the training of scientists and the creation and support of serious full-time research. The Council has 27 members, including representatives of various agencies, and four divisions. It grants study and research fellowships and helps support five research institutes. The importance of keeping the Council in close touch with scientific work is reflected in the fact that the divisions are headed by active research scientists and applications for support are processed with the aid of the science community, as they are in other countries. It is in a central position to formulate and implement science policy. Other agencies, including the Ministry of Education, the Bank for Economic Development, the Nuclear Energy Commission and various state agencies also provide fellowships or research support.

3. Amount and Distribution of Support. A major increase (over 50%) in the budget of the CNPq in 1967 brought it to the equivalent of about \$5 million, with further increases expected. There has been a proportionate increase in the number of grants awarded. The CNPq is not an operating agency but it does support some research institutes until they gain separate support. It endeavors to keep its funds available for fellowship grants in all areas of research. As yet, for instance, it has not supported research in the social and political sciences but it is now regarded as important that it do more in this area. There are now about 1,200 fellowships (95 for work overseas), which enable the recipient to do research on a full-time basis. Four hundred are for undergraduates who work on the projects of senior scientists. The rest are for scientists up to and including chiefs of research (29).

4. Strategies for the Development of Science. Brazil is emphasizing a strategy for manpower development and utilization. Advanced studies at home and abroad are being facilitated. Outstanding scientists are being identified and encouraged regardless of their field of interest, while efforts are also being made to attract researchers to basic fields (such as chemistry), which promise to contribute much to the development of the country. Discussion reflected differences in view as to the relative emphasis to be placed on these alternate approaches and on the extent to which Brazil could consciously benefit from and short-cut (by unconventional means) the stages in scientific development which the United States has gone through. It was suggested that much might be learned from studying the recent series of U.S. National Academy studies on the needs of different fields of science (e.g., chemistry).

It was generally agreed that neither Brazil nor any other country could expect to excel in all fields of science and that quality was therefore more important than quantity of scientific activity. There was less apparent agreement on how much social priorities could or should effectively determine the areas of quality research on the need to avoid the autonomous growth and high prestige

of "basic" research without an appropriate balance and interaction with applied research. Priorities are harder to apply in the basic science area than in the applied science area. It was noted that some people believe a country does not need basic research but it seemed generally agreed that brilliant scientific research should not be discouraged. It should be possible, for instance, to set aside a certain percentage (say 10%) of research funds for support of such work regardless of the priority considerations applied in allocating the major share of research funds.

5. Policy Towards Science. In discussion it was pointed out that Brazil must consider the need for other kinds of trained manpower, as well as scientists. Thus it is necessary to consider the ways in which the needs of science may (and may not) be competitive within a total manpower plan. Here too it may be possible to benefit from knowledge about priorities which was not available to or applied by the United States in the past. The application of priorities and planning need not eliminate "surprise opportunities" for science development. It may, indeed, be the way to take best advantage of such surprises.

APPENDIXES

Statement by Dr. Amadeu Cury, opening Workshop

Statement on Science Policy in Brazil by
Dr. Amadeu Cury (opening Science Policy discussions)

Scientific and Technological Development (The 1968-
1972 Five-Year Plan)

The Nuclear Powerd Agro-Industrial Complex by
Alvin M. Weinberg

OPENING STATEMENT

by

Dr. Amadeu Cury

Chairman of the Brazilian Delegation

This workshop represents the follow-up of a former meeting held at Itatiaia, Brazil, April 11 to 16, 1966, with the participation of several Brazilian and American scientists, some of whom are here today.

As a result of the first workshop a document entitled "Science and Brazilian Development, Report of a Workshop on Contribution of Science and Technology to Development" was published. This document outlines and suggests several programs of cooperation between Brazil and the United States.

Now we are together again in this great country with the same spirit and the same aims and purposes we had at the first meeting-- these aims and purposes being the desire to increase and strengthen the interchange and the relationships between the universities, the research institutions, and the scientists from our countries with the hope that it will be of mutual benefit.

A good example of what can be done between the scientific communities of our countries is the support given by several private American agencies to the scientific activities in Brazil beginning with the Rockefeller Foundation and more recently by others, such as the Ford Foundation. However, we should not forget that this collaboration would not be possible without the support and the efforts of our scientists.

Since the first workshop we have made remarkable progress but we are all conscious of the fact that a great amount of work is still to be done. We do not expect that we will achieve the remarkable scientific advances of your country in a very short period of time. If this were our intention it would be legitimate and desirable, since good examples are to be imitated. Being aware that the social and economic development of our country is strictly dependent on our scientific and technological development, our present purpose is to intensify our efforts, by all means possible, for our scientific and technological progress.

For all these reasons, our delegation is participating in this meeting to present new plans which will be discussed during the next few days.

In spite of our financial difficulties, the decisive support given by the Brazilian government to the National Research Council has been continuous and, whenever it has been necessary, the budget

of the Research Council has been increased or supplemented without restrictions. As a result of this strong support and the desire of our government to stimulate our scientific and technological development, a five-year plan was elaborated at the National Research Council, with the cooperation of our most outstanding scientists.

I would like to introduce the members of our delegation, although they are well known to many of you. May I present:

1. Annibal Alves Bastos, Geologist
National Department of Mineral Production, Ministry of
Mines and Energy
Member of the Brazilian Academy of Sciences
Member of the Brazilian Research Council
2. Amadeu Cury, Biologist (Microbiologist)
Director, Institute of Microbiology
Federal University of Rio de Janeiro
Member, Academy of Sciences
Member, National Research Council
3. Paulo de Góes, Biologist (Microbiologist)
Our Scientific Attaché, whose presentation, I believe, to
be unnecessary since he is well known to all of you.
4. Aristides A. P. Leão, Biologist (Neurophysiologist)
Director, Institute of Biophysics
Federal University of Rio de Janeiro
President, Brazilian Academy of Sciences
Member, Brazilian National Research Council
5. Manoel da Frota Moreira, Biophysicist
Director, Technical and Scientific Division
Brazilian National Research Council
6. Oscar Sala, Physicist
Department of Physics, University of São Paulo
Member, Academy of Sciences
Member, Brazilian National Research Council
7. Glauco Pinto Viegas, Agronomist
Formerly Director of the Agronomic Institute, Campinas
Formerly Secretary of Agriculture of the Government of
the State of São Paulo, Brazil
Member, Brazilian National Research Council

I want also to convey to you a message from our President, Antonio M. Couceiro, from the members of the Executive Board of our National Research Council, as well as from all the Brazilian scientists. This message expresses our faith, our hope and our confidence that this meeting will continue to contribute to a mutual understanding and trust, that better days will come to all of us--days of peace, hope, and happiness for the whole of mankind.

SCIENCE POLICY IN BRAZIL*

by

Dr. Amadeu Cury

Chairman of the Brazilian Delegation

In Brazil, the carrying out of research is decentralized, that is, any federal, state, municipal, or private agency is free to outline their own research programs and, together with the government can look for support through private, international, or foreign organisms, for means to carry out to completion their programs.

This kind of action does not interfere in the fact that the different ministries elaborate their very own short- and long-term plans (for example: the three-year plan of the Ministry of Planning, the ten-year plan of the Ministry of Mines and Energy) within their legal rights, and through which they can achieve certain goals.

The task of the CNPq is to coordinate the different programs and to elaborate a scientific policy in which are included all the goals of all the agencies and ministries that are carrying out research programs.

The Brazilian government seeks to elaborate fundamental guidelines that can assure a better cohesion of efforts of the national agencies and, through financing facilities to support the best elements of research at the public (municipal, state or federal) and private administration level. We hope that as a consequence of this action a great number of scientists and research institutions can get together so that when critical mass is achieved, it will have been a joint effort.

Neither our government nor our scientists desire in any way to direct all the scientific activity. All efforts are however planned so as to insure the continuation of the present freedom that our researchers enjoy. We are only looking for ways that we can use to give greater support and more means for the execution of research programs considered to be of greatest importance for our national development and enrolled in the five-year plan. It is necessary to emphasize the fact that any scientist is free to choose spontaneously a program that he likes best, that is, if he desires to continue in a program not under the five-year plan he may do so. However, the researchers that are not enrolled in the five-year plan will receive a smaller share of the available resources.

*Statement made at opening of science policy discussions.

The national budget, that is, that part destined for research is justified to the Ministry of Planning by the different ministries and agencies carrying out research programs such as the CNPq and the National Atomic Energy Commission. This budget is then sent by the Executive Branch of the Government to the Congress. It must be pointed out that the Brazilian Congress has never failed to approve the submitted budget.

The application of financial resources consigned by the Congress to the CNPq is done through its Deliberative Council with special attention to research projects which are submitted to it individually by the different scientific institutions and researchers, after its examination by the technical and scientific organs of the CNPq. With respect to the action mechanism in this particular case, Dr. Moreira has already spoken.

SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

(THE 1968-1972 FIVE - YEAR PLAN)

FOR EVALUATION BY HIS EXCELLENCY THE PRESIDENT OF THE REPUBLIC

Submitted by the

NATIONAL RESEARCH COUNCIL

December 1967

NOTE:

The attached text is an unofficial translation of the introductory sections of DESENVOLVIMENTO CIENTÍFICO E TECNOLÓGICO (PLANO QUINQUENAL - 1968-1972) - À APRECIÇÃO DO EXCELENTÍSSIMO SENHOR PRESIDENTE DA REPÚBLICA. This translation was prepared by the National Academy of Sciences for the use of the workshop participants. The sections describing plans for specific disciplines are not included in this translation as summaries were presented to the workshop by Brazilian participants.

It should be noted that this document has not yet been published; it was made especially available to the panel on science policy and U.S. participants in the workshop. It is not for publication, release, quotation or general distribution.

Introduction

Acquiring knowledge, passing it on from generation to generation, and using this knowledge for the welfare of man--all of this constitute a process whose beginning must be considered to occur simultaneously with all of man's activities as such. Nevertheless, over the past 30 years, the tremendous speed up of this process and, more particularly, the shortening of the interval between discovery and utilization, have brought about a very abrupt and irreversible change in man's living conditions; they have imprinted new characteristics upon society and they have given birth to the scientific and technological era of our time.

Because of the creative power of science, a number of countries have managed to raise the average living standard of their people, to replace routine methods with technology, to expand their industries, to diversify the production of consumer and capital goods, to prepare an inventory and to process their natural resources, to eliminate shortages in terms of power, transportation, and education, to raise the "per capita" income, and to achieve all of the other things that characterize a really developed country.

There is a natural law which enables any country, no matter how little developed it may be, to obtain and achieve--through its own efforts--the benefits of science and technology, just so long as that country gets down to business and makes a major effort to eliminate empiricism and improvisation, both of which are incompatible with scientific development.

Science and technology do not play favorites and the gigantic power of modern technology is available to any country, the moment its government in effect decides to promote scientific development by suitably assisting those who contribute to this development: This includes longer science courses and higher-quality science education, a greater proportion of scientists in the teaching profession, laboratories which will adequately meet the requirements of the various areas of research, post graduate work on an international scale, training of engineers, exchange of scientists, modern documentation and information service, and salaries that will be worthy of the greatness of the mission which the researcher has to play in modern society.

The development of science and technology in Brazil over the past several years is the result not only of a simple, natural, and spontaneous process of growth in all of the country's activities but also of the continued and persistent action of the National Research Council on a nationwide level. The activities of the National Research Council involved support for research groups which, on the basis of their qualification and their potential capacity, played the role of nuclei that produced good-quality scientific works; the Council also supported centers which train qualified personnel who are indispensable in expanding the scientific effort in the various areas.

Along side the National Research Council, the Brazilian universities, federal, state, and private, helped in the intensive and effective scientific endeavor, although perhaps in a less uniform and effective manner, on a nationwide scale; this entire effort was primarily aimed at helping achieve international standards. Brazilian universities are very archaic in terms of their structure and operations; this fact has always made it difficult to promote scientific expansion--something which has now become absolutely necessary in the interest of national development. The current university reform will, gradually and efficiently, help improve the conditions of university professors and researchers by removing current obstacles and bottlenecks and by thus facilitating the harmonious development of all the sciences. The activity of the National Research Council is based on a methodology which involves direct aid to the researcher or to research groups who have the necessary qualifications and possibilities for expansion; without in any way detracting from the contribution made by other factors, this was one of the causes for the development of research in Brazil. Because of the circumstances, this action has been expressed in very broad planning, on a national scale, and in short-range, medium-range, or long-range terms. But this situation is no longer justified, especially if we realize that the most varied activities of the nation are being increasingly tackled in the form of nationwide programs, although they may be influenced by regional requirements, with a view to the growth and development of all activities in the most harmonious fashion possible.

Thus we can say that the programming of the nation's science effort has become an imperative part of our national life. The absence of such a programming effort or the delay in its implementation will be expressed in an abnormal development and this, in turn, will be harmful to true technological autonomy.

This document spells out the foundations for a program for the kind of scientific and technological development which, in successive steps, must be formulated in a scientific policy which will encompass all of the activities of basic research, applied and industrial research, by harmonizing, integrating, and orienting the efforts of the research centers and by guaranteeing the necessary financial resources for the development of science education and the implementation of research projects.

Purpose

Science and technology have become the very source and the method of progress.

The participation of scientific and technological research in the acceleration of the technological advance and in consistent economic and social progress is so significant that scientific activity planning is more than ever before an urgent requirement for development; it is no longer a political or ideological option.

Brazil does not have any tradition of industrial research; our applied and basic research facilities do not have the necessary equipment and personnel; we must therefore demand the establishment of a program for a scientific development effort that will be more logical than theoretical, a program that will be consistent with the real means and resources that must be strengthened and expanded and wisely used in solving the most urgent national and regional problems.

The development of national scientific research requires the determination of the basic measures which are essential to the establishment of a system and which must be expressed in terms of sectors, projects, and work standards that will assure their perfect coordination and that will facilitate the utilization of the results achieved as well as the readjustment of plans and projects throughout the implementation of the five-year plan, if necessary.

Doctrine

Science and technology require planning and coordination but they also require executive action which will determine the achievement of research programs and projects. They require objective contact with all of the federal, state, and private areas where a tremendous surge in scientific production or technological expansion is now beginning to emerge or where such a surge has become absolutely necessary. It is up to the government, through specialized scientific missions to visit those regional centers which engage in promising or already successful activities, so as to determine their possibilities, to list their requirements and to provide them with the resources which they need for the accomplishment of their tasks. We must tackle and resolve all cases which may develop in any of our states, in any of our cities, in any of our institutes, in any of our universities, and we must determine the local characteristics and the special features of each case and each area. This effort of strengthening our endeavor here obviously calls for a coordinating agency with the right kind of organizational setup, an agency that will cover many departments of government in its activities. This tremendous effort can be carried out only by an agency that can act on its own, within a flexible system, an agency that will not be hampered by the artificial formalism of bureaucratic structures. The only way to free science and technology from formalistic shackles is to place them under the guidance of a highly specialized agency, staffed with a sovereign group of engineers and scientists, men who, as far as the government is concerned, can take the responsibility for spending public funds for the benefit of the country's scientific and technological development. This is exactly what the National Research Council has been doing.

The National Research Council has many different objectives and works along many different lines; because of its very essence and its objectives, it must be an inter-departmental agency, provided

with an organizational structure of its own, an agency which, without any administrative bonds, will be able to manage its own budget for the benefit of research, an agency which will engage in a scientific or technological effort. It must have the mission of locating and vitalizing the human potential, such as it exists today, wherever it may be found, wherever it may require help and support for expansion.

Among the most important factors in the success of a nationwide scientific programming effort, we might mention the following: close cooperation between the directors of institutions responsible for the implementation of research and the opening of credit which will make it possible to take care of needs in terms of equipment, material for consumption, and scientific and technical personnel.

More than in any other sector of activity, the success of a national program destined for scientific and technological development depends on the firmness with which basic principles are established and carried out, such as the following:

Centralized management;

Decentralized execution;

Concentration of national financial resources and their most appropriate use.

Objectives

Scientific research, in any field of science, requires the integration of knowledge and techniques which have been collected or developed in apparently distant and independent sectors.

The growing interaction of scientific disciplines becomes indispensable in the development of techniques for the implementation of a particular research project and it also requires the researcher to have available to him a vast wealth of varied knowledge; because of this, there is a need for a specialization in certain restricted fields of science.

Specialization has altered the tradition of scientific activity based on individual contribution and has created an absolute need for a working system employing teams of researchers who are specialized in certain fields and who can thus enable the entire team to conduct a particular investigation in a multidisciplinary manner.

The existence of research centers, staffed with highly qualified technical and scientific personnel and provided with very expensive and diversified equipment today is an indispensable requirement for the implementation of basic or applied research.

We cannot deny that scientific research in Brazil is still far from meeting the requirements of modern research and we still can feel the inadequacy of scientific and technical personnel, equipment, installations, as well as modern documentation and information facilities, and measures which will permit the integral utilization of the human and material resources which we have in the laboratories of our ministries, universities, and government and private establishments.

In view of the limitations and deficiencies in science education and research, we must say that the country does not have the means for removing these limitations and deficiencies overnight. This means that the task to be accomplished in the long run, through programs running over several years, must be broken up; these programs of course will spell out the successive objectives which we must achieve.

Some of these objectives must be achieved within a relatively short period:

(1) Equipment or re-equipment of two or three of the best research centers in each sector of scientific activity, so as to guarantee their full participation in the implementation of research projects and in the training of new researchers;

(2) The rapid increase in the number of scientists, technologists, and science professors through high-level post-graduate courses both at home and abroad;

(3) Establishment of priorities for the equipment and expansion of the existing research centers;

(4) An incentive for the creation of research centers in as yet little explored areas which are part of our priority fields;

(5) The organization and supervision of basic and applied research programs, with emphasis on the fact that the former, to be developed at our university centers, must be coordinated with the latter, to be conducted at the research centers, institutes, and laboratories both public and private,

(6) The formulation of sector research programs, both basic and applied, in the various fields of activity, in which connection private industry must be interested also in this effort;

(7) The determination of priorities for the implementation of the various programs, with major emphasis on those that are connected with the production of food;

(8) An incentive for higher standards in science education, at universities, through the following:

(a) Broad disclosure of the best achievements in the most

advanced countries;

(b) Teacher exchange;

(c) Special training courses for students in research centers and institutes and in industry laboratories;

(9) Expansion and strengthening of scientific and technological exchange, both domestic and foreign, with a view to raising the general level of knowledge;

(10) Improvement of scientific and technological knowledge through an intensive program of foreign scholarships, with a view to post-graduate study and personal, individual perfection in the various areas of science and technology, on the basis of the priorities established in the national programs;

(11) Stimulation of the publication of science and technology books, particularly on the university level, in Portuguese and at minimum prices, as well as the importing of books and technical periodicals for which we do not have any similar products in the Portuguese language;

(12) Implementation of a national policy intended to modernize our libraries, as well as the disclosure of scientific and technological results and the registration of patents.

Long-Term Measures:

(1) Increase in the number of scientific and technological cadres in all sectors of human knowledge;

(2) Development and establishment of multidisciplinary programs aimed at preparing an inventory and laying the foundation for the rational exploration of our natural resources, particularly in the Amazon region and along the continental shelf;

(3) Periodic meetings between officials responsible for managing the research agencies with a view to coordination of efforts, improvement in work organization, evaluation of results, and, if necessary, revision of programs and projects;

(4) In the case of industrial research, meetings of industrialists with technologists and scientists so as to facilitate the transfer of knowledge and to speed up the creation of new production methods and processes.

Implementation Policy

Because of the growing role it plays in technical progress and in economic and social development, basic or applied research day after day takes on the characteristics of a government task, a government responsibility.

The fact that the scientific and technological activities here are carried on in government departments, in government or private universities, and the fact that these activities go beyond the interests of the university and extend to agriculture, public health, and industry, as well as the fact that they play a role of singular importance in national security--this fact means that the activities that are intimately involved in the development of science and technology must, indisputably and necessarily, be oriented within the competence of the President of the Republic.

In keeping with this orientation, the National Research Council has worked out this five-year plan and it will be able to carry it out, through a coordination and stimulation effort, if the necessary steps are taken both at home and abroad.

At Home:

The National Research Council must:

- (1) Work out or prepare an estimate of general plans and programs and specific projects connected with basic and applied research, in all fields of human knowledge;
- (2) Coordinate and followup on the execution of these programs and projects by the public or private research agencies;
- (3) Establish a system of cooperation in the field of scientific and technological research, involving private enterprises, with respect to the general, overall orientation;
- (4) Coordinate scientific and technological activities which are carried out through programs now in progress as well as those concerning nuclear research;
- (5) Work out basic and applied research programs, in combination with university activities, so as to expand the objectives of education, both scientific and technical;
- (6) Propose the necessary changes in science education so as to adapt this educational effort to the objectives in view here;
- (7) Keep the training of researchers at the highest possible level, establish the basic grade as of which scientists and technologists, to the extent necessary, must be sent abroad for advanced and post-graduate training;

(8) Establish a publications system for scientific and technical books in the Portuguese language and at minimum prices;

(9) Promote the coordination of the universities with the research centers in order to speed up the transfer of basic and applied scientific discoveries to the sectors that are connected with national production;

(10) Establish a system of cooperation with specialized institutes abroad for the exchange of scientific and technical information and publications;

(11) Establish an information system which, as quickly as possible, will furnish the necessary information pertaining to research being done in the most advanced countries;

(12) By all means possible, seek to remove the scientific and technological gap between the various regions of Brazil.

Conditions of Implementation

Scientific and technological development must be achieved through plans covering several years and through programs derived from these plans so that we may systematically and efficiently tackle all of the problems of basic and applied research, considering also the requirements of economic and social development.

In working out the five-year plan, the National Research Council tried to take into account the activity plans of the various ministries, and it also incorporated the suggestions submitted to it by the representatives of these ministries, who are on its consultative board.

In particular, the understandings between the Council and the Ministry of Planning and general coordination were worked out by the commission appointed by the minister to tackle the topic of science and technology, as contained in the "strategic development program," which covers a programming effort extending over several years.

The basic objectives of the five-year plan prepared by the National Research Council include the following:

1. Increase in high-level scientific personnel through post-graduate training at home and abroad.
2. Equipment and re-equipment of Brazilian research centers to be taken care of on a priority basis in terms of personnel qualifications and actual work, measured in terms of original and regular scientific output.

3. Contracts for Brazilian and foreign researchers so as to strengthen the best qualified research centers and the science teaching body.
4. "Sector Programs" in basic and applied research.
5. Integrated programs.
6. Integration of the activities of institutes under the National Research Council.
7. Utilization of financial resources.

The research priorities in each field of human knowledge, as spelled out in accordance with the thinking of Brazilian scientists, constitute the chapter entitled "Sector Programs" which is a part of this document.

The specific research projects can be spelled out only after the evaluation and approval of this five-year plan by the President of the Republic. Only then will the consultative board of the National Research Council be able to compare the different projects presented by the research institutions or by individual researchers and only then will it be able to select those which offer the most reliable elements for execution and only then will it be able to determine the financial resources that are necessary.

As this program is carried out over the years, the changes that may have to be made will have to be justified to the chief executive who will make the final decision.

There are various reasons why we did not list the "most outstanding centers" today in this document, that is, those centers which are to be mobilized for a twin mission by the Council:

Training of new researchers;

Implementation of priority research projects.

In addition to the sector programs spelled out under the particular chapter heading, the plan has two integrated, high-priority research programs, that is:

A survey of natural resources in the Amazon region;

A study of the Brazilian Continental Shelf.

We must repeat at this point that the implementation of all of the programs in this plan will require the perfect coordination of all efforts by government agencies in the field of research and technology as well as the universities and research institutions.

Increase in Scientific Personnel:

The recruiting, training, and advanced education or manpower for basic and applied research undoubtedly constitute the most decisive elements and the priority measures to be tackled through the full utilization of the best training centers in Brazil and abroad as well as efforts aimed at evaluating scientific activities and at facilitating a fitting remuneration as well as the realistic utilization of scientific personnel.

The shortage of adequately trained personnel to step up scientific research and to revitalize science education must urgently be corrected; this shortage is now felt by all Brazilian centers of this type.

We must realize that the process of training personnel for scientific and technological education takes place in the post-graduate area, although we must not overlook certain courses prior to graduation. In Brazil, a large part of the functions of our present-day post-graduate training centers consists in filling the gaps that result from the inadequate preparation of our students in undergraduate courses, both in terms of quantity and in terms of quality as well as basic knowledge of degree candidates. During undergraduate studies, in turn, we try to bring the students up to the level of preparation which they should have had during high school. We must realize this situation if we want to make any progress at all here. This applies to just about any case here. In certain regions of the country, the problem may be more serious and it may require a more determined and broader effort.

A researcher cannot be trained in a short time; moreover, a seasoned researcher can be developed only after years of actual scientific activities in a scientific institute.

Today, we can initiate or expand certain high-level courses in all sectors of research and we could thus matriculate approximately 350 candidates in 1968; the plan calls for the granting of 280 post-graduate study scholarships. In addition, we must continue our recruiting and advanced training of scientists according to the traditional standards of the National Research Council, by granting study scholarships in the categories of basic science training; these scholarships must be given to university students, preferably during the second half of the undergraduate course for the purpose of getting these students to select a career in scientific research. The scholarship students in this category must have the guidance of a full-time scientific researcher and they must carry out a work program which will provide research training and practice in research techniques.

The advanced-study scholarships, which will be granted for short-duration courses, are aimed at familiarizing researchers with certain techniques or at a review of new working methods in certain fields of science; they must be used in research centers for the

benefit of researchers who have specialized in a certain field and who must perfect their mastery of the techniques and methods involved.

The post-graduate study scholarships are of the utmost importance in the training of researchers and they will be granted after the completion of undergraduate studies; in this case, the scholarship student will have to concentrate on a very specific field of activity.

These scholarships will be utilized at one of the educational centers selected for this purpose by the National Research Council and the number of these scholarships, at each center, must not exceed a certain ratio to be established on the basis of the teaching staff and its size.

The amount of the scholarship funds to be paid out to post-graduate scholarship students must be so determined as to make this study attractive and to enable the scholarship students to devote themselves exclusively to their course work and to the corresponding research.

Post-graduate courses will have to be tied in intimately with the research activities of the centers and the professors should preferably be researchers themselves.

During post-graduate study, the candidate will take advanced courses and will actively participate in the work of his research group; he must also try to acquire experience as an instructor.

For a certain period of time, these post-graduate courses will have to cover some of the earlier subjects in order to make up for any deficiencies that are discovered in the basic scientific training which the students received at the universities.

The basic requirement of the post-graduate study program will be the preparation of a thesis, based on the candidate's personal research; this will lead to the award of the degree of master of science or doctor of science.

Post-graduate study scholarships in Brazil will be granted for those sectors which are already developed or which are in the process of being developed. Post-graduate scholarships abroad will be granted only to those candidates who have exhausted all possibilities for advanced training in Brazil and who can go into sectors which are not yet sufficiently developed; in this case, scholarship students who are sent abroad must be utilized as researchers upon their return to Brazil. In granting these scholarships, the Council will give special consideration to the formation of new research groups or centers devoted to those areas that have not yet been covered in Brazil

Research Center Equipment:

The revitalization of our research centers, which are going to participate more actively in the training of scientists and in the implementation of research programs, involves one step which must be taken if we are going to achieve the basic objectives of this plan; this step involves the increase in the number of researchers and in the development of conditions that will make it possible to speed up scientific activities to the point where we can compete with foreign scientific research.

In most sectors of basic or applied research, material requirements keep increasing and this is why science and technology becomes more and more extensive, year after year.

Since industry and the research laboratories did not have the resources for producing the instruments required in scientific research, Brazil must supply itself from the international market.

The domestic production of instruments for scientific use is certainly worthy of special attention by those agencies which promote our development but since our Brazilian industrialist establishment does not have the means for meeting this research requirement, we cannot avoid nor postpone the purchase of equipment for our best Brazilian research centers as part of an orderly program which will facilitate the support of these activities in the various regions of the country in an adequate fashion.

Foreign aid must be obtained in the form of loans; this foreign aid will enable us to correct the most outstanding shortages in terms of scientific instruments and it will certainly also help us speed up the entire national scientific machinery.

The inventory of our research centers--which the National Research Council has just completed and which it keeps up to date with the collaboration of Brazilian researchers--will certainly enable us to meet the real necessities in terms of equipment without any unnecessary duplication and it will also enable us to place that equipment wherever it can do the most good, in other words, where it can be used by the largest teams of researchers.

During the coming five-year period, we must not only equip our best national research centers but we must also take care of the equipment of the regional centers since many regional problems have a tendency to turn into national problems; another reason here is the rather strong differentiation in applied research.

It will be up to the national centers, to be taken care of initially, to act as the trigger for the improvement of the national centers through the gradual elimination of the inequalities that still exist in higher education and in scientific and technological output.

The supply and use of scientific material and the programming of the allocation of this equipment to the national and regional centers must be handled in keeping with the qualifications of the available scientific personnel so that both personnel and equipment can be utilized in the most efficient manner possible.

Contract Researchers:

In order to achieve our researcher training objectives, we must hire researchers to work at our universities and research institutions.

In order to provide more such jobs, under suitable working and salary conditions, the National Research Council must have financial resources available which will enable it, through legal contracts, to grant research scholarships in various categories, on the basis of the experience or the scientific titles obtained by the researchers in question.

Within the limitations of the available resources, the Council has been pursuing this policy, since its establishment, with success and much understanding on the part of the research institutions which, as much as possible, help by providing the initial initiative, thus facilitating the constant release of financial resources which the National Research Council can then use to pay for the contracts of other researchers.

All of this leads us to believe that the government will shortly be able to improve the salary conditions for scientific and technological personnel; in view of this, a council will enter into less permanent commitments and will be able to spend more money on the effective expansion of the researchers as such; this will mean that those men who had scholarships will find immediate employment in the following categories:

(1) Assistant-researcher, a job title to be given to those holding the degree of master of science, earned at a center of education recognized by the National Research Council, or to researchers who have published an original research work in a competent periodical; the salary will be roughly double the post-graduate study scholarship amount.

(2) Researcher, a job title to be given to a person who has earned the degree of doctor or, provisionally, a man who has more than 5 years of practical experience and significantly original scientific output. The minimum salary here will be 2.5 times the post-graduate scholarship amount.

(3) Chief of research, a job title for researchers of proven experience with more than ten years of job experience, in other words, men who actively participate in the training of new researchers and in the coordination of research. The minimum salary for researchers in this category will be three times the post-graduate scholarship amount.

Participation of Institutes Subordinate to the National Research Council:

The specialized institutes, which have been created within the National Research Council, on the basis of the specific law, that is: the National Research Institute of Amazonia, the Brazilian Institute of Bibliography and Documentation, the Institute of Pure and Applied Mathematics, the Institute of Railroad Research, and the Organizational Group of the National Commission of Space Activities-- these will have to activate their programs during the coming five-year period in a coherent fashion, on the basis of the provisions of this plan; they will have to be properly supported in their efforts and the activities of their researchers will have to be properly coordinated and integrated.

The Brazilian Institute of Bibliography and Documentation, in particular, will have to be the key to the establishment of a national documentation and information network, to be tied in with the regional centers so as to facilitate the rapid circulation of experimental results obtained at home and abroad as well as the prompt disclosure of technological innovations to be applied in industry.

The financial resources, which are indicated in a special chapter in this document, include allocations for the agencies under the National Research Council; these funds are intended to enable the agencies to expand their research activities.

Integrated Programs:

(1) Exploration and Inventory of Amazon Region

The Amazon region very probably contains areas which have not yet been touched by man and our knowledge of this region is certainly quite superficial and spotty.

The real takeover of this region and the full utilization of the resources which it offers require detailed study covering many years of patient and persistent work, repeated over various seasons of the year, so as to collect a wide variety of scientific data involving geology, botany, zoology, soil fertility, water supply, weather, and so on.

The vast size of the region to be investigated will make it necessary to subdivide it into certain areas which will be laid out for concentrated study by specialists; the idea here is to prepare sketches and diagrams on whose basis we can begin the rational exploration of the area or the region's resources, after laboratory tests, of course.

The demarcation of the areas to be studied, the recruitment of specialists, as well as transportation and maintenance activities--these will require careful planning so as to eliminate any possibility of failure.

This is a very important task and we must make sure that all of the national agencies and the majority of the researchers will cooperate toward the successful accomplishment of a number of expeditions.

(2) Study of the Continental Shelf

The systematic collection of scientific information on ocean water and on the water covering the Continental Shelf will facilitate the exploration of the oceans on the basis of a perfect knowledge of the biology of marine animals and their utilization for human or animal feeding.

The study of submarine geology, particularly along the Brazilian Continental Shelf, will--in view of its vast size and the limited manpower and equipment resources currently available--require a concerted effort by all Brazilian oceanographers, the mobilization of existing facilities in terms of oceanographic vessels, and it will also require the establishment of a well-oriented program intended to train researchers who will enable us to fill up the existing gaps in the various fields of oceanographic research.

THE NUCLEAR POWERED AGRO-INDUSTRIAL COMPLEX¹

Alvin M. Weinberg

This summer the Oak Ridge National Laboratory conducted a study of the technical and economic feasibility of what we call the nuclear powered agro-industrial complex. The study was led by Professor E. A. Mason of Massachusetts Institute of Technology; the team included experts in nuclear power, chemical engineering, agricultural husbandry, economics, and regional planning. I want to acknowledge the great help given us by the Atomic Energy Commission which sponsored the study, and particularly by Commissioner James T. Ramey. We have received ideas and support from the Department of the Interior's Office of Saline Water, the Department of Agriculture, the Tennessee Valley Authority, and the Rockefeller Foundation. I should like to tell you about those aspects of the study that are relevant to your consideration of Senate Resolution Number 155.

The basic question set by the study team was the following: To what extent could energy, particularly from nuclear reactors, be used as the basis for an integrated agricultural and industrial development of arid coastal deserts such as occur in northern Mexico, Australia, in the Southeast Mediterranean, or the Gujarat Peninsula in India? That a massive energy source might have considerable impact was suspected, a priori, because of four major developments, all of which seem to have gelled within the past year. These developments are:

1. Nuclear energy, especially in very large reactors, has become competitive with fossil fuel in most of the United States. It is a reasonable presumption that, with the development of so-called advanced breeder reactors, nuclear energy may become the cheapest form of energy, especially for off-peak power. The importance of this is magnified by the mobility of nuclear energy. A nuclear reactor, unlike a hydro-plant, or even an oil- or coal-fired plant, can be built anywhere, without suffering a large fuel cost penalty.

¹/ For presentation before the Foreign Relations Committee, United States Senate, Washington, D. C. October 19, 1967.

2. The art of desalting the sea has, under the auspices of the Department of the Interior, made very significant progress in the past couple of years. Whereas the capital cost of a large evaporator was around \$1/daily gallon some three years ago, we now estimate that the capital can be reduced to around 30¢/daily gallon or possibly even less in very big plants. Thus the cost of desalted sea water anticipated at the 150,000,000-gallon Metropolitan Water District Plant in Los Angeles of about 22¢/1000 gallons might within ten years fall to around 15¢/1000 gallons, or even less as more efficient reactors are used to power the desalting plant.

3. With water in this range, the possibility of conducting a new kind of intensive agriculture based on distilled water, and on new high-yielding grains such as the Mexi-Pak variety of wheat developed by the Rockefeller Foundation, becomes credible. The general idea is to use a highly rationalized agriculture, so highly rationalized that we would speak of food factories rather than farms, in which water and fertilizer are applied at precisely the right time and in exactly the right amounts. If such highly rational agriculture is indeed feasible, we estimate that only 200 gallons of water would be needed to produce a man's daily ration of 2400 calories. If the water cost as much as 15¢/1000 gallons, this would amount to 3¢/day for the water required to feed a man.

4. But such nuclear desalting plants produce large amounts of by-product power--around 2.0 megawatts of electricity for every million gallons per day of water. What can one do with this by-product electricity? The most natural use is as a basic raw material in energy-intensive heavy industry such as manufacture of fertilizer and primary metals. The basic process here is the electrolysis of water to produce hydrogen; if recent fuel cell technology spun off from space research is exploited, we believe that the price of electrolytic hydrogen can be competitive with hydrogen from naphtha. Thus electricity would be substituted for the raw material naphtha. The main use of hydrogen would be to produce ammonia, a highly essential fertilizer. The hydrogen could also be used as a substitute for coke to reduce iron ore to iron. Or the electricity could be used directly to convert phosphate rock (which is very abundant in the Middle East) to the much more easily transportable elemental phosphorous; or it could be used to win aluminum from bauxite.

The advantages of combining all these processes--energy, water, industrial processes--into a single complex are manifest. By combining these processes one can make the entire complex, especially the energy source, larger than would otherwise be the case, and, because of the "scaling" laws, one would thereby reduce the unit cost of each of the products. Moreover, the by-products of one process would be used as the raw material of a companion process. For example, the electricity by-product of the desalting plant would be used, say, to refine phosphorous by the TVA electric furnace process;

or the caustic produced by electrolysis of salt water for chlorine production would be used to prevent formation of scale on the desalting evaporator. And finally, one can hardly speak of agricultural development in abstracto: at the very least, one needs abundant fertilizer if one is to conduct modern agriculture. Moreover, agricultural development, as was stressed in the PSAC report on world food problems,² is embedded in total economic development. One would hope that an agricultural complex that is part of a larger industrial complex would be more viable than either alone.

I would like now to describe one of the agro-industrial complexes which we studied. The complex would produce 1,300 Mwe and 610 million gallons of water per day. A general layout of the complex is shown in Figure 1*: The reactors surrounded by the evaporators are the hemispherical structures in the lower center of the diagram. The food factory with its irrigation system, and the various industrial plants, are shown surrounding the reactor. Not shown are the community facilities and towns. Figure 2 is a plan view of the complex showing the food factory, private farm plots, town, and industrial area. From a complex producing 1,300 Mwe and 610 million gallons of water per day we could produce food for three million people on the adjacent farm of 180,000 acres. Ammonia fertilizer would probably be made from natural gas in the Middle East; however, we assumed it to be made electrolytically, in which case enough ammonia is made in the complex to produce food for about 20 million people off-site, provided adequate water and other ingredients were available. For comparison we show the range of power and water outputs of various other complexes we have studied (Table 1):

Table 1. Outputs of Various Complexes

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<u>Approximate Range of Power and Water for AI3P</u>	
Thermal	3,000 - 10,000 M.t
Electric	(500) 1,000 - 2,500 - (4,000) MWe
Desalted Water	(250)- 1,000 mgd
<u>River Water Flow Rates</u>	
Jordan River (mean)	0.4 bgd
Tigris, Euphrates Rivers (mean basin runoff)	45 bgd
<u>Power Production Capacities</u>	
VA Brown's Ferry Nuclear Station	10,000 MWt
	3,200 MWe
Aswan High Dam	1,200 MWe
Norway (1963)	5,000 MWe
<u>Fertilizer and Chemical Production</u>	
Basis:	1,000 MWe used in each product
Nitrogen:	690,000 T/yr = (1/9 x USA, 2 x India)
Phosphorus:	1.5 x 10 ⁶ T P ₂ O ₅ /yr = (1/3 USA, 13 x India)
Aluminum:	0.5 x 10 ⁶ T/yr - (1/8 USA, 7 x India)

^{2/} "The World Food Problem", Vols. I and II, A Report of the President's Science Advisory Committee, U.S. Government Printing Office, Washington, D. C. (May 1967).

*See Figures at end of text.

The following two tables (Table 2; Table 3) show the agricultural products and industrial products we have considered in our complex:

Table 2. Food Produced from Agro-Industrial Complexes

Water to Farm	600,000,000 gal/day	
<u>Products</u>	<u>Area</u> <u>(acres)</u>	<u>Yield</u> <u>(tons/yr)</u>
Wheat	109,000	163,000
Potatoes	58,000	1,380,000
Peanuts	38,000	77,000
Dry Beans	35,000	38,000
Cotton (fiber)	35,000	22,000
(seed)		36,000
Soybeans	13,000	23,000
Sorghum	13,000	51,000
Safflower	6,500	13,000
Tomatoes	6,500	190,000
Citrus fruits	6,500	140,000
Total yield		2,133,000
Total summer acreage	130,000	
Total winter acreage	180,000	
<u>Fertilizer Usage</u>	<u>tons/yr</u>	
Nitrogeneous fertilizers (as N)	27,000	
Phosphatic fertilizers (as P ₂ O ₅)	10,700	

Table 3. Industrial Products from Agro-Industrial Complexes

Total Industrial Power	1,000 Mw	1,000 Mw
<u>Products</u>	<u>Capacity</u> <u>(tons/day)</u>	<u>Capacity</u> <u>(tons/day)</u>
Ammonia	1,600	
Phosphorus	800	1,300
Aluminum		350
Chlorine	350	1,000
Caustic	400	1,100
Salt	2,700	2,700
		(ammonia from natural gas)

Of course, these could be varied depending on the exact locale. We have examined sites in five coastal deserts--Lower California, Gujarat, Peru, Australia, and the Sinai-Negev area, especially around El-Arish in the Sinai Peninsula (Figure 3).

I turn now to our estimates of the economics of such complexes. The estimated capital investments are shown in Table 4 below:

Table 4. Capital Requirements for Agro-Industrial Complexes*

	<u>A</u>	<u>B</u>
Industrial power, Mwe	1,012	1,012
Grid power, Mwe	25	25
Power for water, Mwe	257	257
Total	1,294	1,294
Desalted water, Mgd	610	610
Farm size, acres	180,000	180,000
Station size, Mwt	6,600	6,600
Number of reactors	2	2
Technology	LWR-NT	LWR-NT
Economic bases	Foreign	Foreign
	<u>Capital Costs (millions of \$)</u>	
Nuclear reactor plant	115	115
Turbine-generator plant	75	75
Evaporator plant	250	250
Industrial complex	125	380
Farm	145	145
Town	15	22
Electrical-grid tie facilities	1	1
Total	726	988
Interest during construction	90	104
Total depreciating capital	816	1,092
Fuel inventory and working capital	85	110
Total capital	901	1,202
Total number of workers	8,800	14,700

* Calculated on the basis of 10% cost of money.

Of the entire investment of about \$900 million, the part attributable to the food factory is \$440 million, not counting the reactors and electric system. The return on the entire investment, industrial and farm--that is, (Income-Costs)/Investment--comes to about 10% as shown in Table 5, Column A. If high cash value products, such as citrus, tomatoes, potatoes, or cotton, are grown rather than cereals, the return will increase. Similarly, if high value products such as aluminum are added to the industrial mix, return on investment goes to about 15%, as shown in Table 5, Column B:

Table 5. Annual Operating Costs and Income for Agro-Industrial Complexes

	<u>A</u>	<u>B</u>
Total capital, 10 ⁶ \$	901	1,202
<u>Operating Costs, 10⁶\$/yr</u>		
Nuclear reactor plant	3	3
Fuel cycle	20	20
Turbine-generator plant	1	1
Evaporator plant	10	10
Industrial complex	65	136
Farm	<u>40</u>	<u>40</u>
Total	139	210
<u>Value of Products - Income, 10⁶\$/yr</u>		
Plutonium credit	4	4
Electricity to grid	1	1
Industrial products	125	280
Agricultural products	<u>100</u>	<u>100</u>
Total	230	385
(Income-costs), 10 ⁶ \$/yr	91	175
(Income-costs)/total capital, %/yr	10	15

We have tried to estimate how many workers would be required to man such a complex. Those directly employed on food factory and industrial plant would number 8,800. Assuming about four persons (including family) to service each worker, we estimate that the entire enterprise might involve 35,000 people. One would expect that, if the whole idea works, this central activity would attract much subsidiary industry and therefore additional people.

How credible is this whole approach to economic and social development in coastal desert areas? From the technological standpoint, we see no reason to doubt that very large, and reliable, reactors could be built; and the same is to be said for the desalting plants. Whether the energy source is to be nuclear or conventional in the near term depends on the circumstances; if oil is nearly free one would use oil. However, in the long term most of us in the nuclear business believe nuclear will be the fuel of choice even in the cheapest oil areas.

As for the feasibility of such distilled water agriculture, we are assured by our agricultural consultants that our numbers are reasonable and can be achieved. We are particularly impressed with the sociological advantages of setting up agriculture in a virgin desert and organizing it ab initio on rational lines. This is the

pattern adopted successfully in the Gezira cotton project in the Sudan;³ most of the workers need little education, but the few managers are very highly trained.

The farm plus the desalting plant costs \$2,500 per acre of irrigated land. This amounts to about \$150 per person fed on-site, and, what is most important, the investment, once made, will provide a means of feeding the inhabitants continually. Moreover, just as the high dam at Aswan created an enormous elan in the United Arab Republic, so one could conceive of a massive, integrated project of this sort having similar impact, especially in water-short areas of the world. I have given only an example; other combinations of outputs, product mixes, capital investments will surely have to be examined if one is to take seriously possibilities of this sort. Thus the proposed small 100-million-gallon-per-day Israeli desalting plant might well be the first step toward a larger integrated plant of the general sort described here. I would certainly hope that out of studies such as this would come some sensible project that could not only capture the imagination of a war-weary world, but could make a positive and substantial contribution to the economic development of coastal desert areas like the Middle East.

^{3/} The Gezira scheme of rationalized cotton agriculture in the Sudan has many of the elements of a proposed agro-industrial complex. See Arthur Gaitskell, The Gezira, A Story of Development in the Sudan, Faber & Faber, London (1959). Another example which, however, is primarily industrial, is the huge SASOL synthetic oil complex in South Africa.

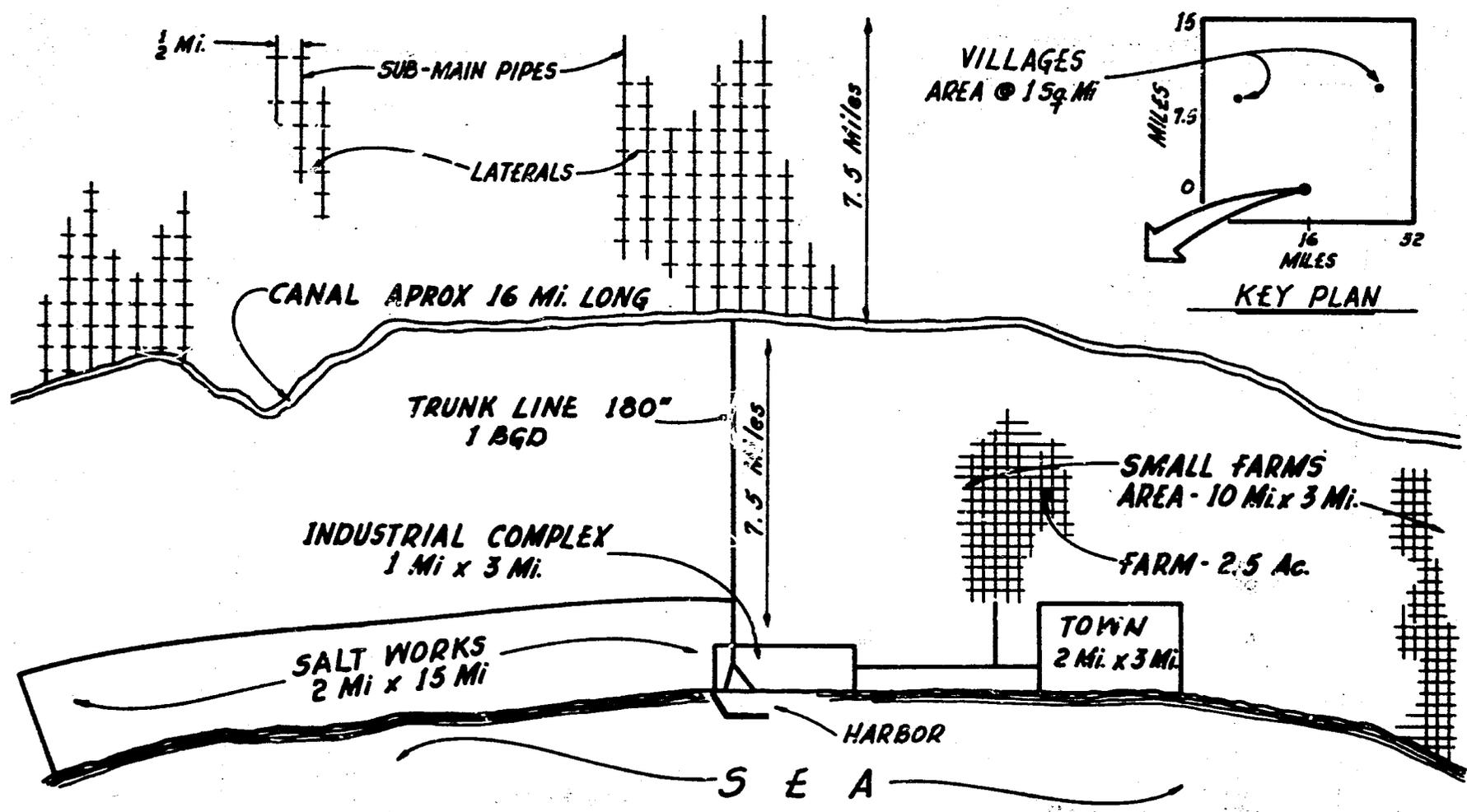


Figure 2. Conceptual Layout - Agro-Industrial Complex

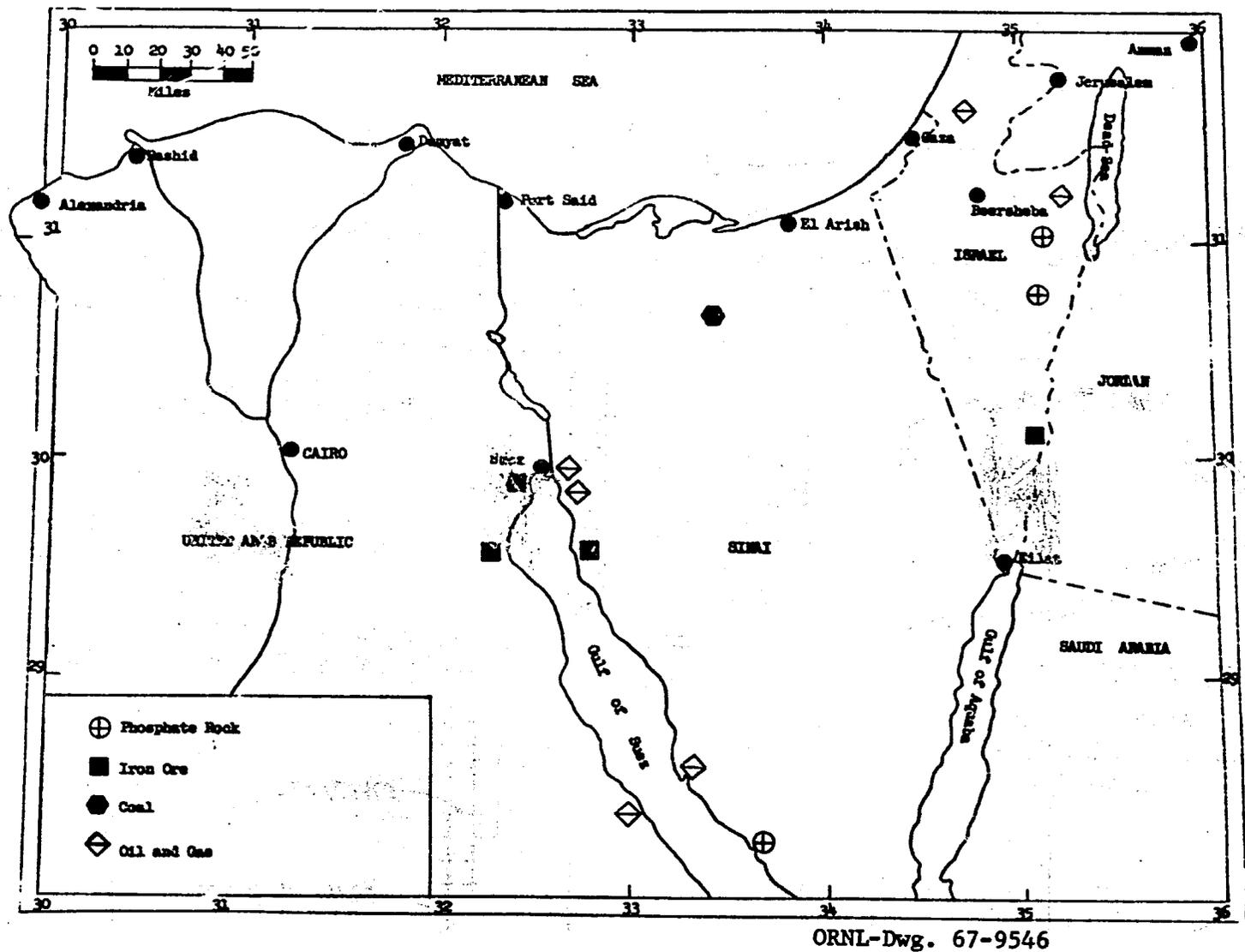


Figure 3. Mineral Resources of the Eastern Mediterranean