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Report of the
ARGENTINE-U.S. WORKSHOP ON
SCIENCE AND TECHNOLOGY IN ECONOMIC DEVELOPMENT

Mar del Plata, Argentina
July 28 - August 1, 1969

Co-sponsored with the
Consejo Nacional de Investigaciones Científicas y Técnicas
Academia Nacional de Ciencias Exactas, Físicas y Naturales

Office of the Foreign Secretary
NATIONAL ACADEMY OF SCIENCES
Washington, D. C.

This report records the issues discussed and the conclusions reached at the Argentine-U.S. Workshop on Science and Technology in Economic Development held in Mar del Plata, Argentina, July 28 - August 1, 1969. It was compiled from reports of session chairmen and rapporteurs, as well as staff notes.

This report will be presented to the Board on Science and Technology for International Development and will be made available to interested institutions in Argentina.

It is part of a continuing study of science organization and development in a number of countries that is currently being conducted by the National Academy of Sciences-National Research Council under contract AID/csd-1122.

TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
Summary of Recommendations	2
Agenda	5
Participants	6
Opening Session	10
General Session, Tuesday, July 29	12
Recommendations of Working Groups I, II, and III	15
Reports and Recommendations of Special Working Groups	
Scientific Information	23
Food Technology	29
Groundwater Hydrology	32
Agricultural Research	34
Closing Session	40

APPENDICES

I. List of Discussion Papers	42
II. Remarks by Dr. Alberto Taquini	44
III. Remarks by Dr. Harrison Brown	48
IV. Use and Management of Scientific Resources for Economic Development, W. Deulofeu	50
V. The Use of Scientific Resources for Economic Development: Basic Problems and Issues, J.H.G. Olivera	52
VI. Present Situation of Scientific Information in Argentina, Roberto Couture de Troismonts	68
VII. A Study of Underground Waters in the Argentine Republic	76

INTRODUCTION

The idea of the bilaterally-sponsored science workshop held in Mar del Plata was initially proposed by a member of the Argentine National Academy of Exact, Physical and Natural Sciences. The Academy together with the Argentine National Council for Scientific and Technical Research (CNICT) invited the U.S. National Academy of Sciences to co-sponsor the meeting which took place on July 28 - August 1, 1969.

The theme of the meeting was the "Use and Management of Scientific Resources." Nine U.S. delegates, ten Argentine delegates and approximately thirty observers participated. Special panels considered these major topics: (1) food technology; (2) groundwater hydrology; (3) scientific information; and (4) agricultural research and training, with emphasis on pasture ecology and management. A number of discussion papers were presented (see Appendix I). In addition to the scheduled panels, three working groups were established to discuss the following topics: (1) Planning the Formation of Human Resources for Scientific and Technological Development, Economic Aspects, Scientific Careers and Orientation; (2) Basic Problems in the Use of Scientific Resources for Economic Development and Technology Transfer; and (3) Relationships Among Organizations of the Scientific-Technological Complex.

Prior to the meeting, most of the U.S. participants accepted invitations to visit research institutions and universities with their respective Argentine colleagues. The interest and enthusiasm which characterized the meeting is reflected in the recommendations of the various panels, which worked diligently to select areas for feasible cooperative endeavor between individual scientists and institutions of Argentina and the United States. Argentine participation included representatives from a number of institutions, including some from outside the capital complex. The participation of Dr. Alberto Taquini, Secretary of the newly-created National Council of Science and Technology, was particularly welcome in view of the governmental mandate the Council has in formulating a national science policy for Argentina. U.S. Ambassador John Davis Lodge addressed the closing session of the meeting. A number of observers from the U.S. Embassy and AID attended most of the working sessions. Mr. Stanley Grand and Dr. John Halpin of AID, and Dr. André Simonpietri of the U.S. Embassy provided valuable assistance with the preliminary arrangements for the meeting.

Dr. Venancio Deulofeu served as the General Coordinator of the workshop. Mr. Federico Cross was responsible for the secretariat and physical arrangements of the meeting. Miss Theresa Tellez of the U.S. National Academy of Sciences coordinated arrangements for the U.S. participants.

Summaries of the discussions are contained in this report. Three of the discussion papers have been appended as supplementary information to the relevant topics. The full texts of recommendations adopted appear as part of the report of the respective working group. The principal recommendations calling for bilateral action may be briefly summarized as follows:

SUMMARY OF RECOMMENDATIONS

Scientific Information*

It is recommended that:

1. An Argentine committee be established, similar to the NAS-NAE Committee for Scientific and Technical Communication which operated during 1966-69, and that it undertake a critical evaluation of the Argentine situation in order to establish a basic orientation for an adequate national policy in scientific information;
2. A CNICT-NAS Pilot Project be established between one of the cities in the interior, Buenos Aires, and eventually with a suitable group of information centers in North America and Europe, and that a more general study be made of the characteristics, costs and benefits of such a system;
3. The CNICT should keep abreast of the work of the ICSU-UNESCO committee (UNISIST)** and should take steps to join the world information system when appropriate; and
4. Argentina should operate an up-to-date repository of patents issued in the United States, Canada, Great Britain, Germany, Belgium, Switzerland, South Africa and in addition make an analysis of all patents issued in Argentina since 1964. A study group should subsequently evaluate the implications of this material in terms of industrial, economic and research possibilities for Argentina.

*For complete text, see page 24.

**Study for a world-wide science information system.

Agricultural Research*

It is recommended that:

1. The CNICT and the NAS promote and encourage academic and financial assistance to the Graduate School for Agricultural Sciences in Argentina;
2. The NAS lend assistance to efforts aimed at training Argentine students at the doctoral level;
3. The CNICT and the NAS establish joint committees for planning and evaluating agricultural research projects, exchange of scientific information, and exchange of consultants;
4. The NAS utilize the International Biological Program for the exchange of students;
5. A joint study group consider the drafting of a work guide for agricultural research; and
6. The CNICT consider the creation of a permanent National Committee on Agricultural Research.

Groundwater Hydrology**

It is recommended that:

A joint Argentine-U.S. panel study the physicochemical controls of fresh-brackish water relations, with the expectation that the findings of such studies be transferred to regions having problems of this nature.

Manpower

Considering national development plans, it is recommended that:

1. The Argentine Group prepare a report on the scientific and technical personnel that Argentina will require in the forthcoming years, and establish a list of priorities according to areas; and
2. As soon as the above information is available, one or more small Argentine-U.S. groups should be established to propose cooperative mechanisms for overcoming manpower deficits.

* For complete text, see page 37.

** For complete text, see page 32.

Technological Research*

There is a great need for strengthening technological research and development capabilities in Argentina within industry itself and in other institutions dedicated to the solution of practical problems. Therefore it is recommended that:

1. An intensive study be made which could lead to policy recommendations aimed at stimulating industries to develop internal research capabilities;
2. The study should be undertaken as part of a joint Argentine-U.S. program of cooperation in science and technology.

*For complete text, see "Relationships among organizations of the scientific-technological complex", page 21.

A G E N D A

- | | |
|---------------------------|---|
| <u>Monday, July 28</u> | Opening Session and Plenary Meeting
on the Use and Management of Scientific
Resources for Economic Development |
| <u>Tuesday, July 29</u> | Working Groups I, II and III on Human
Resources, Scientific Resources and
Scientific and Technological Organiza-
tions |
| <u>Wednesday, July 30</u> | Working Groups on Agricultural Research,
Food Technology, Groundwater Hydrology
and Scientific Information |
| <u>Thursday, July 31</u> | Presentation of Panel Recommendations
Visits to scientific institutions |
| <u>Friday, August 1</u> | Final Recommendations and Closing
Session |

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WORKSHOP ON SCIENCE AND TECHNOLOGY
IN ECONOMIC DEVELOPMENT

Opening Session, Monday, July 28
Rapporteur: Dr. Davis

Members and guests of the workshop were greeted graciously by Dr. Houssay at the opening session. Dr. Houssay mentioned the organizations sponsoring the meeting, the events that gave rise to it, and the general objectives. He recalled that in 1962 the U.S. National Academy of Sciences had held a meeting in Washington at which it was agreed that Latin American countries should form national research councils. Many countries already have or are organizing these institutions and he praised the NAS for its efforts in this connection.

A keynote address followed, given by Dr. Alberto Taquini, Secretary of the National Council of Science and Technology (Appendix II). Dr. Taquini pointed out the importance of having a national policy with regard to science, and described some of the measures already taken by his office to help formulate such a policy. In this regard, Dr. Taquini expressed great interest in the recommendations which might be made at the workshop. In this connection, he stressed that Argentina's present state of development clearly places it in a leadership position within Latin America.

Dr. Harrison Brown responded on behalf of the North American delegates (Appendix III). He underscored Dr. Taquini's remarks by commenting that two of the three Foreign Associate Members of the U.S. National Academy of Sciences from Latin American countries are from Argentina. He then emphasized the importance of engineering, science, and economics in decisions that must be made by national leaders. Dr. Brown also stressed the fact that local problem-solving is also highly dependent on scientific research.

Ing. Ernesto E. Galloni continued the morning session by presenting some concise and interesting remarks about the close relationship between economic and technological development. He also cited the critical need for the rapid exchange of technical information. He concluded by stating that he hoped to see the workshop bring into better focus the problem facing the four specialized fields that had been singled out for detailed discussion.

Dr. Venancio Deulofeu concluded the morning session by commenting on his prepared paper that had been distributed to the group. (See Appendix IV.) In this paper, Dr. Deulofeu stated clearly many

of the basic questions involved in the relationship between the economic growth of a nation and the development and management of its scientific resources. One of his points was that innovative steps in complex and advanced technologies require large investments of human and material resources; the economies of countries which are developing cannot support repeated failures.

Before the close of the morning session, Dr. Brown suggested that the prepared paper by economist Dr. Julio H. G. Olivera be discussed in the afternoon, and that Dr. Olivera be invited to make some further comments on this important and stimulating paper. (See Appendix V.)

The following are salient points of the afternoon session.

Dr. Olivera emphasized that economic theory has not been developed as yet into an exact science, and that applications of theory should accordingly be tempered with all the wisdom and knowledge available.

Dr. García Olano developed this thought further by asking Drs. Hart and Olivera several important questions, including the question of the proper method of summing the effects of many separate and individual events in order to treat a complex economic analysis from a stochastic viewpoint. And Ing. Wilson asked how a final economic decision concerning investments in scientific ventures can be made without foreknowledge of future events.

In answer to Ing. Wilson's question, Dr. Hart stated that the best method is to make a study of alternative investment possibilities and to choose the one that appears to provide the greatest benefit. He pointed out that experiments have demonstrated the fact that the individual potential productivity of non-skilled workers in so-called underdeveloped countries and in developed countries is the same. The most critical factor that affects the average productivity of these people appears to be the degree of cooperation between people rather than the overall level of technical development of the country.

Dr. Brown cited the need for future studies of the measurable benefits of scientific research. Two studies of agricultural research which appear to show a high return on money and energy invested were cited. He also ventured the opinion, based on statistics from several countries, that the rate of growth of the number of technologists and scientists probably cannot be too rapid. A realistic maximum for Latin American countries might be to double the total number every 15 years. However, Dr. Taquini noted that within certain fields where numbers of scientists are small the initial "doubling time" could easily be only one year.

Dr. Djerassi commented that the United States imports vast numbers of scientists to help its growth of scientific manpower. Ing. Marzocca reminded those present that Argentina also has distinguished scientists that were originally from other countries, and that at the present time Argentina welcomes new scientists with open arms.

At various times throughout the afternoon Drs. Houssay, Taquini, Brown, Prego, Wright, and others cited many specific prerequisites for a healthy research organization. Some of these are: (1) adequate support in the form of housing, equipment, technicians, and secretarial staff; (2) communication with scientists of all nations; (3) adequate and dependable salaries; and (4) efficient, rapid, and thorough information retrieval systems, including first-class, research-oriented libraries.

In conclusion, both Drs. Taquini and Olivera made strong pleas for good practical suggestions that could be implemented in the near future.

General Session, Tuesday, July 29
Rapporteurs: Drs. Cardón and Owen

The session was devoted to reports of the three subgroups which had met in the morning, and to discussion of those reports (see p.15). Dr. Jorge Wright, serving as rapporteur for Group I, outlined the discussions which dealt mainly with the identification and development of scientific and technical talent. Later in the session, a set of draft recommendations was submitted for the group by Dr. Albert Hart.

Dr. Salinger Becker reported for Group II, which dealt with the development of science and technology in Argentine industry. In the discussion, Dr. Djerassi asked about patent policy, noting that the Wisconsin Alumni Research Foundation policies had operated to the conspicuous benefit of university research in that institution. A few cases of patents taken out as a result of university research in Argentina were noted by Dr. Houssay. He said that the concept that a university must create as well as disseminate knowledge has now been widely, though not universally, accepted in Argentina. Problems exist in the geographic distribution of research funds, and the Council has tried as much as possible to help distant and regional centers. There are exchange agreements with Spain, Germany, Great Britain, and France. Russians have been accepted for intervals in Argentine universities, and people have occasionally been sent to visit the U.S.S.R. Relations with the United States remain most important; half of the scientific and technological people who go abroad go to the United States. The basis of effective associations is mutual understanding; those who

came and watched and helped - such as people from the Rockefeller Foundation - have done a great deal of good.

There was intense discussion of "full-time" industrial consulting. At many U.S. universities professors are permitted to consult in a controlled way. Consulting is currently prohibited in Argentina, if it serves to increase the personal income of the professor. Dr. Houssay's summary statement that Argentina needs to perfect its "full-time" arrangements for which it has had to struggle before it begins to modify them, seemed to receive general approval.

Dr. Brown, as rapporteur for Group III, read the group's five recommendations. There was extensive discussion of the first recommendation, which dealt with basic (as distinct from applied) research and identified the universities as the major appropriate agencies for such research. Dr. Taquini noted that the Secretariat (CONACYT) is in agreement with this emphasis, and will make some relevant recommendations within the next month, especially in relation to the expenditure by universities of research funds that serve teaching as well as research ends, and to the development of particular research centers (four are now under consideration), such as a new Institute of Physics to be located in Balcarce. These would be research "conglomerates" sufficiently well manned to develop a basic science enterprise, as well as to provide for technical development related to the regional environment. With respect to exchange of scientists and the travel of Argentine scientists abroad, Dr. Taquini expressed concern that the present convention of the large scientific meeting may not provide the most fruitful way of developing significant personal contacts by the travelers, and suggested that a study might be made of the best ways of developing personal contacts and of making them more fruitful. He said that the Secretariat has followed almost entirely what was suggested in the Group III resolutions, and that Dr. Brown's report might in fact be considered "a very good synthesis of our attitude."

Point 1 (on basic research at universities) was tentatively accepted without further discussion. Point 2, suggesting the possibility of a joint study of specific steps that might be taken by the government to encourage applied research in industrial laboratories and research institutes, provoked some discussion of "oriented pure" research. It was tentatively concluded that the point should best remain a more general one, rather than venturing into more specific and difficult areas such as "oriented basic" research. Point 3, dealing with the need of balance between pure and applied research, is under study by the Secretariat. Dr. Taquini said that "when the plans are fully formulated, we will go ahead and discuss them with agencies that may be able to help us." He emphasized that Argentina can act as a bridge between the highly developed technology of the United States and the relatively under-developed countries elsewhere in Latin America. From its own relatively advanced level, Argentina recognizes an obligation to provide

aid to the technological and scientific development of other Latin-American countries who require help. Point 4, on the desirability of strong interactions among university, institute and industrial research needs and personnel in science and technology, provoked a very extensive discussion. There is already considerable activity in this direction, particularly through the inclusion of representatives from the production sector on the National Advisory Council, and in INTI and INTA. Ing. Marzocca described the integration of all levels of agriculture within its Institute (INTA); he felt that relationships from "the bottom up" are generally functioning rather well (through the regional advisory councils), but that an adjustment is needed at the level of "current coming from the other direction . . .", i.e., from top national leadership into the enterprise. Dr. Deulofeu expressed his opinion that industry must be convinced of the importance of carrying out real research, not simply quality control of products, and of evaluating the problems of the future of what is going to happen, not what is happening or has happened.

Dr. Olivera referred to the desirability of stimulating industry to conduct research locally in Argentina. Dr. Djerassi cautioned that premature requirement of such a condition, by law or manipulation, might have the undesirable effect of actual loss of industry. He emphasized that fields would have to be carefully selected, and that any general requirements might prove unfortunate, as has happened in some other areas.

The last recommendation from Group III deals with the desirability of maintaining and developing contacts between Argentine scientists and technologists and those abroad. Dr. Brown noted that an NAS committee in the United States, after studying the matter of travel funds, had concluded that the cost of travel is usually only a very small part of the total cost of doing research, and that it is as integral a part of research as is publication. It can be abused, but abuses can be controlled; and it is particularly important for young researchers.

Dr. Djerassi urged the advantages of having congresses and other international meetings in Argentina, so that hundreds of young scholars could be exposed to people from abroad at relatively little cost. It was pointed out that Argentina has hosted a number of international meetings, and there are tentative plans for others. Dr. Houssay said that the question is frequently discussed. He feels that the principle is good, and that the policy suggested in the recommendation exists but that implementation cannot always be optimal.

Dr. Hart presented eleven draft recommendations for Group I which were referred to a "drafting committee"; they were not discussed in the session.

Working Group No. I

PLANNING THE FORMATION OF HUMAN RESOURCES FOR SCIENTIFIC AND
TECHNOLOGICAL DEVELOPMENT, ECONOMIC ASPECTS, SCIENTIFIC
CAREERS AND ORIENTATION

Chairman: Dr. B. Houssay

Rapporteur: Dr. Wright

The large number (over 18) of participants did not permit drawing definite conclusions during the time available due to the wide scope of the subject. The main problems of training scientific personnel in Argentina were analyzed, as well as the type of dedication, the experience obtained in the United States in this regard, the lack of critical mass in certain fields in Argentina, the possible solutions in function of time and cost, what other nations are doing in this regard, the problems of adaptation of returning fellows, remunerations, training of leaders, and some of the results obtained.

There appeared to be consensus regarding the following points:

One of the main problems in Argentina concerning scientific and technological development is that of its human resources, at least in a good number of fields.

Difficulties exist in obtaining high-quality personnel for the training of scientists in some disciplines.

Talent is sometimes lost to science and technology due to failures in the adequate selection of personnel, or due to shifting to other occupations, or because of inadequate training which prevents the rational choice of the maximum-self vocation.

It is necessary to promote the establishment of centers of graduate study and research to allow those better qualified to continue advanced studies, whether locally or abroad, and to initiate fundamental research by integrating groups that may eventually expand.

Better prospects should be offered to qualified persons, not only with respect to remuneration, but also regarding working conditions.

The above-mentioned confirms the necessity for an adequate policy for science and technology, in consonance with the objectives for national development.

On the basis of these considerations, it is recommended that:

1. The Argentine Group, considering national development plans, prepare a report on the scientific and technical personnel that Argentina requires in the forthcoming years, and at the same time establish a list of priorities according to areas.
2. As soon as the above information is available, one or more small Argentine-U.S. groups be established to propose cooperative mechanisms for overcoming manpower deficits.

A supplementary statement on the foregoing topic follows.

Supplementary Statement on the

FORMATION OF HUMAN RESOURCES FOR RESEARCH

by

Dr. Albert G. Hart
Dr. Julio H. G. Olivero
Ing. García Olano

With the aim of directing attention to the fundamental problem of training for scientific and technological research, we present the following points which are of special importance for scientific-technological policy:

1. Satisfactory careers for scientists and technicians, from the stage of preliminary selection, through that of training, and into that of participation as mature scholars in research and instruction.
2. Organization of secondary and higher education, so that potential scientists and technicians can choose their fields of activity wisely and determine their capacity for work in these fields - presenting to students not only results but also modern methods of research over a wide range of natural and social sciences. Opportunity for students to act as apprentices in selected research activities, so as to obtain a just impression of the nature of the research work.
3. Professional training of scientists and technologists in centers of graduate studies, closely linked with centers of research for particular disciplines or groups of disciplines. Centers of graduate studies, with an adequate ratio of professors to students, will put the student in close relationship (through seminars, advanced courses, and research work) with professors active in scientific research. The methods of training and the climate of research work in such centers

should stimulate interaction of students with each other and with the research staff.

4. Cooperation among related disciplines, and formation of inter-disciplinary groups in the centers of research and graduate instruction. Constitution of such centers as joint enterprises of different universities or other organizations concerned with research.

5. Advantages of having a large proportion of graduate students complete their studies within the country, in disciplines where the scale of operation and the depth and variety of subjects treated permit the organization of first-class doctoral programs. Opportunity for such students, at various stages of their careers, to work in other countries as visiting scholars or as temporary members of research teams.

6. In fields where conditions for doctoral programs are not as yet fulfilled, training in centers of graduate study up to a level of professional competence that will permit students to work in foreign centers at an advanced level, so that within a reasonable length of time they can pass preliminary doctoral examinations and set up practicable dissertation projects.

In many cases involving study abroad, dissertations can be so designed that they can be carried out at an Argentine center. To coordinate such programs effectively, continual contact must be maintained between Argentine centers and their counterparts abroad.

7. Opportunity for highly qualified students who have obtained adequate training - either along the lines indicated above, or in some other way - to become integrated in Argentine scientific activities through work in a research center. This opportunity should be complemented, in most cases by the opportunity to give advanced courses at universities and at centers for graduate studies. This group of young professors can provide a large share of the staff necessary to give such courses, and can also make a major contribution to the modernization of the curriculum. Senior scientists will be responsible for basic instruction and for conducting seminars, clinics, laboratories, and so on, in association with junior colleagues.

8. Possibility for the scientist of living with dignity and reasonable comfort from the earnings of full-time work in research and instructions, at all stages of his career. Sufficient number of such careers to support a vigorous scientific life.

9. Possibility of finding roles in pure or basic research for those (including young scientists) who demonstrate capacity

for such work. Even though the majority of scientists and technicians will make their contributions mainly or entirely through applied research, the interaction of applied and basic research will be of value both for the quality of applied research and for the orientation of basic research.

Working Group No. II

**BASIC PROBLEMS IN THE USE OF SCIENTIFIC RESOURCES
FOR ECONOMIC DEVELOPMENT AND TECHNOLOGY TRANSFER**

Chairman: R. L. Cardón

Rapporteur: John Green

Discussion was opened with reference to the lack of a satisfactory connection between the scientific and technological institutions and the sector of economic production in Argentina, although it was recognized that some notable exceptions existed.

After considering different aspects of the subject, the following recommendations are made:

1. In the general planning of scientific and technological research, strong emphasis must be given to the immediate and future requirements of the development of the country. At the institutional level, the programming of scientific and technological research should take into account the aim of intensifying cooperation with the production areas.
2. Universities should multiply their contacts with private and public industry. Examples of ways to increase such contacts are given below:
 - a) Encouraging professors and assistants to act as advisors and consultants to industry;
 - b) Promoting research in areas which are considered of interest for industry;
 - c) Publishing results of proven practical value in a journal which reaches the appropriate industry;
 - d) Accomplishing points a), b), and c) should provide additional funding for further R&D.
3. Efforts should be made to enact legislation that would provide incentives for industry to devote resources to the funding of research and development.
4. Institutions which plan, sponsor, finance, or do research and development work should make a periodical evaluation of the results obtained. Through this procedure they will

gain a realistic base for the continuation of the projects which have produced results of value and for the reappraisal of others.

5. With respect to the matter of benefits and patents emerging from industrial exploitation of results of research undertaken at public institutions, the opinion was expressed that participation in such benefits ought to be given to the authors of the discovery or innovation and to the laboratories in which the research was performed.

Working Group No. III

RELATIONSHIPS AMONG ORGANIZATIONS OF THE
SCIENTIFIC-TECHNOLOGICAL COMPLEX

Chairman: V. Deulofeu

Rapporteur: H. Brown

The following is a summary of the basic points made by the group.

1. Most basic research - by which we mean research which is undertaken for its own sake without any particular applied goal in mind - belongs in the universities. We recognize that a modest amount of basic research can, on occasion, be usefully undertaken in laboratories whose goals are primarily of an applied nature; but generally speaking, basic research should not be isolated from postgraduate education.
2. One of the most important functions of the National Research Council and of the National Council on Science and Technology should be to keep the support of basic research in reasonable balance with the support of applied research.
3. There is great need for strengthening technological research and development capabilities in Argentina within industry itself and in other institutions dedicated to the solution of practical problems.

An intensive study should be made of this situation. Hopefully, such a study will lead to policy recommendations aimed at stimulating industries to develop internal research capabilities. The recommendations should also aim at establishing such other research institutions as might appear necessary. We suggest that this study might be undertaken as a part of a joint Argentine-U.S. program of cooperation in science and technology.

4. There should be strong interactions between research workers from industry, technological research institutes, and the universities, without interfering with the primary legitimate functions of those institutions. The National Research Council and the National Council on Science and Technology should take the initiative in stimulating these interactions.

5. It is important that Argentine research workers in science and technology be in close contact with their colleagues overseas. Rational plans should be established concerning overseas travel for international scientific congresses and symposia. Programs of scientific exchanges should be expanded.

Special Working Group on Scientific Information

Chairman: Harrison Brown

Rapporteurs: John Green
Ing. E. Jáuregui

The following were members of the working group: Harrison Brown, Raúl L. Cardón, Roberto Couture de Troismonts, Carl Djerassi, Francisco García Olano, John Green, Emilio Jáuregui and Jorge Wright.

The discussion papers submitted by the Argentines indicated that a number of computers are available in different study and research centers as well as in private commercial and industrial organizations. Practically all of them - even those which belong to the third generation - are of reduced capacity. Several institutions intend to buy new computers with larger capacities. They will then be able, not only to support their own needs, but also to offer computer services to other institutions in the country, through remote terminals.

In Argentina there are trained analysts, programmers, and several persons trained in computer research, who would be able to assume responsibility for larger third-generation computers when they become available.

Argentines believe that because of the enormous development of computers in the United States, the experience of the U.S. could undoubtedly benefit the country in helping it obtain more efficient use of its computers.

The areas of interest indicated by the Argentines were as follows:

1. Application of automation to systems of information, services in libraries, information and documentation centers, bibliographical tasks, etc.
 - a. Present trends of automation in bibliographical services.
 - b. Automation in services. Accession, etc.
 - c. Retrospective bibliographical search by means of automatical systems. Selection systems.
 - d. Information processed by automatic means in American systems: possibility of its use in our country.

2. Application of non-conventional systems to the transference of scientific information.
3. National systems to check information produced by official organizations in the different jurisdictions and levels.
 - a. Checking and recording.
 - b. Circulation.
4. Exchange of scientific and technical information among American and Argentine libraries and centers. Present state and development expected.
 - a. Exchange of publications, reports, etc.
 - b. Exchange of services.

For a more detailed report on the "Present Situation of Scientific Information in Argentina" see Appendix VI.

The group discussed the rapidly growing volume of scientific and technological literature and the growing expense of building and maintaining conventional libraries adequate for the needs of modern scientific research. It was further noted that modern communications technology makes it possible for a working scientist in the interior of the country to be in close contact with major centers of scientific information in North America and in Europe.

Such modern methods of information retrieval and dissemination are expensive, notably when applied to specialized scientific and technological fields. It should be recognized that if used wisely and to their fullest extent, the benefits of such methods far exceed their costs. These benefits include the tremendous savings of time in searching for existing information, and the elimination of needless repetition of research. Even more important, these benefits constitute a powerful stimulus for scientific and technical efforts in new areas of economic importance to the country.

Recommendation 1

The group took note of the work undertaken by the Committee on Scientific and Technical Communication established by the U.S. National Academy of Sciences, that operated during 1966-69, and was composed of

well-known personalities in the field of scientific and industrial research and specialists in documentation of the United States.

Due to the importance of the results obtained by the aforementioned committee, which have been published in the book, Scientific and Technical Communication, the group considers it desirable to study the possibility of creating a similar Argentine committee which could benefit from the experience gained by the U.S. committee, and eventually obtain the support of the U.S. National Academy of Sciences, if it is deemed useful to request this and if it lies within the possibilities of that organization to grant it. In any case, the activities of this committee ought to be included in the agenda of future meetings of the present Argentine-U.S. Workshop on Science and Technology.

Without entering into the analysis of the problem of composition and dependence of the suggested committee, it is considered that it ought to fulfill the following objectives:

1. Undertake an examination of the Argentine situation regarding documentation and the circulation of scientific and technical information, utilizing specialists, questionnaires, or samplings, or any other procedures deemed appropriate.
2. Determine the present situation and principal trends in this field in advanced countries (automated services, new systems of indexing, use of telex, prospects for transmitting bibliographic information via satellites, international cooperative projects, etc.). The documentation made available at this Workshop by the North American participants already constitutes a valuable contribution.
3. Make a critical evaluation of the Argentine situation in the above-mentioned fields, and a comparative study that takes into account the conditions and possibilities within the country, in order to establish a basic orientation for an adequate national policy in scientific information. These orientations should emphasize future developments and needs in relation to equipment and reproduction systems, connections with international services, etc.
4. While the above-mentioned studies are in process, the committee should promote action through exhibits, courses, etc., toward familiarizing the largest number of researchers (including the industrial sector) in the most modern techniques and procedures for obtaining access to scientific and technical documentation.

Recommendation 2

It was suggested that by making use of modern communications technology, Argentina need not await the time when the studies suggested above are completed, and its library facilities throughout the country are adequate for the conduct of modern scientific research. Each scientific and technical center might be supplied with a basic "minimum" of such searching tools as Chemical Abstracts, Physics Abstracts, Biological Abstracts, the Bibliography of Agriculture, and the Engineering Index, for example. Similarly, Current Contents might be obtained by air from the United States and then widely distributed throughout the country through an appropriate National Center. Major laboratories and libraries in the interior of the country might be connected by Telex with a National Documentation Center, thus enabling them to request copies of journal articles. Articles available could be quickly dispatched by air. Articles unavailable would be immediately requested by Telex from abroad and again could be dispatched by air.

In the light of its discussions, the work group recommends that:

1. In order to test the feasibility of the aforementioned system, a pilot project be established between one of the cities in the interior, Buenos Aires, and eventually with a suitable group of information centers in North America and Europe.
2. A more general study be made of the characteristics and costs, as well as the direct and indirect benefits of such a system.

The group suggests that the study and the pilot demonstration might be a suitable project for Argentine-North American scientific cooperation. Such cooperation might take the following forms:

1. The study should be undertaken jointly by specialists provided by the National Research Council of Argentina and the National Academy of Sciences of the U.S.A.
2. The pilot demonstration could be jointly operated by the National Research Council of Argentina and the National Academy of Sciences of the U.S.A.
3. The National Academy of Sciences of the U.S.A. could help secure the cooperation of scientific information services in the United States.

Recommendation 3

The group considered the ICSU-UNESCO committee (UNISIST), which is directed toward a worldwide information system. This effort contemplates achieving compatibility among existing and prospective national programs. At the present time, the project is aiming at coordination of the activities of the more industrialized countries which are the major producers of scientific and technical literature. However, the participation of all countries of the world is intended.

The group considers that Argentina should carefully observe the development of this program and take steps to join it when appropriate. As a consequence of this view, it is recommended that:

1. One of this country's institutions (such as CNICT's Scientific Documentation Center) should assume responsibility for keeping informed concerning said program. In addition, this institution will provide UNISIST with such data as may be of interest to it regarding scientific information in Argentina.
2. Programs adopted locally should strive for compatibility with recommendations and policies emerging from the ICSU-UNESCO project, to facilitate the eventual incorporation of Argentina into the world system which is being planned.

Recommendation 4

1. It is suggested that the Argentine Patent Office operate an up-to-date repository of issued foreign patents from (at least) the following countries: U.S.A., Canada, Great Britain, Germany, Belgium, Switzerland, South Africa, and preferably also Holland, Sweden, France, Italy, and Japan*.

Gradually, this collection should be extended backwards in time, so as to include all issued patents in these countries since about 1957. Argentine requests for copies of issued patents would be filled promptly at a moderate price, and the Argentine Patent Office should also assume the responsibility for ordering from abroad copies of those foreign patents which are not available in Argentina.
2. An analysis should be performed of all patents issued in Argentina since 1964 with respect to the following criteria:
 - a. Number of patents arising from inventions performed in Argentina.

*These countries have been listed because they represent a variety of patent systems including some (Belgium, South Africa) which publish complete patent specifications rapidly.

- b. Number of patents arising from inventions performed abroad and subsequently filed in Argentina.
 - c. Breakdown according to major fields (such as pharmaceuticals, plastics, electronics) of patents under (a) and (b).
 - d. As far as (a) is concerned, separate patents coming from American companies and send their titles and patent numbers to the George Washington University, Washington, D.C., which is willing to survey those American companies in order to determine the reason why they decided to file patents in Argentina.
3. After the results of the statistical survey (2 above) are available, convene a study group to evaluate the implications of these statistical results in terms of industrial, economic, and research consequences to Argentina.

Special Working Group on Food Technology

Chairman: Pedro Cattáneo

Rapporteur: Edward Seltzer

The following persons comprised the working group: Pedro Cattáneo, Guido S. Becker, Juan C. Sanahuja, Rodolfo Antonissen, Edward Seltzer, André Simonpietri. In advance of the meeting, the following information had been made available.

In 1967, Argentina produced nearly 1,000,000 tons of "meals, cakes, and expellers" as byproducts of the vegetable oil industry (about 330,000 tons from linseed, 450,000 tons from sunflower seed byproducts, and the balance from peanut, rapeseed, and cottonseed). The total protein contents of these byproducts has been estimated at nearly 500,000 tons. Based upon this information, it was proposed that a discussion be held on isolation of the proteins, or direct transformation of the byproducts into low-cost protein concentrates, taking into account the economic, technological, and nutritional aspects.

Argentina has recently witnessed a growing increase in the consumption of dry soups. Research is necessary to improve the yields of some vegetables, to determine the solid content and other characteristics which would lead to improving this industry. There is special interest in dehydration and other methods and techniques of preservation, as well as storage and packaging. Argentines have an interest in establishing graduate training programs in the field of food technologies, especially in cryodehydration, freeze-drying, foam-mat drying, and reverse osmosis. Other areas mentioned included: (1) preparation, packaging, compressing, transporting, and handling of cooled or frozen meat; (2) packing and sterilization of meat products; (3) hygiene in industrial processing plants; (4) new meat products; and (5) sanitary and industrial microbiology.

In the course of its deliberations, the Working Group principally considered the following technical subjects:

1. Human Resources - Training
2. Protein Concentrates
3. Dehydration

The participants reached the conclusion that there is an urgent need for the creation of a permanent Working Group on Food Science and Technology. This Working Group should serve as the coordination point for efforts to achieve the following:

1. A survey of existing professional competence and of laboratory facilities in both universities and in industry. The survey should be made preferably by a representative of the Working Group through personal visits to the appropriate organizations.
2. The establishment and maintenance of contact with advanced centers of food science and technology, especially through the creation of an Argentine chapter of the Institute of Food Technologists whose headquarters are in Chicago.
3. Preferential attention to protein concentrates and dehydration.

Recommendation 1: Training of Human Resources

The Working Group on Food Technology recognizes that there are many existing institutions in Argentina engaged in the study of various aspects of food science and technology, but that there are not sufficient university centers at the postgraduate level where scientists and technologists can make meaningful contributions in these fields.

The Group noted that training in advanced processes, such as dehydration of food, ought to begin now so that the country may take advantage of opportunities which already exist or will exist in the future.

The Working Group recommends, therefore, that:

1. There be established one major postgraduate Department of Food Science and Technology.
2. The new Department consult with national and international institutions in order to obtain equipment and a pilot plant for training in modern techniques.

Recommendation 2: Vegetable Protein Concentrates

The annual production of the vegetable oil byproducts industry of Argentina of approximately one million tons, including expeller cakes and meals, merits special consideration with respect to its possible utilization for human consumption.

Some 650,000 tons of such byproducts, produced from sunflower, peanut, and cotton seed, could be transformed into protein concentrates after adequate processing. These, in turn, would be appropriate basic materials for the preparation of foods of high biological value and low cost, for internal and external markets.

The 350,000 remaining tons of byproducts, coming from linseed, represent a special category since they contain toxic or other undesirable substances. In view of the magnitude of annual production and their high protein content, two possibilities should be considered, namely:

1. Use for animal feeding, whether direct or indirect.
2. Protein isolation.

There is an imperative need for pursuing studies leading to the isolation of such proteins for human consumption.

Consequently, it is recommended that funds be made available to the universities and specialized official agencies so that, in collaboration with private enterprise, the studies and research needed to obtain these protein concentrates, the selection of the most adequate processes, their nutritional and economical evaluation, and their internal and external application be carried out.

Recommendation 3: Dehydration

The second problem chosen for studies related to economic growth is concerned with an increase in the use of food dehydration techniques for transforming Argentine commodities into products of higher economic value for both internal and external consumption. The panel identified conventional as well as non-conventional materials and processes for diversification of Argentine food industries.

Vegetables, fruits, meats, and fish present numerous opportunities, and the present level of manufacture is modest relative to its potential. Existing Argentine dehydration procedures are mainly conventional. Advanced new methods are known, but manufacturing investment is not yet justified by market demand, although such demand can be obviously developed.

Accordingly, it is recommended that particular attention be devoted to the utilization of new techniques in the dehydration of Argentine food commodities, and that the universities and industry collaborate in the exploration of processes most adaptable to the Argentine situation.

Special Working Group on Groundwater Hydrology

Chairman: José S. Gandolfo

Rapporteurs: Alfonso Wilson
Oscar Ruiz Huidobro

Members of the group included, in addition to the above, Stanley Davis, Amilcar Galván and José M. Sala. The group considered the topics outlined in Appendix VII entitled "A Study of Underground Waters in the Argentine Republic" and also discussed university teaching of groundwater hydrology. As a result of its discussions, the group urges that:

1. Mathematics, physics and chemistry be intensified to complement the teaching of hydrology.
2. A postgraduate course in hydrology be given for engineers and geologists who wish to follow that discipline.
3. Experts be assigned to the "Instituto de Geología Isotópica y Geocronología" to assist them in their hydrologic studies.
4. Technical advice on analog and mathematical models be given to on-going hydrologic investigations.

Recommendation

Considering the vast importance of groundwater to the development of the Pampa region, the great complexity of the problem, and its scientific impact, the panel recommends that a joint Argentina-U.S. workshop study the physicochemical controls of fresh-brackish water relations, with the expectation that the findings of such studies may be transferred to similar regions.

The following considerations should be taken into account with regard to such a study group*:

1. The work group should be composed of three members from Argentina and three from the United States.
 - a. The U.S. members should be selected by the NAS from the best-qualified groundwater hydrologists who have had experience in problems closely related to the Argentine problems. The present panelists will help in the search, if formally requested.

*Upon request, these details were worked out by Drs. Sala, Carriquiriborde, Wilson and Davis for the final session.

b. The Argentine members should be selected by the Consejo Nacional de Investigaciones Científicas y Técnicas (CNICT) from scientists having at least five years experience in groundwater hydrology, and actively working on the problem in EASNE, CIAS and Dirección Nacional de Geología y Minería.

2. The U.S. members should make a trip to Argentina to participate in an on-the-ground appraisal of the problem, selection of the pilot area, and delineation of preliminary work.
3. Subsequently, within six months to a year, the Argentine and U.S. groups should meet again at a place and time designated by them, either in the United States or other foreign country where similar conditions may prevail, or again in Argentina.
4. Further meetings will be necessary. The nature and frequency of such meetings could depend on the outcome of the study.
5. Although some benefit may be derived from the location of local water supplies, the importance of the study lies primarily in the development of techniques of investigation, and an understanding of the geochemistry of the fresh water-brackish water relationships of the Pampa region.

Special Working Group on Agriculture Research

Chairman: Ing Agr. Marzocca

Rapporteurs: Ing. Agr. Marzocca
Dr. Cook

This group was composed of the following persons: Dr. C. Wayne Cook, Dr. Ray . . Owen, Agr. Eng. J. Brun, Agr. Eng. I. O. Galli, Agr. Eng. E. A. Gil, Agr. Eng. G. Joandet, Agr. Eng. A. Marzocca, Dr. J. Ostrowski, Agr. Eng. A. J. Prego, Agr. Eng. M. A. L. Reichart, Agr. Eng. A. Soriano, and Agr. Eng. M. J. R. Zaffanella.

Prior to their arrival, the participants from the National Academy of Sciences had familiarized themselves with the working papers covering three specific fields considered to be of priority in this area. The discussions were therefore based on a summary report on the main features of Argentine agricultural production, and on illustrations of problems that must be solved by scientific and technological research, presented by the coordinator. The authors of the papers presented had an opportunity to make pertinent comments.

The three topics considered were soils, pasture ecology, and animal production.

The papers discussed gave rise to questions concerning certain problems connected with research in those fields. It was kept in mind that the purpose of the meeting was to work out - or recommend - guidelines for the authorities of the National Academy of Sciences and the National Council for Scientific and Technological Research in matters that could grow out of U.S.-Argentine cooperative projects or activities in this area.

The main problems identified were soil conservation and management in the pampas, soil fertility, and the productivity of soils in the Argentine subtropical region. The pampa region is the main source of foreign exchange from exports of Argentine agricultural products, whereas the subtropical region produces the country's most important industrial crops, and has a promising future for cattle raising.

In dealing with the subject of pasture ecology, the following matters were analyzed: (1) the scientific and technological aspects that should be considered in a region still unexplored ecologically with scientific methods, such as the seminatural pastures of the humid pampas, and more specifically the pastures of the so-called "Salado River depression"; (2) the current ecology of Entre Rios province, where a project which included studies on the subject has just been concluded, and where

transfer of technology to producers is now being carried out; and (3) pasture ecology in arid and semi-arid areas of Argentina, with special reference to Patagonia, where research is currently being conducted in this field through another project which, like the aforementioned project, is conducted with the cooperation of the FAO and the National Institute of Agricultural Technology (INTA).

The group also received information on the status of research in animal production, with particular attention to the problems of reproduction, genetic improvement, and nutrition of cattle in the country.

The discussions also touched on matters directly related to sanitation and health measures applicable to cattle in Argentina for the control of foot-and-mouth disease and other diseases, and the aims of research currently under way in the country to provide longer immunity against that disease through new types of vaccine. The efforts of Argentine producers and researchers in this regard were pointed out. The activities of the Joint Argentine-U.S. Commission to Study Foot-and-Mouth Disease are considered important and the group expressed the view that continuation of this work was deemed desirable.

The specific discussions in each of the three principal areas covered can be summarized as follows:

There is a considerable body of technological information, which Argentine agricultural producers have not utilized. It seems necessary to attempt new dynamic planning in agricultural research, which will take into account limitations in infrastructure and in human and material means (financing, implements, equipment, and experimental fields) that often prevent Argentine scientists and agricultural researchers from following in the footsteps of the highly developed countries as concerns technology.

It is obvious that there is a shortage of university graduates adequately trained to undertake high-level scientific research in the various fields of agricultural sciences, or at least to accomplish the volume of work the country requires over the short term. In this respect, the Committee evaluated the importance of scholarship programs in providing for training and the earning of academic degrees up to the Ph.D. level under the sponsorship of various U.S. institutions (universities, foundations, government agencies, and the like) to benefit Argentine agricultural universities. Moreover, the Committee considered it very desirable that the activities of those institutions be encouraged by the National Academy of Sciences to make this a continuous benefit. This is not only to enable former scholarship students to raise the level of Argentine agricultural research, but

also so that they will cooperate actively and continuously in the training of new generations of Argentine agricultural graduates.

Considerable attention was given to the Graduate School for Agricultural Sciences as a supplementary alternative for such training. This is a consortium established jointly by the University of Buenos Aires, the Universidad Nacional de La Plata, and the National Institute of Agricultural Technology. Its significant value was recognized, as was the desirability of attracting to its courses, up to the doctoral level, young graduates suited for research in the various specialties that are considered by Argentina to be of priority. The School has the advantage that its structure enables graduates to apply their theses to real farm problems in Argentina and to develop them inside the country.

The training of research assistants also was of interest to the group, which stated its awareness of the need to point out the lack of such assistants and their inadequate level of training. It was also pointed out that it is desirable that the national educational institutions be able, in a short time, to offer intermediate level courses, and that the research agencies be able to create the economic incentives that will better attract young high school graduates to those courses.

In considering a research methodology that will make possible maximum yield in minimum time given the country's relatively limited means and resources, the group felt that it would be desirable to establish working committees qualified to determine, by way of approximation, the intermediate level between the macroecological scales of research that will make it possible (1) to identify the main factors hampering an increase and improvement in agricultural production; and (2) to study the processes that govern the participation and interaction of those factors, their beneficial use or, when feasible, their necessary correction or modification.

Although it is recognized that substantial efforts have recently been made in connection with the inventory of Argentine natural resources, mainly in soils of the pampas and regional flora, there are still extensive and varied areas of the country of significant agricultural value that are yet to be inventoried. Only when the pertinent documentation of those resources is available will it be possible to plan agricultural research in those areas more appropriately and to establish priorities for coping more realistically with problems in the sector.

Due importance was attributed to the contribution that can be made to Argentine agricultural research programs by the experience and knowledge of foreign consultants. But it was emphasized that they should be called upon for programs in which their participation is well defined, so that their activities in the country will not only result in an exchange of ideas for the initiation or continuation of projects,

but will also stimulate or bring about the establishment and harmonious equipping of real permanent research groups, composed of specialists in the various branches of the agricultural sciences, adequately trained to benefit from such a contribution. At the same time, specific mention was made of the significant interest in receiving consultants prominent in science as a guarantee of maintaining a high level and proper approach to Argentine agricultural research in certain areas.

To establish specific plans in priority agricultural research fields, and in view of the possibilities of scientific and technological support from the National Academy of Sciences, it was considered advisable to foster the establishment of committees for study or review of programs related to problems in certain disciplines or specific agricultural products. Such committees should be composed of researchers from both countries, and should aim at channeling and studying the feasibility of joint or cooperative research plans or projects.

Finally, it was decided as a matter of special interest, to recognize that serious efforts should be made in each instance to define specifically the aims of the research and the economic goals to be reached. It was also decided to quantify these goals and to establish the order of priorities for the concentration of institutional efforts in accordance with the priorities.

Recommendations

The Agricultural Research Panel considers the following recommendations to be of the highest importance:

First: It is expressly recommended that the Consejo Nacional de Investigaciones Científicas y Técnicas (CNICT) and the National Academy of Sciences (NAS) vigorously promote and encourage on a continuing basis projects and initiatives of academic and financial assistance for the "Escuela para Graduados in Ciencias Agropecuarias de la Argentina" (Graduate School for Agricultural Sciences in Argentina) which will allow the participation of U.S. institutions and professors in the areas of teaching and in providing equipment, scholarships and grants for graduating students of the Graduate School, as well as other types of assistance for the development and maintenance of high level education and research. As an immediate step, the Agency for International Development (AID) in Washington should be made aware of the importance of a proposal already submitted to it by AID in Buenos Aires regarding the Graduate School, the inter-American scope of which is of vital importance to the education of Argentine graduate students and agricultural investigators, as well as persons from neighboring countries who are admitted under the same conditions as university graduates in Argentina.

Second: It is recommended that the NAS lend its assistance in organizing programs for the training of Argentine students and researchers at the Ph.D. level in U.S. state universities in specific areas of importance to the development of agricultural technology.

Third: It is recommended that the CNICT and the NAS undertake as soon as possible the establishment of "joint committees," consisting of experts from both countries, to consider the following:

1. The planning and evaluation of research projects, academic and other types of activities of agricultural interest.
2. The exchange of scientific information in the area of agriculture, and
3. The sending of consultants for specific agricultural research projects; giving priority to the establishment of "joint study committees" for the following subjects:
 - a. Fertility, management and conservation of soils.
 - b. Pasture ecology.
 - c. Animal reproduction, genetics and nutrition.
4. Analysis of the above-mentioned problems in the Argentine papers presented by this working group, and their recommendations.

Fourth: It is recommended that the NAS, as one effective form of scientific and technical cooperation, which includes active exchange of Argentine and North American students, could promote this type of cooperation further within the framework of the International Biological Program.

Fifth: It is recommended that the CNICT ask the NAS to consider the possibility of forming a "joint study group" which would have the responsibility of elaborating and planning a "work guide," useful for the detection of factors that permit the relative weighing of research objectives, advisable criteria to be considered in the assignments of priorities to programs, projects, and work plans; a recommended index for the selection of research systems; fundamental parameters at the corresponding level of experimental methodology, and the means and variables (controlled or randomized) that must be considered "a priori" in the execution or in the results of agricultural research.

Sixth: It is recommended that the CNICT consider the creation of a permanent National Committee of representatives from Argentine agricultural research institutions. This Committee would be responsible for following through on the contacts and actions agreed upon at this meeting concerning scientific and technological research in this sector.

Closing Session, Friday, August 1, 1969

In the final session, the revised reports of all panels were discussed briefly and the recommendations adopted, with the understanding that measures would be taken to implement some of the cooperative programs suggested. Ambassador John Davis Lodge addressed the session during the early part of the afternoon. The text of his remarks, made in Spanish, are given below.

It is a privilege and a pleasure to participate in the closing session of this first Argentine-U.S. Workshop on Science and Technology in Economic Development.

I have not been fortunate to follow step by step the development of your work, but I am happy to congratulate you for having brought to the magnificent city of Mar del Plata this valuable and significant example of international cooperation.

I am firmly convinced that the exchange of our mutual knowledge and experience will permit us to soon find solutions to problems which affect the rate of economic and social development of our countries. It is a notable joint effort which you have just completed. I can appreciate it all the more because I have had my own experience in cooperative action.

When Governor of Connecticut and Chairman of the Conference of New England Governors, I proposed a regional program for the peaceful uses of atomic energy. As you know, the New England states, located in the northeast corner of the United States, find themselves far from the natural resources utilized to generate energy in my country. As a result, the application of electric energy for municipal and industrial use in the New England region had to depend over the years on non-conventional sources of energy. The regional program we developed permitted us to combine our resources. Today we can not only meet our present necessities but can also project satisfactorily those of the future.

Also, we have just seen the culmination of a gigantic joint effort - the successful mission of Apollo 11. There were many warm expressions for North American technology, but we should not forget that the majority of the world's free nations contributed their efforts and their resources toward development of this brave and fascinating adventure. This contribution is especially noted in the field of communications, a vital aspect in the conduct of the space

program. The tracking stations located along the world - among them those of Villa Dolores and Comodoro Rivadavia - were also valuable contributions to the success of this conquest which pertains to and benefits all humanity.

Almost as significant and amazing as the first trip around the moon was the fact that it occurred before the eyes of the majority of human beings. This was the consequence of technical cooperation which we are developing in the field of communications. Here in Argentina the efficiency of the earth station at Balcarce permitted television to register this historic moment.

In this context, I wish to express my firm belief in the new approach to bilateral cooperation represented by this meeting. Because here some of the best scientists of our countries are making joint efforts to find solutions to the problems which impede development. And these solutions will not only serve the needs of this great country but will also help guide others toward the road of progress.

Although I am not a scientist, I understand that topics such as the Maximum Utilization of Human Resources in the Development Process, Food Technology and the Exchange of Scientific Information are basic areas. Your knowledge, experience, and future vision have all been brought to bear at this meeting. Two sister countries will share the fruits of this sustained effort. This joint endeavor, ending today among representatives of science and technology of Argentina and the United States, is the best testimony of our countries' decision to advance rapidly toward solution of the problems which befall us.

Before concluding, I wish to pay warm homage to the illustrious researcher, Dr. Bernardo Houssay, Nobel winner in physiology and medicine.

The session adjourned at approximately 2:30 p.m. following which the group departed from the Gran Hotel Provincial at Mar del Plata to return to Buenos Aires.

DISCUSSION PAPERS PRESENTED AT ARGENTINE-U.S. WORKSHOP
ON SCIENCE AND TECHNOLOGY IN ECONOMIC DEVELOPMENT
July 28th - August 1st, 1969

Science in Argentina

The status of scientific research in Argentina from the point of view of organization, activities and resources, Raúl L. Cardón

The use of scientific resources for economic development: basic problems and issues, Julio H. G. Olivera

Scientific research and stochastic production functions, Julio H. G. Olivera

Use and management of scientific resources for economic development, Vanancio Deulofeu

Food Technology

Vegetable protein concentrates and dehydration, Pedro Cattáneo

Agricultural Research

Pasture Ecology in Arid-semiarid Zones, Jorge M. Brun

Report on the present situation of pasture ecology in the Entre Rios province, Ignacio O. Galli.

Animal nutrition (ruminants), Enrique A. Gil

Animal breeding in Argentina and its future, Guillermo E. Joandet

Some problems faced by agricultural research in the Argentine Republic, Angel Marzocca

Animal reproduction, Jorge E. B. Ostrowski

Conservation and management of soils in the Argentine Republic, Antonio J. Prego

Productivity of soils in the Argentine subtropical region, Manfredo A. L. Reichart

Semi-natural grasslands in the humid Pampa, Alberto Soriano

Principal fertility problems in the pampean region, Marino J. R.
Zaffanella

Scientific Information

Present situation of scientific information in Argentina, Roberto
Couture de Troismonts

Water Resources

A study of underground water in the Argentine Republic

APPENDIX II

Remarks by His Excellency, Dr. Alberto Taquini, Secretary of the National Council of Science and Technology, at the Opening Session of the Argentine - U.S. Workshop

In my capacity as Secretary of the National Council of Science and Technology, it is a great pleasure to say a few words at this meeting, attended by eminent American and Argentine scientists, which marks the beginning of a cooperative program among the National Academy of Sciences of the United States, the National Council of Scientific and Technical Research and the Academy of Sciences of our country, a program we hope will attain practical results and be highly advantageous.

An essential aspect of the scientific policy of a nation is obviously the identification of those areas that most urgently need support or promotion and a preferential allotment of resources, to obtain determined objectives. The criteria for selection can be variable, depending on the peculiar circumstances of each country and on the country's situation in the field of science and technology. Undoubtedly, in the particular case of Argentina, it is of maximum importance to evaluate the impact which the advances obtained in a determined field will have upon the economic and social development of the country as a whole, that is to say, the effect which those advances would produce once they are incorporated in productive activities, increasing their dynamism and efficiency, allowing for better use of natural resources, or the promotion of less-favored areas; leading to the creation of new opportunities and to a greater welfare for the population as a whole.

Starting from such a concept, the Secretariat of the National Council of Science and Technology has given priority to this job and has started a series of projects to get it done. This is one of the essential functions of the Office of Planning, which is part of the organizational structure of the Council. Through the systematic analysis that the aforementioned office has to make, in close cooperation with CONADE and in contact with the different Departments of State and responsible institutions, under the direct supervision and with the personal participation of the Secretary and his advisors, it is hoped that an integral view of the problem will be obtained and that a method will be established that will allow decisions with a base - as extensive as possible - of information and studies of the different aspects involved.

Notwithstanding this general analysis, and in consideration of the obviousness of some priorities and the urgent need to act in some areas

of vital importance for the country, the Secretariat has already formed special groups to examine these situations and to define certain lines for immediate action.

Thus, the interest with which the Secretariat has seen the formation of this Argentine-American workshop, and the pleasure it has had in sponsoring this meeting, will be easily understood. I am sure that at this meeting there will be many interesting debates which, with the double contribution of Argentine knowledge of the field and the already tested experience of the American participants, will produce conclusions that will be valuable judgment elements for the elaboration of plans for national scientific-technological development, which is the essential mission of the organization under my responsibility. Therefore, in due time, the Secretariat will consider said conclusions with due attention.

This seems to me a fitting opportunity to reflect briefly on international cooperation in the fields of science and technology. It is clear and without doubt that both have developed through, and in a great measure due to communication of new knowledge and programmed or spontaneous collaboration between scientists and institutions of different countries and continents. Argentina is a young nation in its history, and even younger in its scientific tradition. It is geographically situated far away from the great research centers, and therefore the human and material resources that have been applied to this activity have been comparatively limited.

On the other hand, Argentina urgently needs to intensify its scientific-technological development, and to use the powerful means which science and technology contribute as instruments for the transformation, modernization, growth and progress of all the different fields. Thus it is necessary for Argentina to have external cooperation coming both from international organizations or directly from more developed and richer nations. But, for that cooperation to be effective and productive and - I would even say - for it to be acceptable, it must answer the real requirements and needs of the country; and the establishment of those requirements and needs is solely and in the last instance the competence of the country. It is necessary that said cooperation should be well articulated in the activities and plans made by local scientific and technical organizations. Summarizing, it is necessary that said cooperation should be integrated with the national science policy and that it should contribute to the fulfillment of said policy.

The initiative of the National Academy of Sciences of the United States of America in promoting these working sessions with the National Council of Scientific and Technical Research and the Argentine Academy, whereby the identification of areas where science and technology may make a greater contribution to national development, and the possibility of greater cooperation between institutions and scientists of both countries, will be considered, can be particularly useful and productive if, as it

is expected, the discussions develop along the principles hereinbefore mentioned, and lead to effective action.

Allow me to express my conviction that this would not only benefit our country but at the same time will also comprise a valuable contribution to the more general aims of the United States to support and promote the development of Latin America as a whole.

I do not think that my national pride is deceiving me when I objectively believe, based on a series of indices of universal acceptance (national income "per capita," literacy degree, number of college students and professionals, industrial development, average life expectancy, etc.) that Argentina can categorically reject its being indiscriminately included among the underdeveloped countries, and that it can hold that it is now at an intermediate stage, which in more than one aspect places it nearer to the developed nations than to the others.

We can thus draw two conclusions: First, the help given us will have a surer and quicker effect and will accelerate the process of reaching a higher stage of development. Second, even more important, Argentina is ready to contribute to the advancement of other countries in the area, and will be more so as the process continues. Our universities already attract strong currents of students from different Latin American countries. The number of Latin American professionals, technicians, and researchers being trained in our more advanced centers is not small; nor is the number of Argentine scientists working in the teaching centers and scientific and technical institutions of our fellow Latin American nations.

We believe that this work can and should be considerably extended, and I anticipate that this will be one of the aims of Argentine scientific policy at an international level, the guidelines of which will be drawn by the Secretariat of the National Council of Science and Technology. For this reason, the effects of the help we receive, as it increases our possibilities, will be felt beyond our frontiers, and will contribute to the achievement of the aim with which we all feel identified: the complete economic, social, and cultural development of Latin America as a whole.

As Secretary of the organization that is responsible for the elaboration of a national science policy, I have wanted to express the value and the great significance I place upon this meeting. It takes place under particularly auspicious circumstances. Truly, the transcendental achievement of the Apollo 11, and the arrival of man on the moon, is a magnificent testimony of man's capacity, of what his intelligence and energy can do, and of the inexhaustible possibilities of his two great creations: science and technology.

As a member of the Government of the Republic of Argentina, and as a man of science, I wish to take advantage of this opportunity to pay homage to the American scientists and engineers through whose capacity, organization, and effort this achievement has been possible.

In the same capacity, and also as a member of the human family, which today struggles between fear and hope, allow me to express the hope that these manifest possibilities for scientific and technological progress will really serve toward the construction of a better world for all men. For that, it is only necessary that moral progress should equal the progress achieved in technological and scientific fields, and that mankind should find a way to apply reason to arrange its coexistence with the same success it has had when applied to the conquest of space.

I trust that such spirit and hope will preside at these meetings.

APPENDIX III

Statement by Dr. Harrison Brown at Opening Session of the
Argentine-U.S. Workshop, Mar del Plata, July 28 - August 1, 1969

Thank you very much President Houssay, President Galloni, Dr. Taquini, Dr. Deulofeu and members of the meeting. It is indeed a momentous occasion for my colleagues from the United States and me to be here with our colleagues from Argentina to discuss ways and means by which we can undertake meaningful cooperative efforts. I have long been an admirer of your country, of its enormous potential, and of its scientific accomplishments. I am reminded of the three Latin American members of our National Academy of Sciences, two of whom are from Argentina - Dr. Houssay and Dr. Leloir.

I am happy that Dr. Taquiné brought up the accomplishments of Apollo 11. It is, I believe, a vivid demonstration of what can be accomplished when our scientific and technological genius are mobilized effectively. I believe it is a demonstration that we could, if we wished, mobilize that same genius in North and South America to solve the problems which exist in both of our continents. I believe that all of us recognize that scientific and technological developments today have made deprivation, poverty, malnutrition, the scourges of the world, really intolerable and unnecessary.

We are gathered here with a common deep concern as to the need for more rapid development of Latin America, and in the belief that the community of scientists and engineers has an important and indeed critical role to play in that development. Most of us recognize that the problem of the economic development of countries today is enormously complex, requiring a multiplicity of actions. Agriculture must be modernized, roads must be built, distribution systems established, resources surveyed and analyzed, factories designed and built, schools and universities built, teachers trained, health services established, and social and political institutions modified throughout the entire continent. Throughout the process, leaders are called upon to make a diversity of complex and difficult decisions. All too often they lack the combination of wisdom and knowledge which is necessary if the correct decisions are to be made. Frequently the required knowledge itself is simply not available. An economy based upon technology must be backed up by a substantial competence for solving problems covering a broad spectrum of disciplines ranging from management to economics to engineering and science. This competence is necessary if solutions to the development problems are to be obtained as they arise. All too many development plans either ignore or give low priority to this need. The creation of a local problem-solving competence really means the creation of an ability to under-

take research and development. It means creating cadres of engineers, scientists, economists and the like who can apply their talents to development problems. It means creating the institutions which will enable the scientists and engineers to work effectively and to translate their findings into action. We are here today to discuss the role of those institutions in the world generally and in Argentina specifically. We are here to discuss further how the scientists and engineers of our two countries can work together to achieve these goals.

APPENDIX IV

USE AND MANAGEMENT OF SCIENTIFIC RESOURCES
FOR ECONOMIC DEVELOPMENT

by
Venancio Deulofeu

Determining the more efficient ways of utilizing scientific and technological advances for the progress of nations is today a problem strongly related to the creative process leading to the advancement of science itself.

There is a public consensus that the proper use of scientific and technological progress is one of the important factors which can help achieve an increase in the Gross National Product (GNP) of a developing country, and thus increase the resources to finance education, research and development, health services, pensions, etc.

The subject is so important that working groups devoted to its study have been created at the international and national level. At the highest international level is the United Nations Committee on the Application of Science and Technology to Development, which advises the Economic and Social Council. As a private body, we have the Committee on Science and Technology in Developing Countries (COSTED) under the chairmanship of Lord Blackett, created in 1966 by the International Council of Scientific Unions (ICSU) to encourage science and technology in developing countries.

It was on the advice of the Economic and Social Council of the United Nations that the Conference on the Application of Science and Technology to the benefit of the less developed regions was organized and held in Geneva in February 1963. It is interesting to note that the Conference was asked to avoid purely academic discussions, and to consider practical means and ways to use the advances in science and technology in the less-developed regions. I hope that in our workshop similar criteria will be applied.

During the six years following the meeting of the UN Conference, a large amount of time and work has been devoted to the study of ways to use technological advances for the progress of nations. Although many of these studies have been concerned with the use of scientific and technical resources to help the progress of developing countries, some of them deal with cases of developed ones.

The realization that a technological gap exists between two highly developed areas, like U.S.A. and Western Europe, has produced real concern

to governments and individuals. In Western Europe we find countries which, by the usual standards, devote a high percent of their GNP to research and development, where fundamental scientific discoveries have been made, discoveries which have fostered the advance of science and technology all over the world; but their economies have not improved in relation to this expenditure.

Several hypotheses have been postulated to explain the technological gap: the widespread education in the U.S.A., which makes its population more receptive to technological change, the higher managerial capacity of American industrial leaders, etc. The technological gap has also become an "acceptation" or a "market gap," and the word innovation has been coined, and is more or less an indication of where the "gap" is found. We have even an official definition of it: Innovation means the technical, industrial and commercial steps, which lead to the marketing of new manufactured products and the commercial use of new technical process and equipment.

The technology that a country needs can be bought from abroad or produced at home, but until its application leads to the production of goods which can be used in the country or exported, it will not have an impact in the GNP.

This is an important point. A country can spend money on research and development, but if it lacks the capacity to make use of the results obtained, to improve production or to produce new goods, no return will be obtained from the money invested.

It is evident that the men who are responsible for the introduction of new technologies in a developing country must also have a good knowledge not only of its industrial condition but also of its economical and social situation, because only if all the steps in the innovation process can be met, will the new technology produce a return for the efforts invested, in whichever way they are measured.

The more we know about the best ways to use the process of transference of new technologies, the easier it will be for developing countries to employ them in order to make a rational use of their natural resources.

This is one of the reasons why we believe this workshop is of importance. The simple introduction or creation of new technologies is not a guarantee of economical success in terms of raising living standards.

In the case of complex and advanced technologies, the innovative steps usually require more human and material resources than the initial stages of research and development. This is a very important aspect for a developing country, because its economy will not support repeated failures; and this workshop will be very useful and even important if it can clarify some of the problems mentioned.

The Use of Scientific Resources for Economic
Development: Basic Problems and Issues

by

J. H. G. Olivera

Since this paper is to be used as a document for discussion, our main concern will be, as the subtitle indicates, to identify and present in an orderly fashion the various questions which arise on the subject matter. Most of these questions have been posed, at one time or another, in the already abundant literature on the economics of invention and the effects of technical change. Our endeavor here will be to integrate these issues and problems into an appropriate framework. We shall concentrate on questions which have practical significance, leaving aside purely academic points. Further, chiefly to stimulate discussion, we shall venture to suggest in each case the direction in which, in our opinion, the solution is likely to be found.

Let us start off by making clear the meaning we shall attach to some terms.

Definitions

1. Economic growth is the increase over time of the actual output of a given economy.
2. Economic development is the increase over time of the ratio between the actual output and the potential output of a given economy.¹
3. Research capital is the stock of resources, both human and material, available for immediate use in scientific research in a given society.²
4. Research output is the flow of new scientific information resulting from the research activity in a given society.

Let me briefly comment on these definitions. There is no complete uniformity among economic writers in their way of distinguishing--when they do distinguish at all--between economic growth and economic development. This is surely, to a large degree, only a matter of convention. I have proposed the foregoing notions, partly because they seem to be implicit in much of the technical usage of these terms, partly because the distinction between the actual and the potential performance of an economy is at the root of the problems we are about to consider.

As to the concepts of research capital and research output, let it be observed that they specify the somewhat ambiguous idea of "scientific resources" alluded to in the title. Hence our quaesitum subdivides into two: (1) the use of research capital, including human capital (scientific personnel) and material capital, (2) the use of research output. These categories also describe two successive stages in the process wherewith we are concerned. There exists in addition a previous stage, the formation of research capital; but it mainly falls out of the limits of our present subject, except in so far as it represents an alternative use of the stock of scientific resources.

Alternative Uses of Research Capital

Research is not the only activity in which research capital (in particular, human-research capital) can be employed. There are other occupations which compete for the scientific resources of society. Among them, the one closest to research is education, whose importance for economic and social development is not inferior to that of scientific research. It may be noted that education and research are in part substitutes, in part complements in respect of each other:

1. The time that scientists devote to teaching is subtracted from their own research and vice versa;
2. Research gives a deeper insight into the subject investigated, and thus indirectly benefits the quality of teaching; reciprocally, the activity of teaching may cause the researcher to become more aware of points needing further scientific elaboration.

The relative weight of complementarity as compared with substitution is by no means invariant; it depends largely on organization. Although the efficient organization of scientific activity is a subject matter by itself, it seems clear that the opportunity of "maximizing" the points of complementarity between education and scientific research is greatest at the universities.³ This is no other, of course, than the Humboldt principle of "Einheit der Forschung und Lehre." But it is doubtful (to say the least) that there be any actual tendency in the present-day world to concentrate the effort of scientific research in the universities; and, moreover, the principle just mentioned is one of those which is in crisis in the generalized crisis of the modern university system.

Expansion of knowledge and transmission of knowledge do not exhaust the possible use of scientific manpower: the practical application of knowledge is an alternative which, in certain branches of activity, vies intensely against the academic employment of research capital. The resources which are absorbed into these merely applicative occupations are certainly lost to scientific development; but they are not per se lost from the viewpoint of economic development, which demands

increasing supplies of scientifically trained technicians. So, once again, the problem is one of finding an adequate balance of alternative uses. This leads us to the next question.

The "Invisible Hand"

To what extent is the use of research capital determined by supply and demand forces--i.e., by the "invisible hand" of the market, in the famous expression of Adam Smith? And to what extent are the market forces capable of spontaneously generating a socially optimal use of research capital? These are difficult technical questions, on which a considerable amount of dogmatism seems to have been heaping up.

As to the first point, the affirmative answer is tautologically true respecting the research activities undertaken by firms for profit. But even with regard to scientific research effected by public and private agencies for purposes other than pecuniary profit (the so-called non-profit research) the influence of demand and supply factors is often noticeable; for example, the influence of availability of scientific skills in a certain branch of research, or the possible application of the results of research to the solution of current problems affecting the local environment of the scientist. Moreover, it has been shown that response to demand and supply conditions explains some "allocative puzzles" relating to non-profit research.⁴

The second point--which should be clearly distinguished from the first--is whether the operation of supply and demand can be relied upon by itself to procure the socially optimal allocation of research capital. This point, however, is open to some misunderstanding. If we are to interpret the question literally, then the answer is negative in a trivial way. The markets we encounter in real economic life do not possess the idealized structure characteristic of what is technically called "perfect competition," which ensures that the free action of supply and demand will conduce to the social optimum. So the invisible hand--the actual, as distinct from the notional--is unable to produce the right amount of research in the same sense, and for identical reasons, that it fails to provide the right output of pins. But these generic aspects concerning the working of the market mechanisms do not greatly concern us here. The question which really matters in the present context is whether there are differential grounds, specific to the type of activity under consideration, that cause market forces to deviate from the social optimum in a degree larger than normal.

The answer is affirmative, due chiefly to the two following facts:

1. The presence of what are usually denoted, in technical parlance, as external economies, i.e., cost reductions in other sectors determined by a greater output of the product dealt with, irrespective of any decrease of its price. In the case of scientific research these

economies are "forward" (in the form of technological advances in the production of material goods) as well as "backward" (benefiting the formation of new scientists). Thus the private profit directly accruing from research activity is far inferior to the total social gains derived therefrom.

2. The existence of what may be described as output uncertainty, in the sense that the result of the research effort can never be anticipated with precision. There is a large difference, in this respect, between the activity under consideration and the ordinary production process, where the relation of the quantity of output to the quantities of productive inputs is closely predictable. (We explore the phenomenon of uncertain output--an important but neglected subject--in another paper.⁵ In it we note that the aversion to risk must enervate the effects of profit incentives somewhat, and thus by itself induce some tendency to underinvestment in the research sector.)

In short, not only can the spontaneous functioning of the market mechanisms not be expected to stimulate the socially optimum amount of scientific research, but they are likely to create a specific bias towards a sub-optimum amount of research activity. This proposition is the main contribution made hitherto by economic analysis to this field. It is not a very involved theorem, but it is one with strong practical implications. And there is a general consensus of scholarship about it.⁶

The Optimal Research-Mix

The problem of the overall amount of scientific research is not, however, the only problem of resource allocation which must be faced here. There is the further question of the distribution of the total research capital among the various branches and types of research. Apart from the variety of scientific disciplines, there are a number of general alternatives:

1. Pure v. applied research, a vexata quaestio of scientific-research policy;
2. production-research v. consumption-research, meaning research with economic value, and research with only cultural significance, respectively;
3. creative research v. adaptive research, the latter differing from the former in that it aims solely at making some previous technological invention fit into a diverse environment;
4. "big" research v. "little" research--the counterpart of the distinction between "big" science and "little" science⁷--the first being chiefly characterized (in contrast to the second) by the presence of high equipment costs.

The list could be made longer, but these are the more meaningful categories which define the research allocation problem. There is no sharp line of demarcation between such categories--witness the difficulty of separating "basic" from "applied" science in many fields--rather each type shades off gradually into the other. Yet these distinctions describe real options in the use of the available research capital of society. It is by no means obvious how the total research effort should be distributed among the different types and branches of research in a socially optimum fashion.

It is only natural to ask whether the "invisible hand" of market forces could not yield this optimum, or a tolerable approximation to it. This possibility, let it be noted, is not excluded as such by the previous conclusion that the market cannot be trusted to lead to the optimum amount of research. Even if it is incapable of giving the right scale to the research process, it can perhaps give it the right internal proportions--the right "structure", to employ an overworked but expressive term. If this were so, the allocation problem would consist mainly in manipulating the general incentives so that the appropriate total of research is reached, leaving to the market itself the task of distributing this total among the various alternatives.

Even on this point, however, the autonomous working of the market should not be expected to furnish a reliable guide to the allocative optimum. A little reasoning suffices to show this. In the first place, the external economies to which we alluded previously are not a result which the various forms of research produce in the same measure. They differ widely in intensity from one type of research process to another. The extreme case (though not, indeed, the only one) is what we have described as consumption-research, where the forward external economies are wholly absent. Moreover, within the same type of research activity, the generation of external economies differs substantially among the different sciences and directions of scientific work.

Much the same occurs with output uncertainty, the second factor of distortion mentioned above. In all fields and manners of research the product of the scientific effort is more or less unpredictable; but in some of them this only means that the precise result cannot be foretold exactly, whilst in others it may even be impossible to say in advance whether a new result will be obtained at all. The more ambitious and original a research project--the greater the degree in which it breaks away from trodden paths--the larger the coefficient of uncertainty it contains is bound to be.

In such circumstances, the market must show up poorly as an allocator of resources. It will tend to cause a relative over-expansion of forms of research with the weakest external benefits and the least uncertainty of output. It will discriminate systematically against some highly valuable types of scientific venture. Thus, if the market is

left to its own drive, it must bring about an unbalanced distribution of research activity. The extent of disequilibrium cannot be established a priori; it depends on the specific features of the various possible allocations, as well as on those of the society concerned--for instance, on the degree of risk aversion prevailing in the economy.

The Visible Hand

It is one thing, however, to demonstrate that the market does not lead up to the research optimum, and quite another to devise a way of replacing or supplementing the market so that the optimum can be reached. The planning of scientific research is still in a pre-scientific situation; it is a set of problems, rather than a method rationally elaborated and based on well-attested facts. Let us succinctly enumerate some of these problems:

1. What is the optimal amount of research in any given society and time? What is the relation between the quantity of research and the rate of economic development? What are the precise links and "trade-offs" between economic development and other social goals to which the progress of science may contribute? And what is the measure of the "total" amount of research?⁸

2. What is, in any given society and period, the optimal composition of aggregate research? What is the relative contribution of the various forms and fields of scientific effort to the social goals? What are the relative costs in terms of required inputs and foregone alternatives? How far may short-run considerations in determining the allocation optimum impair long-run possibilities?

3. Supposing we have the answers to the above question, by what means should the proper amount and pattern of research be procured? Should it be promoted through direct action, via state universities and research institutes, or indirectly, by regulating the economic incentives which guide private activity? In the latter case, should we prefer the use of subsidies or tax provisions?

4. Is centralized or decentralized planning the more efficient procedure in regard to research? Moreover, should planning in this field attempt a detailed coordination of the scientific effort, or instead limit itself to pursuing some broadly defined strategy? And, furthermore, what is the appropriate relation that the planning of research should bear to other, partially overlapping forms of economic and social regulation?

The stock of scientific knowledge accumulated about these matters to date is distressingly small. True, some of them depend rather on Weltanschauung than on positive information--like those concerning the freedom of research. But others are of a purely technical character,

and of a level of difficulty that rules out the recourse to intuitive methods. This lack of rational criteria may not be without serious consequences. The "visible hand" of the state, if misguided, may cause graver distortions than the "invisible hand" of market forces. The following quotation suggests that this is not a mere hypothetical possibility:

"The massive influx of federal research funds into the universities clearly has posed some difficult adjustment problems, and raised subtle questions about supporting science in ways that are consistent with the integrity of the scientific enterprise. . . A general concern is frequently voiced that Congress and the public are being led to think of science in terms of spectacular results like a moon landing or cancer cure. Consequently, there is an understandable anxiety that major imbalances in our scientific effort may result and that the massive ventures may drain off a disproportionately large share of the nation's scientific and technological talent."⁹

But we must not overstate the case. The risk that public action in the sphere of research may bring about disequilibria is no ground to desist from it, and thus to accept the certainty of disequilibrium through the unrestricted operation of the market process. The proper inference from the preceding argument is (we submit) that the planning of scientific research and the intervention of the state in this area should be consciously adapted to the narrow base of objective truth on which, at least for the time being, it must rest. Therefore, rather than attempting to direct the allocation process in all its different aspects, the state should endeavor to recognize and redress the major imbalances, and to attract unemployed scientific resources to points where a concentrated effort of research is clearly justified. We may describe this as selective planning, in distinction to comprehensive planning, which of course requires a more advanced stage of knowledge and elaboration of technique. The main assumption underlying the selective method is that, although at present it be impossible to locate the social research-optimum, it is nonetheless feasible, in most cases, to identify research "bottlenecks" and thus to promote efficient action for the purpose of avoiding or removing them.

The Underdeveloped Economy

Up to here our discussion has run in fairly general terms, leaving aside, in particular, the somewhat simpliste and usually overstrained dichotomy between "developed" and "underdeveloped" countries. But we have come to a point where some such distinction, if soberly interpreted, may be of use. Let me describe the problem as follows.

Empirical studies in international trade have revealed that the high-income or developed countries have a comparative advantage, as indicated by the actual composition of their exports, in goods whose production reflects intensively the employment of professional skills-- especially scientists and engineers. By the same token, to the contrary, the lower income or underdeveloped countries are at a comparative disadvantage with respect to such goods. It follows, then, from the elementary notions of standard trade-theory, that the former group of countries has a relative abundance, whilst the latter has a relative scarcity, of scientific personnel. This, by itself, is quite a credible inference, but one which, as will be seen immediately, poses a number of difficult and disturbing questions.

From a theoretical standpoint, the case might be construed as suggesting that the underdeveloped countries had better give up scientific research completely. Research is just one line of production. And conventional international trade theory, at least in its more rudimentary forms, implies that maximization of worldwide welfare requires each country to specialize in those products which are intensive in its relatively more abundant resources. Therefore, assuming that scientists represent a comparatively scarce production factor in underdeveloped countries, it is not a large step to deduce that their efforts in the research field are a mere waste of resources. I do not know that any one has advocated this view; but a slightly mitigated version of it, to the effect that the less developed countries should devote their scientific labor-force mostly to education and applied research, was recently advanced by a distinguished authority.¹⁰

It is, however, to place too heavy a burden on the "factor proportions" theory of trade to use it in support of such exclusivist policy conclusions. Though this is not the place for embarking on an argument about international economics, it must be remembered that the factor-proportions model of trade is essentially stationary in character, and therefore not per se well-suited to furnish criteria for economic development. Moreover, as we show elsewhere,¹¹ the fact that the output of research is uncertain affects the structural features of the production function, causing it to diverge from the properties upon which the "factor proportions" schema is founded.

There are general reasons to believe that achieving a vigorous rate of scientific activity is an inseparable part of the transformation of a backward into a modern economy. A strong mutual complementarity exists between advanced technology, scientific education and scientific research. The latter two obviously go together; and without them it is unlikely that modern industrial techniques, and the tempo of technological change, can become fully acclimatized in any country. Such complementarity surpasses the limits of mere "adaptive" research. It calls for an integrated scientific effort, of as great a scope and as high a quality as the resource-base permits.

An additional side to this question presents itself in the case of developing countries affected by the so-called "brain drain." We shall not stop here to set down the various causes of this phenomenon, which are neither simple nor uniform.¹² But sometimes it undoubtedly reflects an insufficiency in the demand for scientific skills in the country of origin. That is to say, despite the relative scarcity mentioned above, there is an absolute surplus of scientific labor-force which induces the emigration of part of it. Whenever such is the case, the complete and efficient employment of the domestic supply of scientific personnel must be a primary consideration, both for economic development and for shorter-run goals, in evaluating the optimal amount and composition of research.

The Productive Use of Research Output

We come now to our final topic, namely, the use of the results of science in the production of other goods. Let us first recall to mind some basic points:

1. There is no mechanical relation between technological change and economic growth. The improvement of technology increases the joint productivity of the factors, but this does not necessarily mean a corresponding rise in the quantity of product. If the market does not expand, the result may be a reduction in the amount of factors employed.

2. There is no mechanical relation between changes in factor productivity and technological change. Although the latter certainly implies productivity increases, the converse is not true. Mere variations of employment, organizational changes, and institutional alterations may cause wide differences in the productivity of the factors. Accordingly, the effect of technological advance may be counteracted by a deterioration in the institutional efficiency of the economy, for example.

3. There is no mechanical relation between research output and technological change--i.e., to use a distinction now widely accepted, between "inventions" and "innovations." The practical use of new technical procedures depends on other people and responds to other considerations than the activity from which the new methods stem. Inventions enhance potential output; it is only when they give rise to innovations that actual output can follow suit.

In our enthusiasm for scientific progress, we sometimes talk as if there existed a predictable short-period correlation between research and growth. Yet there is no basis for such presumption. Apart from the phenomenon of output uncertainty examined previously, the distance which separates invention from actual economic growth is by no means negligible, and the road may be quite up-hill. An empirical investigation for twelve countries from 1950 to 1960 gave the result that

"there is no correlation between the rates of growth of output and research outlays during the period studied."¹³ It can hardly be questioned that this is the general case. If, in the fairly long chain connecting research to actual growth, we concentrate attention on the link between invention and innovation, there are several possible obstacles which may hinder the effective or prompt use of the fruits of research in the productive process:

1. First of all, the dimension of the market. Many types of invention (certainly most of the modern ones) not only shift the cost of production curve, but also increase the quantity of output at which the curve attains its minimum. It may be that for small rates of output the old technique be more economical than the new.

2. The high capital cost of some innovations may considerably diminish the rate of adoption. There is strong empirical evidence in this respect.¹⁴ Technological change is frequently "embodied" in costly capital equipment; the higher the purchase price, the more difficult may be the financing of the necessary investment. This consideration is particularly relevant in countries with small or inadequately organized capital markets.

3. The existence of monopoly is another influence to be reckoned with. The introduction of technical improvements often involves the replacement of existing capital goods by new equipment. A monopolist will have no incentive to take this step until it brings him a net profit, that is, until the moment when the non-depreciated value of the old equipment is more than offset by the total economies expected from the new one. Under competitive conditions, the diffusion of new techniques depends only on their effect upon production costs.

The last obstacle, however, is one to which different writers attach different degrees of stress. Some point out that large corporations can afford large laboratories, which in turn are generally more successful than small laboratories as centers of technological invention. Yet empirical studies made to date present conflicting evidence on this matter.¹⁵ At any rate, the effects of dimension should be kept distinct from those of monopoly--we would lose sight of some of the more characteristic features of the contemporary economic organization if we confused them.

We must not close without noting that the factors just discussed are only a subset of the relevant influences. There is always a risk, in these matters, that the range of vision be not broad enough to encompass the process in its true complexity. Like every vital phenomenon, economic growth results from an interplay of stimuli and responses. Differences in economic growth--and, a fortiori, in economic development--may result not only from differences in the stimuli acting on different economies, but also from disparities in their responsiveness to given stimuli.

In turn, the responsiveness of an economy to the opportunities and incitements to grow is a reflection of the entire institutional setting. Market structures, legal relations, social attitudes towards change, all contribute to determine the amplitude, character, and promptness of response. It is in this wide perspective, and not as a rigid chain of causation, that the influence of an expanding scientific horizon upon economic development ought to be viewed.

The function of public policy in the problem on hand emerges clearly. Something can doubtless be achieved through specific action, by measures designed to promote the incorporation of new technologies in production at a more rapid pace. For example, extension services may prove useful for this purpose, particularly in the form of technical assistance to small and medium-sized production units.¹⁶ On the whole, however, not much can be expected from such serviceable but short-ranged policies. For the reasons just given, this is a matter in which the more general characteristics of the economic structure play the decisive role.

Attachment

The purpose of this attachment is to supply some quantitative information on the subject with reference to Argentina.

1. From the viewpoint of its foreign trade, the Argentine economy presents a pattern which is usually characteristic of under-development. Primary products account for 60 percent of its total exports, whereas its imports are chiefly of manufactured and intermediate products. The situation varies radically, however, from the standpoint of the internal economic structure. The primary sector represents only 14 percent of the domestic gross national product, whilst manufacturing industries constitute 28 percent of the said aggregate.

2. Also the human resource development of the country exhibits contradictory features. Under a well-known four-level classification¹⁷ of 75 countries on the basis of a comprehensive number of indices, the Argentine appears among the 16 countries in the highest level group. But with respect to the distribution of the university population among the various careers she differs widely from the other members of the same group, and is closer to countries with a lesser degree of human resource development.

3. The existing data on research expenditures, though far from complete, afford some indication of their relative magnitude. On the basis of detailed information concerning the universities and research institutions, it has been calculated that in the years 1961-66 the research expenditures amounted to about 0.3 of the gross domestic product.¹⁸ Another authoritative estimate¹⁹ places the figure at 0.2 of the same total. Those results are in harmony with proportions found, e.g., for Greece and Spain;²⁰ they exceed those prevailing in under-developed countries, but fall short of the ratios (generally in the range from 1 to 3 percent of the national product) characteristic of advanced countries. Yet it is difficult to establish how far the difference in ratios represents merely the consequence of different price and wage structures. It is worth adding that the central administration's expenditure on research and science promotion for 1968 has been estimated at 2.7 percent of its total budget.²¹

4. A number of investigations have been carried out in the last years on the contribution of technological progress to the economic growth of the country. The results are summarized in the accompanying table. As might be expected, the findings are very sensitive with respect to period, sector and type of function used. For the total economy, however, these studies indicate unambiguously that the over-all rate of technological advance has been slow. The negative rates mean that in some periods the real national product failed even to keep pace, on average, with the increase in the quantities of production factors. This seems to be due, particularly during the Sixties, to an insufficient expansion of aggregate real demand for the domestic product.

<u>Researcher</u>	<u>Period</u>	<u>Sector</u>	<u>Function Type</u>	<u>Annual Rate of Technological Progress (%)</u>	<u>Multiple Correlation Coefficient</u>
H. Aldabe	47-61	Manufactures, Minery and Building	Cobb-Douglas Exponential time trend	6.2	0.62
	47-52			0	
	53-59			3.5	
	60-61			4.7	
J. Katz	46-54	Manufacturing industry	CES	0.6	0.70
	55-61			4.7	0.75
	46-61			2.4	0.80
R. Lamdany	35-63	Total economy	Cobb-Douglas	1	0.99
	50-63			-0.05	0.97
L. Montuschi	48-62	Total economy	CES	2.3	0.70
	50-63			2.4	0.94
M. E. Sanjurjo	35-61	Total economy	Cobb-Douglas	-0.3	0.98
	35-61			0.2	0.99
	35-61			-2.3	0.99
	35-61			-2.9	0.99
	35-40/47-61			-3.6	0.99

- 64 -

REFERENCES:

- H. Aldabe, "Ensayo de Establecimiento de una Función de Producción," Revista Desarrollo Económico, Vol. 5, No. 17-18-19, Tomo II, 1965.
- J. Katz, "Una Interpretación de Largo Plazo del Crecimiento Industrial Argentino," Centro de Investigaciones Económicas, Instituto Torcuato Di Tella, Buenos Aires, 1968.
- R. Lamdany, "Productividad e Incremento de los Factores: Argentina 1935-63," Instituto de Investigaciones Económicas, Facultad de Ciencias Económicas, Universidad de Buenos Aires, 1968.
- L. Montuschi, "Sustitución de Factores, Precios Relativos y Distribución del Ingreso: Argentina 1935-63," Instituto de Investigaciones Económicas, Facultad de Ciencias Económicas, Universidad de Buenos Aires, 1966.
- M. E. Sanjurjo, "Economías de Escala y Cambio Tecnológico: Argentina 1935-61," Centro de Investigaciones Económicas, Instituto Torcuato Di Tella, Buenos Aires, 1968.

NOTES

1. For a detailed analysis we may perhaps be allowed to refer to our previous work "Crecimiento, Desarrollo, Progreso, Evolución: Nota sobre relaciones entre conceptos." El Trimestre Económico, México, July-September 1959, pp. 410-22. In his paper "Main Problems of Long Term Science Planning in Latin America," UNESCO, Second Meeting of Directors of the Councils for Science Policy and Research of the Latin American Member States, Caracas, 10-17 December 1968, Professor Alberto C. Taquini shows that a symmetrical set of concepts can be used with reference to scientific advance.
2. The qualification "for immediate use" is necessary in view of the shiftability of resources among different activities.
3. We have studied the various aspects of the university as a production unit in our paper "Die Universität als Produktionseinheit," Weltwirtschaftliches Archiv, vol. 98, 1967, fasc. 1, pp. 50-64.
4. T. W. Schultz, The Allocation of Resources to Research (mimeographed paper), Centro de Investigaciones Económicas, Instituto Di Tella, Buenos Aires, March 1969, pp. 13-33.
5. J. H. G. Olivera, Scientific Research and Stochastic Production Functions, annexed to the present paper.
6. See, especially, R. R. Nelson "The Simple Economics of Basic Scientific Research," Journal of Political Economy, 1959, pp. 297-306; and K. J. Arrow "Economic Welfare and the Allocation of Resources for Invention," in The Rate and Direction of Inventive Activity: Economic and Social Factors, A Conference of the Universities-National Bureau Committee for Economic Research and the Committee on Economic Growth of the Social Science Research Council, Princeton, 1962, pp. 609-24.
7. D. Price, Little Science, Big Science, New York, 1963; H. Brooks, "Future Needs for the Support of Basic Research," in Basic Research and National Goals, National Academy of Sciences, Report to the Committee on Science and Astronautics, U.S. House of Representatives, March 1965, pp. 80-81.
8. This "Gretchenfrage" has not up to now received a satisfactory answer, and it is doubtful if it will ever get one. The various possible methods and their shortcomings are discussed by S. Kuznets "Inventive Activity: Problems of Definition and Measurement" and B. S. Sanders "Some Difficulties in Measuring Inventive Activity" in The Rate and Direction of Inventive Activity: Economic and Social Factors, cit., pp. 19-90, with comments by J. Schmookler,

- S.C. Gilfillan and H.I. Liebling. See also G. A. Lakhtin, "Operational Research Methods in the Management of Scientific Research," Minerva, Summer 1968, pp. 524-40, esp. 529-31.
9. B.L.R. Smith, The Concept of Scientific Choice: A Brief Review of the Literature, The Rand Corporation, June 1965, p. 36.
 10. R.S. Eckaus, "Notes on Invention and Innovation in Less Developed Countries," American Economic Review, Papers and Proceedings, May 1966, p. 108.
 11. Scientific Research and Stochastic Production Functions, annexed to this paper.
 12. See the various contributions included in W. Adams (ed.), The Brain Drain, New York, 1968.
 13. Economic Commission for Europe, United Nations, Some Factors in Economic Growth in Europe During the 1950's, 1964, ch. 5, p. 7.
 14. E. Mansfield, "Technical Change and the Rate of Imitation," Econometrica, October 1961.
 15. In his paper "The Origins of the Basic Inventions Underlying Du Pont's Major Product and Process Innovations," W.F. Mueller shows that a small part of Du Pont's major innovations derived from their own laboratories (The Rate and Direction of Inventive Activity cit. pp. 323-58).
 16. A possible and interesting form of doing this is by means of a programme to support the technical extension services of the universities. This method of action was adopted in the United States by the State Technical Services Act of 1965 (Public law 182, 89 Cong. 1 sess.). For a discussion of this topic, v. R.R. Nelson, M.J. Peck and E.D. Kalachek, Technology, Economic Growth and Public Policy, Washington, 1967, pp. 204-9.
 17. F. Harbison and Ch. A. Myers, Education, Manpower and Economic Growth, New York, 1964, ch. 3, esp. p. 48.
 18. H. Arce, P. Skupch, C. Pozzo, Una Estimación de los Gastos de Investigación y del Número de Investigadores en la República Argentina, Institute de Investigaciones Económicas, Facultad de Ciencias Económicas, Buenos Aires, 1968, p. 12.
 19. A. Aráoz, "Investigación y Desarrollo Industrial en la Argentina," Estudios sobre la Economía Argentina, November 1968, pp. 1-20.

20. Organisation for Economic Cooperation and Development, Science Policy and Development, Paris, November 1968, p. 129.
21. R. L. Cardón, Situación de la Investigación Científica en la Argentina desde el punto de vista de la Organización, Actividades y Recursos, Consejo Nacional de Investigaciones Científicas y Técnicas, document presented at the Second Meeting of Directors of the Councils for Science Policy and Research of the Latin American Member States, Caracas, October 1968. p. 47.

PRESENT SITUATION OF SCIENTIFIC INFORMATION

IN ARGENTINA

by

Roberto Couture de Troismonts

Origin of the information

Mostly coming from abroad, in conventional ways--originals or reproductions.

Originated in the country. More difficult to locate because of the lack of works and reference material:

- a. Absence of current national up-to-date Argentine bibliography.
- b. Scarcity of current scientific Argentine bibliographies. 1,2,5
- c. Compiled works or works in process of compilation, but not yet published (Argentine medical bibliography gathered by the Faculty of Medicine of the University of Buenos Aires).
- d. Research in progress. The University of Buenos Aires has arranged that the Bibliographic Institute maintain a record of all research carried out within the scope of the University. The Institute is to publish the details of these investigations annually. 3

Libraries and information-gathering documentation centers

The dissemination and retention of material destined for scientific research coincides with that of the centers of investigation existing in the country. 4

Universities

Fifty-five percent 4 of the researchers of the country work within the university domain; thus the most important current information is found in university libraries.

Central Libraries. They exist in most universities although there is no centralization of scientific information. The University of La Plata is operating a new library system through its central library.

Libraries from the Faculties. The specialized bibliographic material is mainly located in the faculty libraries. However, it must

be pointed out that these libraries primarily meet the needs of the teaching staff and are not able to devote themselves to the search for bibliographies or documentation, for various reasons (lack of specialized personnel, proper material, installations, etc.).

A great number of libraries of this kind can be estimated on the basis of existing careers. ⁶

Libraries in institutes, laboratories, and a good number of departments are devoted to research.

Institute Libraries depending on the University. There is a certain number of this type, among them those of the Natural History Museum, the Astronomic Observatory at the National University of La Plata, the Medical Research Institutes, the Oncology Institute "Angel Roffo" of the University of Buenos Aires, and the "Lillo" Institute of the University of Tucumán.

Documentation Centers. The Main Library of the National University of Córdoba started its Documentation Center in 1961. The Southern National University maintains an important bibliographic documentation center.

The National University of La Plata has just created a Center which will be opened to the public before the end of 1969.

The Instituto Bibliotecológico (UNBA) is a bibliographic center of general character. Its main informational tool is the centralized catalogue of works existing in libraries at the University of Buenos Aires. At present, the possibility of incorporating works of all other university libraries is being studied.

Reproduction Services. A great number of libraries have equipment for the reproduction of documents: the Faculties of Engineering, Agronomy and Veterinary Sciences of the University of Buenos Aires, and the central libraries of the Universities of Córdoba and La Plata. ^{7, 8}

Scientific Research Commissions

In some universities (Buenos Aires and La Plata) these commissions have been established. They have been provided with funds to encourage scientific research through the appointment of fellowships, grants, and aids for the acquisition of certain bibliographic material.

Private Universities

Recently, a number of private universities have been created. Most of them suffer from a lack of well-furnished libraries. Consequently,

libraries from the national universities and specialized ones are consulted, so that the number of users is being increased.

National and Provincial Organizations

There are several organizations that directly or indirectly carry out or encourage scientific and technical research, and they have qualified libraries and information services. Among the main ones are:

- The Centro de Documentación Científica (Scientific Documentation Center) of the C.N.I.C.T., which maintains contact with similar centers from abroad and obtains material and scientific information requested by researchers. It offers translation services.
- The Junta de Investigaciones Científicas de las Fuerzas Armadas (Board of Scientific Investigations of the Armed Forces). It keeps a specialized library and issues a publication called "Cuaderno de Traducciones", in which articles from foreign periodicals are summarized.
- The Consejo Nacional de Desarrollo (National Council for Development) CONADE. Useful material for scientific and technical research is available in its library.
- Comisión de Investigación Científica de la Provincia de Buenos Aires (Scientific Research Commission of the Province of Buenos Aires). It keeps a specialized library (presently in the process of transformation) which will operate in coordination with other centers such as the Documentation Center of the National University of La Plata.
- The Instituto Nacional de Tecnología Agropecuaria (National Institute of Rural Technology) INTA. It maintains a bibliographic collection of 58,000 volumes out of a total of 351,500 existing in the country, distributed among 36 libraries.
- The Instituto Nacional de Tecnología Industrial (National Institute of Industrial Technology) INTI. It maintains a library in Migueletes, in the Buenos Aires province.
- The Comisión Nacional de Energía Atómica (National Atomic Energy Commission). Its library is a depository of IAEA publications.
- Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (Argentine Museum of Natural Sciences "Bernardino Rivadavia").
- Instituto Nacional de Geología y Minas (National Institute of Geology and Mines).

- Instituto de Investigaciones Aeronáuticas y Espaciales (Institute of Aerospace Research).
- Instituto Nacional de Microbiología (National Institute of Microbiology).
- Military Institutions issue military bibliographies. (Military Geographical Institute, Military Manufacturing, Navy Hydrographic Service, Antarctic Institute, Naval Center)
- Major state agencies. (Specialized Ministries: Public Works, Navy, Agriculture, Transportation, Roads, Central Bank, etc.)
- LEMIT (Laboratory for Testing Materials).
- Instituto Nacional de la Salud (National Health Institute).
- Instituto Nacional de Nutrición (National Institute of Nutrition).

Academies

Practically all national academies have their own libraries. Those of the Academia Nacional de Ciencias de Córdoba (National Academy of Sciences of Córdoba) and the Academia Nacional de Medicina (National Academy of Medicine) are noteworthy.

Private Sector

The specialized libraries of the private sector also contribute to the sources of scientific and technical information.

Professional Associations

(Physicians, engineers, chemists, etc.)

Institutes

Darwinian Botanical Institute, Institute of Biology and Experimental Medicine, Institute of Biochemical Investigations, Institute of Medical Investigations "Mercedes y Martín Ferreyra" of Córdoba, Bariloche Foundation, and the "Torcuato Di Tella" Institute.

Commercial Concerns and Laboratories

(Atanor and Laboratories "Gerardo Ramón," Squibb, Lazar, Lepetit, etc.) They photocopy articles for professionals and researchers.

Hospitals

(French, German, British). Their corresponding libraries.

Works and Reference Material Which Help to Locate Information

Aside from the ones quoted on pages 1 and 2:

- "Union catalogue of periodicals" published by the C.N.I.C.T. is the most valuable tool for locating specialized publications in the country; with the publication of its supplement it will gather more than 30,000 titles.
- "Directory of university libraries," published by the Universidad Nacional del Sur (Southern National University).
- "Directory of Argentine Libraries," compiled by Carlos A. Giuffre and published in 1967.
- Newsletters containing interesting news research work (C.N.I.C.T., Bibliographic Institute, Library of the National University of La Plata).

Exchange of Information and Services

The exchange among Argentine and North American Institutions is frequent and regular, through personal contacts among scientists as well as through libraries. It is possible that exchange services in Argentina are not wide enough. One of the reasons is that in many cases a general exchange service does not exist. The most frequent exchange is among specialized institutes, so that the library does not always take advantage of this service and thus control of information is lost. The possibilities offered by the national and University centers (central libraries, national libraries, USBE, etc.) are oftentimes lost. It must be kept in mind that in the exchange of services it is not likely an absolute equilibrium will be established since much more is "imported" than "exported."

Present Situation

To sum up, the present situation regarding information varies according to the scientific fields (degree of advancement of one specialty in the country, prestige of the researchers, number and quality of the bibliographic sources existing in the world). The view presented in the report submitted by Dr. Raúl Cardón in the Latin American Seminar on Scientific Documentation held in Lima in 1962 continues to be valid in many aspects, though the situation has improved during the last years, because of the following reasons:

- More significant university budgets (although not enough) are granted for the purchase of library material and equipment
- Lifting of currency exchange restrictions, which for many years hindered the action of libraries
- Support from the C.N.I.C.T. for purchasing publications

Some Possibilities to Improve the Situation

- The establishment of communication systems which would provide immediate knowledge of new publications issued daily in different fields of science
- Completion of periodical collections contained in the libraries
- The gathering of missing titles which are considered essential, especially periodicals (this task has been started by the Argentine Libraries Association and scientific and technical information centers)
- The use of information retrieval systems existing at other centers and their "memories" to take local advantage of them (MEDLARS, ISI, etc.)
- Facilitating the organization of information services in Argentina in order that the material published by organizations comprising various branches of science (Clearinghouse Federal Agency, Library of Congress from Washington, C.N.R.S., ASLIB from Great Britain, American Institute for Information, NIDER, ISO, etc.) as well as the scientific news distributed by the embassies, the publications from national academies, and the material from international organizations can rapidly reach researchers
- The establishment of documentation centers and reference services which keep permanent up-dating of information tools
- An increase in university budgets to at least ensure the regular renewal of subscriptions for periodicals
- The dissemination of microfilm readers, in order to support the use of microfilms coming from abroad

Application of Automation Systems

The following works are known:

- C.N.I.C.T. Publication of the Union Catalogue of Periodicals and its updating by means of a computer. This work has been undertaken with the advice of an expert, Dr. J.V. Karandikar. Possibility of carrying out the Argentine bibliography through the same procedure.
- Universidad Nacional de La Plata (National University of La Plata). It has decided to create an Advanced Center of Information with the installation of an IBM 360/50 equipment. The works programmed are technical processes of book cataloguing and classification; catalogue of periodicals from the National University of La Plata, in a program synchronized with the C.N.I.C.T.; printed catalogues and special bibliographies.
- Bibliographic Institute (UNBA). It is carrying out the final printing proofs for the second supplement to the catalogue of works existing in the institute.

We believe it would be possible to use local computers by adding extra equipment to take advantage of magnetic tapes produced in other centers.

The possibility of using the Balcárce ground station for satellite communication should not be disregarded, in considering the transference of information among specialized libraries on a world-wide cooperation basis.

Finally, it must be pointed out that it is necessary to train personnel in libraries and information centers for the use of automation services, taking into account concrete possibilities for utilizing them. Furthermore, training of programmers for library and documentation work is an essential need.

REFERENCES

1. INTA has published several specialized bibliographies and a back-dated one. The Faculty of Agronomy and Veterinary Sciences of the National University of Buenos Aires in 1967 published the "Argentine bibliography of the theory of agriculture and veterinary sciences" which includes works published in 1965.
2. The Institute of Bibliographies of the Province of Buenos Aires published the "Argentine Bibliography" on education, science, philosophy,

history, psychology, and economics. The National Art Fund publishes the "Bibliography of arts and literature" (BAAL).

3. The Astronomic Observatory (UNLP) distributes the "Information Bulletin for the Southern Hemisphere."
4. Raúl Cardón. Situation of scientific information in Argentina, 1968.
5. Some specialized journals, such as the Annals of the Argentine Association of Chemistry, include national scientific production.
6. For an illustration we may say that there are eight faculties of medicine, ten of civil engineering, eight of agronomy, seven of pure sciences...
7. The National University of La Plata has started a program of micro-filming Argentine and South American newspapers (PMP) in cooperation with other institutions from the country, with the objective of facilitating historical research in the social, economic, political and cultural fields.
8. Outside the University there is the Service of the Scientific Documentation Center at the National Council for Scientific and Technical Research.

A STUDY OF UNDERGROUND WATER IN THE ARGENTINE REPUBLIC

The importance of underground waters in the Republic of Argentina is indisputable, because arid and semi-arid climates dominate two-thirds of the territory. In addition, in some cases the population density makes it necessary to constantly increase the supply of water; and in others, there is an urgency to develop territories and to raise the standard of living. Consequently, several institutions have undertaken exploration and evaluation of the resources in different areas.

I. Studies of Underground Water in the Northeast of the Province of Buenos Aires

This province covers an area of approximately 20,000 km² which includes the most densely populated and the most developed district of the country. The dominant climate is humid to sub-humid. The studies are based on a preliminary plan developed by Dr. W. W. Doyel of the U.S. Geological Survey in collaboration with Dr. Limousin and Mr. J.M. Ricoy of LEMIT, and cover a period of five years, divided into an equal number of stages. In order to complete this task, a technical entity, under the direction of José M. Sala, was created by agreement with the CFI (Consejo Federal de Inversiones) and the PBA (Provincia de Buenos Aires).

The aim is to evaluate and investigate the deterioration of aquifers owing to over-use which results in the permanent lowering of the static water level, and salt-water intrusion. This study is currently in the stage of obtaining basic data, using such methods as sampling the periodic oscillations of the static water level, pumping tests, study of surface geology, and so forth. At the same time, some tests of artificial recharge methods are planned.

II. Integral Study of the "puelche" sands

This study was originated by the DNGM (Dirección Nacional de Geología y Minería) and has been in progress three years. The study area, which has sub-humid to humid climate, covers an area of 50,000 km² that includes the center of the Province of Santa Fe. The study will eventually include the Southeast of Córdoba. This encompasses one of the largest concentrations of population in the country. Because salt-water problems exist, the investigation will outline, evaluate, and find the interrelationship of each type of water.

The study, under the direction of Dr. A.F. Galvan, includes a ground-water inventory, drawing water-table maps, and constructing

iso-salinity maps, etc. In turn, the data that pertains to the (water) levels of the "Arenas Puelchas" or that of similar areas will be analyzed in order to study their relationship to other aquifers. Some test drilling has been completed.

For this purpose, an agreement with Germany has been signed, under which Germany will send a technical team to undertake joint investigations along an east-west line extending from the Parana River to the Sierras de Córdoba, an area of 24,000 km². The survey will use the above-described methods.

III. Committee for the Investigation of Underground Water (CIAS)

This was created by an agreement between the CFI, the PBA and the province of La Pampa according to a plan developed by Dr. A.F. Bordas and J.M. Sala. It has been charged with prospecting for and evaluating lenses of fresh water within salt water.

It covers an area with sub-arid to arid climate, principally grazing land, but with various industrial centers.

The work of the committee has been divided into two stages. The first to be completed covers an area of 45,000 km². The second covers an area of 96,000 km², which includes three distinct geohydrological environments: plains; underground alluvial fans; and one deep artesian basin yielding exceptionally large discharges of thermal water.

The director of the committee is Dr. L.E. Arigos.

IV. The Plan of Underground Water of the Argentine Northeast

In operation since 1965 and facilitated by an agreement between the CFI and the UN Special Fund, this plan is currently under the direction of Dr. J. García (from the CFI) and Dr. F.B. Roberts (United Nations). It covers the study and evaluation of the inter-montane valleys of the arid provinces of San Juan and Mendoza. This embraces an area of approximately 20,000 km². Its ultimate goal is to increase irrigation.

V. Province of Catamarca

On the basis of a geohydrological study of the valley of Catamarca, completed in 1964-65, a detailed study of the valley of Catamarca, under the direction of Dr. C.J.J. Oblitas, has been initiated by agreement

between the CFI, the DNGM, and the Dirección Provincial de Geología y Minería. This study has been divided into two stages. The first, now underway, embraces the head waters of the valley whose surface is approximately 1,000 km² excluding the basins.

VI. Plan for the Province of La Pampa

This has been completed by the DNGM under the direction of Dr. J. Salso. It is a combined study of the deep structures and their reflections on morphology. A survey of drillings and a survey of the superficial physical characteristics of approximately 20,000 km² have been completed. Some exploratory drillings have been undertaken.

VII. Hydrogeological Studies in the Province of Santiago del Estero

These studies have been undertaken by the DNGM under the direction of Dr. A. Battaglia. These are a series of field reconnaissance studies which are well advanced. However, the processing of the collected data has yet to be completed. The area of some 28,000 km² includes part of the Tucuman alluvial fan which is within the jurisdiction of the province of Santiago del Estero, whose climate is primarily arid.

VIII. Valley of the Conlara River

According to the Argentine-German agreement previously mentioned, this study will undertake the hydrogeological study of this arid valley which includes the Northeast of the Province of San Luis and the Southwest of Córdoba, in order to improve irrigation. The DNGM has already begun some surveys of the area, which covers approximately 7,500 km².

The preceding is a brief summary of the principal research being conducted on underground water in the Argentine Republic.

Topics on which Technical Advice is Required:

1. In geophysics, especially in unconventional methods used in the search for fresh water
2. In photogeohydrology
3. In the relationships of salt-water to fresh water
4. In the use of radio-isotopes

5. In the use of models
6. In exploratory drilling and development of the middle and deep depths, in alluvial fans and in aquifers with extreme pressures
7. In artificial recharge of middle and large flows
8. In desalinizing water for small supplies
9. In industrial utilization of salt- and thermal water.