AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

**BIBLIOGRAPHIC INPUT SHEET**

FOR AID USE ONLY
Batch 46

1. SUBJECT CLASSIFICATION
A. PRIMARY: TEMPORARY
B. SECONDARY:

2. TITLE AND SUBTITLE
National Academy of Sciences of U. S. and Conselho Nacional de Pesquisas of Brazil, science cooperation program, staff summary report of activities, 1970-1972

3. AUTHOR(S)
(101) National Research Council, Board on Science and Technology for Int. Development

4. DOCUMENT DATE: 1973
5. NUMBER OF PAGES: 64p.
6. ARC NUMBER: ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
NAS

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

9. ABSTRACT

(SCIENCE & TECHNOLOGY R & D)

10. CONTROL NUMBER
PN-AAC-957

11. PRICE OF DOCUMENT

12. DESCRIPTORS

13. PROJECT NUMBER

14. CONTRACT NUMBER
CSD-2584 GTS

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

CSD-2584 GTS
NAS
PN-AAC-957

# NAS - CONICET SCIENCE COOPERATION PROGRAM

National Academy of Sciences (USA)

Consejo Nacional de Investigaciónes Científicas y Técnicas (Argentina)

Staff Summary Report of Activities
August 15, 1970 - December 31, 1972
Contract AID/csd-2584
Task Order No. 3

Program Sponsors:

Board on Science and Technology for International Development
Office of the Foreign Secretary
National Academy of Sciences

and the

Consejo Nacional de Investigaciónes Científicas y Técnicas

in cooperation with

United States Agency for International Development

June 1973

The NAS-CONICET (Argentina) Science Cooperation Program was initiated by the National Research Council of Argentina (Consejo Nacional de Investigaciones Científicas y Técnicas, or CONICET) and the Board on Science and Technology for International Development, Office of the Foreign Secretary, National Academy of Sciences (NAS), with support from the United States Agency for International Development in Argentina under contract AID/csd-2584, Task Order Number 3. The report covers activities in food science and technology and in groundwater hydrology, 15 August 1970 through 31 December 1972. A separate NAS staff report will cover activities in scientific information systems and exchange.

CONTENTS

Page

I. SUMMARY ..... 1

Food Science and Technology ..... 2

Groundwater Hydrology ..... 3

Future Activities ..... 4

II. FOOD SCIENCE AND TECHNOLOGY ..... 6

Origin and Objectives ..... 6

Activities ..... 7

Observations and Comments ..... 8

Participants ..... 11

II. GROUNDWATER HYDROLOGY PROJECT ..... 13

Origin and Objectives ..... 13

Activities ..... 13

Observations and Comments ..... 15

Participants ..... 17

IV. APPENDICES ..... 18

A. Staff Summary Report: Argentine Seminar on Food Technology, July 1971 ..... 18

B. Staff Summary Report: Preliminary Assessment of Some Problems of Hydrology of the Dry Pampas in Buenos Aires Province, Argentina, September 1970 ..... 45

# I

## SUMMARY

On the theme of "Use and Management of Scientific Resources," an Argentine - U.S. Workshop on Science and Technology in Economic Development took place in Mar del Plata, Argentina, 28 July - 1 August 1969. Sponsored by the Argentine National Academy of Exact, Physical, and Natural Sciences; the Argentine National Council for Scientific and Technical Research (CONICET); and the U.S. National Academy of Sciences (NAS), the workshop included nine U.S. participants, ten Argentine participants, and approximately thirty observers who took an active part in the sessions. Special panels dealt with (1) food technology, (2) groundwater hydrology, (3) scientific information, and (4) agricultural research and training. The Report of the Argentine - U.S. Workshop on Science and Technology in Economic Development (available from the NAS), prepared by the NAS Office of the Foreign Secretary, summarizes the sessions and presents the conclusions.

This staff summary report deals with workshop follow-up activities in (1) food science and technology and (2) groundwater hydrology. A separate report on scientific information, with details of an experimental telex information network linking CONICET with Argentine universities and with scientific information depository libraries in the United States, is in preparation. No activities were undertaken by NAS and Argentine authorities in agricultural research and training.

FOOD SCIENCE AND TECHNOLOGY

The Argentine - U.S. Workshop recommendations dealing with food science and technology concerned manpower training needs in Argentina; better utilization of vegetable-protein products, especially for export; and dehydration of foodstuffs to enhance marketability for both domestic and export sales.

To implement the food science and technology recommendations, the NAS and CONICET concentrated on research training as one major way to meet Argentina's need for highly trained human resources. A seminar was convened on Argentine food-science research, ongoing and planned, with the hope of developing cooperation in specific areas between Argentine and U.S. researchers. The NAS invited representatives from the Consortium for the Development of Technology (five U.S. universities with strong food science and technology programs)* to meet with a representative group, selected by CONICET, from Argentine universities.

The seminar met in Buenos Aires 12 - 17 July 1971 to propose specific projects for research cooperation and, where possible, joint research in (1) vegetable (plant) proteins, (2) protein development from microorganisms, (3) fisheries food science and technology, and (4) dairy food science and technology.

---

*CODOT includes (1) Department of Food Science and Technology, University of California at Davis; (2) Department of Food Science, Michigan State University; (3) Department of Food and Resource Chemistry, University of Rhode Island; (4) Institute for Food Science and Technology, University of Washington; and (5) Department of Food Science, University of Wisconsin at Madison.

This recommended bilateral U.S. - Argentine food science and technology research and training program was never implemented, however, mainly because of funding problems. On the U.S. side, the CODOT group was unable to obtain funds from the USAID Mission to Argentina because bilateral technical assistance programs were being phased out. According to present AID guidelines, Argentina is classified as an economically advanced country, capable of purchasing technical assistance with local funds or obtaining it through the United Nations and international banking sources. On the Argentine side, several events blocked the inauguration of cooperative research projects with U.S. universities: the general economic situation in Argentina resulting in a small budget for CONICET; lack of program coordination among industries, universities, and other interested groups; and reorganization of CONICET following the death of its founding director, Dr. Alberto Houssay.

GROUNDWATER HYDROLOGY

The workshop recommendation on groundwater hydrology was specifically directed toward solving water-quality problems in the semiarid pampas, where cattle production is the important industry. Because of the commercial importance of cattle in the Argentine economy, the need to increase productivity of marginal lands, and a general recognition that the groundwater problem is extremely complex, the scientific-technical design of the study was of fundamental importance. Workshop participants recommended that a special study group be appointed by NAS and CONICET to review the problem and prepare a research-program design.

In September 1970 a U.S. - Argentine study group met to review technical aspects of the proposed research project on groundwater geology problems in the dry pampas of Buenos Aires Province. Subsequently, Argentine authorities proposed financing of local costs and requested an NAS grant for equipment--a research proposal outside the terms of reference of NAS international programs, which are usually limited to problem identification and analysis and recommendations for solutions. Consultation continued through September 1972 when a participant in the original U.S. study group again visited Argentina. By then it appeared that Argentine authorities had not raised funds for the research and would be dependent on external financing. Although problems of water quality in the Argentine pampas are comparable to those in semiarid regions elsewhere in the world, international financing for the research had not been obtained by December 1972, when NAS funding for the overall cooperative program with CONICET expired.

FUTURE ACTIVITIES

Since AID has terminated its grant funding for bilateral programs with Argentina, NAS-CONICET activities on science and technology planning will require another source of financial support. For specific conferences, seminars, and workshops, private funds may be available from time to time, but continuing assistance for general planning and evaluation activities has not so far been obtained.

A bilateral science and technology agreement between the Government of Argentina and the United States Government exists. The executive agency for the agreement in the United States is the National Science

Foundation. This government-to-government agreement provides a formal procedure, or mechanism, for research collaboration of the type desired by Argentine and U.S. scientists, provided each agrees to finance the work of the scientists plus necessary program-coordination costs. To date, the project on groundwater hydrology has not been identified as a subject for this type of collaboration.

## II

## FOOD SCIENCE AND TECHNOLOGY

### ORIGIN AND OBJECTIVES

According to a special working group of the 1969 Argentine - U.S. Workshop, the Argentine food industry was neither achieving its potential nor providing adequately for domestic or foreign markets. After hearing the group's review of the technological aspects of the industry, the workshop recommended that a joint National Academy of Sciences - Consejo Nacional de Investigaciónes Científicas y Técnicas study group on food science and technology be formed to undertake the following tasks:

1. To survey the professional competence and laboratory facilities in food science and technology in Argentine universities and industries,

2. To establish strong and continuing communications between Argentine food scientists and their counterparts in countries where the state of the art is more technologically advanced, and

3. To encourage research and development on vegetable proteins and food dehydration to enhance the market potential of Argentine agricultural products.

In 1970, as a first step in fulfilling the workshop recommendations in food science and technology, CONICET and NAS agreed to organize a seminar to explore ongoing research and development activities in specific areas that were of mutual interest and held promise of rapid development in Argentina. Seminar topics were (1) proteins of plant origin, (2)

protein production from microorganisms, (3) fisheries food science and technology, and (4) dairy food science and technology. The goal was to provide a basis for cooperative research on specific food problems and to explore opportunities in the United States for training Argentine food scientists and technologists in research methods.

ACTIVITIES

Held in Buenos Aires 12 - 17 July 1971, the Argentine Seminar on Food Technology was the CONICET - NAS activity as a follow-up to workshop recommendations. Appendix A is a staff summary report on the seminar. Recommendations of the seminar--addressed to Argentine authorities, particularly to CONICET--are summarized as follows:

1. General recommendations. The participants emphasized the applied nature of food science and technology and the unrealized potential of the Argentine food industry in both domestic and export markets. CONICET was urged to increase training opportunities for food scientists and technologists; to strengthen facilities in universities; to encourage incentives for R&D in industry; to improve standards; to effect greater industry-university cooperation in setting standards, information exchange, and cooperation in research; and to create strong links between Argentine and foreign food scientists.

2. Vegetable proteins. Because of growing world food needs and the great Argentine potential for oil seed production, the seminar recommended an R&D program concerned with human and animal consumption.

3. Dairy products. Although climatic and agricultural conditions favor a massive increase in dairy production in Argentina, no such program

is under way. Participants recommended several basic studies on the Argentine dairy industry; on milk quality in Argentina; on ways to strengthen marketing and manufacturing standards; on the use of dairy byproducts in producing meat for export; and on other projects to enhance manufacturing and consumption of dairy products.

4. Single-cell proteins. While producing great quantities of meat for domestic consumption and for export, Argentina has neglected other protein sources. Yet, the worldwide protein deficit is clear evidence of a potential market for other forms of protein. One possible source of additional protein is waste material from plant, animal, or marine sources that have been transformed by single-cell proteins such as bacteria, yeast, fungi, and algae, all of which are of microbial origin. Because Argentina has abundant resources for the production of single-cell proteins and a world market for cheeses, wines, soy sauces, and similar products is growing, greater R&D efforts in universities and industry are needed to insure that Argentine products can compete with those from other countries.

5. Marine food technology. Marine foods are not a significant source of protein in Argentina, possibly because of present catching, preserving, and marketing techniques. Argentine coastal waters contain a vast amount of marine life; coordinated studies of marine species and ways to improve marketing could help to stimulate the marine food industry. Argentine authorities should encourage and support this growth.

OBSERVATIONS AND COMMENTS

Argentina has not developed a sophisticated food industry, probably

because of its remarkable ability to export raw agricultural products--grain and chilled meat. The existing food industry needs more technical and professional personnel to apply more appropriate technologies to the preservation, marketing, and distribution of agricultural products that have great potential for local and export sales. There is evidence that industrial, university, and government food experts are becoming increasingly aware of the problems, but far greater efforts are needed to solve them. The greatest opportunity for a joint NAS-CONICET food science and technology study group would be to foster university-industry-government cooperation, helping to formulate strategies for food-industry development and to create local understanding of ways to expand food markets.

Unfortunately, the study group was unable to realize this catalytic function. Perhaps the principal reason a continuing policy-level food science and technology study group was not formed was that the Argentines viewed a joint study group principally as a means to attract grants to university groups for specific research. A similar goal by Philippine authorities--to use joint study groups with the NAS to attract grants from U.S. agencies and U.N. sources--resulted in failure of activities there. The primary benefit of NAS cooperation with scientists in developing countries is strengthening links <u>within</u> countries to mobilize the limited local resources in applying science and technology to economic development. NAS activities can help define problems, analyze alternate solutions, and evaluate courses of action so that decisions are made. NAS programs are not a vehicle for grants-in-aid.

Argentina has a tremendous need to improve food science and technology as <u>one</u> way to enhance local industries, increase employment, promote

exports, improve internal food distribution and marketing, avoid pollution, and prevent waste. The objectives were explained and to a limited extent discussed during the 1971 seminar, but a lack of local leadership and desire to pursue the goals prevented their realization.

## ARGENTINE - U.S. SEMINAR ON FOOD TECHNOLOGY

### Members from Argentina

PEDRO CATTANEO, Professor of Food Science, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires, Chairman

RODOLFO J. ERTOLA, Professor of Industrial Microbiology, Facultad de Ciencias Exactas, Universidad de La Plata, La Plata

JUAN C. SANAHUJA, Director, Department of Food Science and Nutrition, Facultad de Farmacia y Bioquímica, Universidad de Buenos Aires, Buenos Aires

### Members from the United States

C.O. CHICHESTER, Department of Food and Resource Chemistry, The University of Rhode Island, Kingston, Rhode Island, Chairman

HAROLD E. CALBERT, Department of Dairy and Food Industries, University of Wisconsin, Madison, Wisconsin

MARTIN W. MILLER, Department of Food Science and Technology, University of California, Davis, California

GEORGE N. PIGOTT, Department of Food Science, College of Fisheries, University of Washington, Seattle, Washington

### Other Participants

ANTONIO P. BALATTI, Faculty of Exact Sciences, Department of Technological Chemistry, National University of La Plata, La Plata

CARLOS M. CUEVAS, Faculty of Exact Sciences, Department of Technological Chemistry, National University of La Plata, La Plata

MAXIMO BOCKLET, Faculty of Agrarian Sciences, National University of Cuyo, Mendoza

EZIO EMILIANI, National University of the Litoral, Santa Fe

ROBERTO HALBINGER, Faculty of Agronomy and Veterinary Medicine, National University of Buenos Aires, Buenos Aires

ERNESTO KASDORF, Director, Kasdorf and Company, Buenos Aires

Other Participants (Cont'd)

JORGE J. RONCO, Faculty of Exact Sciences, Department of Technological Chemistry, National University of La Plata, La Plata

RAUL E. TRUCCO, Institute of Chemical Sciences, National University of Córdoba, Córdoba

# III

# GROUNDWATER HYDROLOGY

## ORIGIN AND OBJECTIVES

Because arid and semiarid climates dominate two-thirds of the country, Argentine authorities chose groundwater hydrology as one discussion topic for the 1969 NAS-CONICET Workshop. A group of geologists, all workshop participants, reviewed university training and research programs under way in Argentina and discussed additional measures needed to solve the country's hydrology problems.

From these discussions arose a specific recommendation for a continuing study group to design and supervise a research program in the semiarid pampas; where cattle raising is the most important industry. The commercial importance of cattle in the Argentine economy, the need to increase productivity of marginal lands, and a general recognition of the complexity of groundwater problems led the geologists to recommend a groundwater hydrology study be designed as an essential to further progress in water management.

## ACTIVITIES

After the CONICET and the NAS selected members for the study group, a meeting was held 24 August - 1 September 1970 in Argentina (see Appendix B). The study group first visited an area of semiarid pampa in Buenos Aires Province and then reviewed what steps would be required to initiate a comprehensive research program. Two general objectives were desired from the Research:

1. To determine what actions were required to maintain and, if possible, increase agricultural productivity of the region, and

2. To obtain basic data for a clearer understanding of scientific questions concerning groundwater resources in the region.

Under these objectives several specific types of information were desired, including:

a. the determination, as accurately as possible, of the origin of both low- and high-saline waters;

b. the determination of hydrogeologic controls that serve to localize waters of various qualities;

c. the origin of minor and of trace constituents occurring in the water; and

d. the development of exploration criteria to facilitate water-quality studies in the area.

In addition to the specific data outlined above, the study group underlined a need for basic data that would lead to an understanding of applied problems such as well construction, estimation techniques for determining the quantity of available fresh water, elucidation of salt-water conversion economics, and design parameters for drainage systems.

When the Argentines later suggested a specific research plan based on the conclusions of the study group, the U.S. panelists commented on its design and proposed methodology. The Argentine National Service of Geology and Minerals requested funds from CONICET and NAS to conduct the research. NAS does not fund or participate directly in ongoing research projects; it limits its activities to evaluation and policy planning in cooperation with national research councils. NAS staff members, however,

made inquiries on behalf of the Argentines with U.S. private and government funding agencies, but funds were not available in 1970 or 1971. Furthermore, because of economic conditions in Argentina, CONICET was unable to grant funds for local costs of the proposed research. Inquiries to international organizations (AID, the Inter-American Development Bank, and U.N. agencies) did not elicit a firm commitment of financial help.

In September 1972, at the request of Argentine authorities, Dr. Stanley Davis made a second trip to Argentina to consult on research design and on funding strategies. His role was mainly that of a resource person, not a foreign collaborator who would be responsible for obtaining a research grant. Discussions in Buenos Aires again were centered on technical aspects of the proposed research program, although research funding and project management were also discussed. Efforts were made to redefine the scope of the research in terms that might enable Argentina to support the entire cost.

## OBSERVATIONS AND COMMENTS

As in the proposed food technology program, Argentine authorities viewed the NAS as a sponsor for a specific research program of interest to scientific groups in both countries. ("Sponsor" as used here means fund-granting agency or intermediary through which funds would become available to Argentine scientists.) Thus, there was a basic misunderstanding of the function of the groundwater hydrology study group.

An explanation of the failure of the food technology and groundwater hydrology projects must take into account the economic and political climate of Argentina during 1970 - 1972. CONICET was in transition after the death of Dr. Alberto Houssay. The Argentine economy was experiencing

rapid inflation, which adversely affected funding of all CONICET grant programs. The CONICET council, furthermore, was examining and evaluating its policies in light of new conditions in the country. Although the specific research programs desired by the U.S. and Argentine participants in the food technology and groundwater hydrology programs did not take place, scientific contact and exchanges were maintained, thereby promoting the larger, long-range goals for bilateral scientific cooperation. Given the realities of the situation, it is difficult to suggest how more concrete research programs, desirable as they are, could have resulted.

## ARGENTINE - U.S. GROUNDWATER HYDROLOGY STUDY GROUP

### Members from Argentina

JOSE S. GANDOLFO, Argentine Academy of Exact, Physical, and Natural Sciences, Buenos Aires, Chairman

OSCAR RUIZ HUIDOBRO, Department of Geology, Faculty of Exact and Natural Sciences, University of Buenos Aires, Buenos Aires

AMILCAR GALVAN, National Service of Geology and Minerals, Buenos Aires

### Members from the United States

STANLEY N. DAVIS, Department of Geology, College of Arts and Science, University of Missouri, Columbia, Missouri

JOHN D. WINSLOW, Staff Hydrologist, U.S. Geological Survey, Mineola, Long Island, New York

## APPENDIX A

Staff Summary Report

Argentine Seminar on Food Technology

Buenos Aires, Argentina

July 12 - 17, 1971

Jointly sponsored by the

Consejo Nacional de Investigaciónes Científicas y Técnicas
Argentina

and the

Board on Science and Technology for International Development
National Academy of Sciences
United States

## APPENDIX A: Contents

Page

A-I. Introduction .....20

A-II. Recommendations.....22

General Recommendations.....22

Vegetable Proteins.....24

Dairy Industry.....26

Single-Cell Proteins.....28

Marine-Food Technology.....29

A-III. Supplemental Information.....31

The Argentine Dairy Industry.....31

Single-Cell Proteins.....36

Marine-Food Technology.....38

## APPENDIX A

## Argentine Seminar on Food Technology

### A-I INTRODUCTION

In July 1969 the Argentine - U.S. Workshop on Science and Technology in Economic Development was held in Mar del Plata, Argentina, sponsored by the Consejo Nacional de Investigaciónes Científicas y Técnicas (CONICET); the Academia Nacional de Ciencias Exactas, Fisicas, y Naturales; and the Board on Science and Technology for International Development (BOSTID) of the United States National Academy of Sciences. Discussions and workshop recommendations led to the choice of scientific information, food technology, groundwater hydrology, and agricultural research as topics for priority attention.

This document summarizes the findings of the Argentine Seminar on Food Technology, Buenos Aires, 12 - 17 July 1971, resulting from the 1969 workshop. In Argentina, as in many other countries, agriculturally based industries form the largest segment of the nation's industrial complex. Because of a shortage of trained food scientists and technologists, Argentine food enterprises have not been major competitors in world food markets. Lack of trained personnel also contributes to significant waste of food products in national marketing. A recent survey indicated a minimum need for 8,000 - 10,000 university-trained food scientists and technologists. An even larger number with secondary-school training is needed if the industry is to realize its growth potential.

Several areas of food science and technology can be singled out as the most promising for upgrading present, and developing new, industries in Argentina. Topics chosen for discussion at the seminar were

1. Proteins of plant origin

2. Development of protein from microorganisms

3. Fisheries food science and technology

4. Application of technology to the dairy industry

These areas, important now and potentially the bases for new industries, do not comprise a list of all food-industry opportunities. Additional work would be valuable in the cereal, fruit and vegetable-processing (a major industry in Argentina), and fermentation industries. The joint U.S. - Argentine groups covered these topics in general discussions. Upgrading training and research in food science and technology with industrial-governmental research linkages offers Argentina one immediate way to stimulate economic development and, because most of the food industry is labor intensive, to create employment. Another important result would be increased food materials for the domestic population and the export market. It is estimated that substantially more than 25 percent of agricultural food products in Argentina are lost before marketing. These loses could be greatly reduced by the application of improved technology.

A-II

# RECOMMENDATIONS

## GENERAL RECOMMENDATIONS

Considering that:

- Food Science and Technology is a discipline in the early stages of development in Argentina.
- Research programs, in both industry and the university, are isolated.
- Expenditures for training and research are modest.
- Lack of technology, particularly in small and medium food industries, has led to a competitive disadvantage with respect to international markets.

It is recommended that:

1. An agency be established that would foster better information excnange among industry, government, and the universities.
2. Research developments in food science and technology be considered as they relate directly to Argentine industrialization opportunities.
3. Food science and technology research and teaching be developed in appropriate locations throughout the country where agricultural inputs now exist. For example, it would be highly appropriate to develop institutes of food science and technology where fruit and vegetable products are grown, and where marine resources are available. Teaching and other training should, wherever possible, emphasize basic operations rather than specific commodities or specific operations.

4. Pilot plants be utilized for food science and technology research and teaching. It is virtually impossible to translate bench-scale experiments to industrial utilization without the intervening pilot-plant investigations. This is particularly true of economic viability testing.

5. A substantial acceleration in food science and technology be obtained by coordinating efforts of Argentinian groups with institutions in the major food-exporting countries. This coordination could consist of joint development, joint research projects, exchange of professionals, and exchange of information. In many cases, developments in food technology consist of adaptive research, which must be done in Argentina. Nevertheless, joint activities and coordination with external agencies would materially increase the rate of transfer of technology to Argentina.

6. Realistic standards for the industrialization of food be developed. These standards must, of necessity, be enforced; but they should be developed jointly by the existing industry and the government. Universities and research institutes could serve as a focal point for the development of standards.

7. Development of a professional society of food science and technology be accelerated. Argentine groups are already considering formation of a section of the Institute of Food Technologists. This would greatly aid the interchange of research results, experiences, and personnel; and it would develop a forum for discussions within Argentina, thereby helping to close the gap between industry and research-and-teaching groups.

8. A food science and technology coordinating committee be formed which would meet regularly and be representative of universities, research institutes, and industry. The committee should review research programs that are under way in Argentina and recommend rational, overall food research strategies.

VEGETABLE PROTEINS

Considering that:

- Argentina is a major world producer of oil-seed products.

- Approximately 90 percent of these products are exported as animal food sources.

- These products are an extremely important potential source of protein, either for animal consumption within the country or as protein concentrates or isolates for utilization in food industries.

- Substantial work in the production of protein isolates or concentrates from oil-seed meals has been undertaken in the developed countries, and a significant research capability at the laboratory level has been developed in Argentina.

- Laboratory investigations in Argentina have demonstrated the feasibility of producing essentially nontoxic protein isolates from linseed and high-quality proteins from sunflower meal expeller cakes.

- Nutritional and chemical evaluations have demonstrated the possibility for utilizing these proteins.

- This field offers substantial opportunities for economic as well as social development because development of high-quality animal feeds would complement the well-established meat industry in Argentina.

An excellent possibility exists that protein isolates developed from the vegetable-oil industry could be used directly in human food, in either Argentina or neighboring countries with a protein deficit.

It is recommended that:

1. Vegetable-protein research be expanded and integrated with other areas of food research.

2. Pilot-plant facilities be built to develop an economic base for research. A typical facility should first be integrated with a teaching program in food science and technology, which is planned at the University of Buenos Aires. The committee estimates that the cost of such a pilot plant would be from US$40,000 to $60,000.

3. Utilization of oil-seed proteins be considered in relation to food for animals, as well as humans.

4. Development of an expanded program in protein resources be undertaken, with particular attention to the functional products of proteins isolated from these sources.

5. Studies of pesticide residues and mycotoxins in plant-protein products be developed, since these problems represent possible impediments to the program and to the organization of an industry.

6. A study of vegetable proteins be multidisciplinary with a substantial input from engineering and economic sciences.

7. This program be coordinated with those in other countries, to allow exchanges of information, personnel, and research methodology. Such coordination could be facilitated through a consortium of U.S. universities.

8. In any protein research the organoleptic (taste) properties of the end products be considered.

In pilot-plant operations consideration be given to possible textured products from protein concentrates or isolates. Extrusion offers a significant possibility in the development of structured products by chemical or mechanical methods.

10. Consideration be given to the development of mixed-protein sources using marine- and plant-protein products, as a method for improving nutritional qualities of plant proteins at low cost and without affecting taste (and avoiding the disadvantages of adding amino acids with poor organoleptic properties).

DAIRY INDUSTRY

Considering that:

- Argentine dairy industries show examples of both modern and low-level technologies.

- The dairy industries require improvement in technological development and modern processes.

- Scientific utilization in the dairy industry is poor.

- There is a lack of suitable training at all professional levels.

- Activities of the Argentine Government, including standards for the industry and regulation of hygienic conditions are lacking.

- Incentive policies for modernization of the dairy industry need to be encouraged by the Argentine Government.

- The loss of milk and manufactured products due to poor practice within the dairy industry is excessive.

It is recommended that:

1. Research be conducted on the sanitary quality of raw milk and other dairy products in Argentina. Until this can be done, a guideline for improvement is almost impossible to establish.

2. Research be conducted on cultures and microorganisms that could be utilized for the production of cultured products in Argentina. Cultures normally used in other countries may not be applicable because of the quality of milk in Argentina.

3. Research be conducted to determine the bacterial standards necessary for the dairy products of Argentina. Application of standards from other countries may not be appropriate, but if practical standards are established and enforced in relation to the conditions in the country, a gradual improvement can be experienced.

4. Research be conducted to determine the important aspects of appropriate sanitary inspection and its application to the dairy industry.

5. Research be conducted on the most appropriate cleaning procedures to be used under conditions in Argentina, in terms of their effectiveness and their contribution to the pollution problem.

6. Research be conducted to determine the best methods for producing caseinates from casein. Since it is possible to make casein, but not caseinates, in many small cheese factories, it seems more realistic to obtain casein from the small plants and convert it into caseinates at some central location.

7. Research be conducted to find ways to utilize butterfat in combination with other fats. It may be necessary to study methods of

modifying the properties of butterfat to make it compatible with other fats in order to make, for example, new types of dairy products.

8. Extensive studies be conducted to determine the variation in composition of milk by geographic region and by season in Argentina.

9. Studies be conducted on the use of whey and whey products in combination with plant products as possible feeds for dairy and meat animals--probably a better present use of whey than processing it to a protein end-product, since other protein sources may be available at a lower cost.

10. Studies be conducted to determine if it is possible to modify lactose by rearranging its molecular structure to increase its solubility and relative sweetness.

11. Studies be conducted to determine the feasibility of fortifying dairy products with Vitamin D to meet the nutritional needs of the Argentine population. Concurrently, studies should be made to determine the Vitamin A quality of currently produced margarines. New types of dairy-based foods can possibly be developed to serve groups such as children, pregnant and lactating mothers, and the elderly. Nutritional properties of new products, however, must be studied to insure that they adequately serve a need and are in accord with Argentine law.

SINGLE-CELL PROTEINS

It is recommended that:

1. Research on single-cell protein* sources be expanded in Argentina and coordinated with other, similar programs.

---

*Single-cell protein is a general term for protein sources of microbial origin, including bacteria, yeast, fungi, and algae.

2. In considering use of by-product whey from cheese manufacture in single-cell protein production, careful attention be given to economic considerations such as transportation between small, scattered cheese factories, storage problems, and the seasonal pattern of whey production.

3. Attention be given to yeast as either a feed or food supplement.

4. Particular consideration be given to use of potential waste substances as raw materials in the production of single-cell proteins.

5. Consideration be given in Argentina to combinations of oil-seed materials and single-cell proteins for further protein synthesis.

6. Research programs at the University of La Plata be strengthened because of the potential to expand activities at that location with a minimum of new investment.

MARINE FOOD TECHNOLOGY

It is recommended that:

1. Various Argentine biological and oceanographic groups be coordinated in their efforts to study marine food technology potential.

2. A study of the present fisheries industry be undertaken to determine how present techniques and practices relate to quality and condition of the catch at shoreside plants.

3. In addition to broad academic teaching and research programs in food science and technology, specific courses and other educational programs be developed for workers in the food industry (foremen, plant workers, etc.). The courses should cover sanitation and quality-control standards as well as special techniques for specific jobs.

4. Studies be undertaken to replace solvent extraction techniques that yield products unacceptable for human consumption; and aqueous extraction, fermentation, and enzyme hydrolysis be investigated as means to convert wet proteins such as marine fisheries products into functional high-protein concentrates.

A-III

SUPPLEMENTAL INFORMATION

## THE ARGENTINE DAIRY INDUSTRY: USING MILK AND MILK BY-PRODUCTS

Dairy by-products are a subject of interest as a source of protein for human consumption. As a background to a discussion of the economic feasibility of such use, the status of the dairy industry in Argentina is reviewed.

In the Argentine dairy industry, mechanization of milking is the exception rather than the rule; dairy processing plants are inadequate because of a lack of trained workers at all levels and a shortage of suitable machinery and equipment. Notable exceptions, however, can be found. On a few dairy farms and in a few dairy plants, advanced techniques of production and processing are comparable with modern methods practiced in the United States and Europe.

The volume of production is still comparatively small. Annual production of milk in 1970 was 4.5 billion liters or approximately 1.5 percent of the world production.

Argentina has approximately 40,000 - 45,000 dairy farms with about 3,000,000 dairy cattle, in addition to calves and cattle necessary to maintain the dairy herds, making a total of approximately 8,000,000 animals related to dairying.

A decrease in the production of milk has been observed recently, due, in 1970, to adverse weather conditions. In 1970, total fluid-milk

---

Prepared by E. H. Kasdorf and H. E. Calbert

consumption was approximately 1.6 billion liters, giving a per capita consumption of 68.5 liters, or about 35 percent of the total production of the country. Another cause of the low fluid-milk consumption in 1970 was state intervention that directed milk to other manufacturing processes which were artificially made more remunerative.

The volume intended for manufacture, approximately 2.5 billion liters during 1970, decreased from the previous year's figures of 2.8 billion liters, and is short of the record reached in 1966 of 3.1 billion liters. The products most affected were the less profitable ones, butter and casein. On the other hand, manufacture of cheese continues to increase, although in 1970 even cheese showed a slight decrease.

The manufactured volume of butter during 1970--27,500 tons--is equivalent to 15 percent of the total milk production. This figure shows a decrease in production of 58 percent in terms of the record year 1956, and 21 percent in terms of 1969. During 1970, 6,300 tons had to be imported to satisfy internal demand. Butter consumption is approximately 1.43 kilos per capita. Before the late 1960's butter was a traditional export product for Argentina. Now, because of high cost, butter suffers severe internal market competition from margarine.

Skim milk, resulting from the manufacture of butter, is used mainly to manufacture casein, normally an unprofitable operation; therefore, nearly the entire cost of skim-milk production and processing is written off and borne by butter. Skim milk, however, should bear its portion of production costs, as does powdered milk.

The manufacture of cheese shows promise, notwithstanding the low production of 167,000 tons in 1970. Consumption is 7.1 kilos per capita,

which places the Argentines among the highest cheese consumers in the world.

The manufacture of powdered milk (whole and skimmed) uses 6 - 8 percent of total milk production. Most powdered milk is whole milk because of consumption habits and the lack of an economic outlet for the fat remaining after powdered skim is produced. The total production during 1970 was 24,800 tons; consumption was approximately 1.1 kilo per capita.

Manufacturing capacity of Argentine dairy plants is probably greater than is shown by published production figures, and installed capacity especially of pasteurization plants for processing surpluses, continues to increase.

The practice of redissolving powdered milk and adding it to ordinary milk has increased; the product is marketed as pasteurized milk. As in previous years, the government authorized the importation in 1970 of powdered skim milk (4,500 tons) for this purpose. Prices of imported dairy products have been lower (about 50 percent) because the internal market distorts them, thereby obstructing the placing of national products and discouraging manufacture during months of overproduction.

It is unfortunate that Argentina exported more than six times the milk equivalent, in raw material converted into casein, and obtained an income only three times higher than the cost of importing powdered milk.

The high decrease in the production of casein observed during 1970 (9,700 tons) is due to the equally reduced manufacture of butter, and also to the change experienced in the utilization of skim milk. The

general problem lies in existing industrial patterns, mainly in the butter industry, which is undergoing a marked change. For example, the main Argentine butter manufacturer (more than 60 percent of the total) is installing a margarine plant.

Originally, 50 percent of manufactured milk was intended for the production of butter. In 1956, of 3.1 billion liters of manufactured milk, 1.5 billion were used for butter. The corresponding volume of skim milk was destined to the manufacture of casein (41,000 tons). Only since 1964 have changes from this utilization pattern been observed.

In 1970, of the total of 2.5 billion liters of manufactured milk, only 0.5 billion liters were used in the manufacture of butter, and only 9,700 tons of casein were manufactured (equivalent to 14 billion liters of milk). This leads one to believe that the difference of 0.1 billion liters of milk was not used for the manufacture of casein, but for other products (powdered milk-caseinates).

It is also important to point out the resulting economic situation.

Skimmed milk converted into

<u>Casein</u>

357,000,000 liters x 2.7 % (yield) = 9,600 tons

9.600 tons at US$860 = US$8.300.000

<u>Powdered Milk</u>

357,000,000 liters x 8.5% (yield) = 30,000 tons

30,000 tons at US$530 each = US$16,000,000

Difference = US$7.700.000

For many years the soluble caseins or caseinates manufactured in Argentina have been used mainly for human consumption. Only in recent years have they been utilized in other foods (sausage, bread, etc.). No production figures are reported for these uses, but it is estimated at 200 - 400 tons a year.

Whey has a present annual production of approximately 1.4 billion liters and is used mainly for feeding swine and, on a much lesser scale, for the manufacture of Ricotta cheese. The volume of whey used for feeding pigs is regulated by the minimum available (during the winter months). Therefore, it is less used during the summer months.

Using whey in better ways by manufacturing it into other products is hindered by poor methods of storage and collection.

CITIL (Center of Research for the Milk Industry of the INTI* system) has for over a year been conducting research at pilot-plant level with equipment for reverse osmosis.

There is no manufacture of lactos in Argentina.

The Argentine milk industry in general shows uneven development. In both production and manufacturing are examples of highly developed and highly hygienic conditions on some dairy farms and high technology in some manufacturing plants, but the great majority are still rather primitive. The exceptions are the fruit of private initiative carried out with much sacrifice. It is necessary to create the incentive for change; progress will then occur spontaneously, and conditions will improve rapidly.

*National Industrial Research Institute.

There is a lack of suitable training at all professional levels. Formal education in dairy science and technology is almost nonexistent, as are government extension activities. Even the government's police function is scarce and negligent.

On the other hand, economic leadership is excessive in determining the minimum process for the producers and the maximum prices for the consumers, and in placing unrealistic limitations on imports of the machinery absolutely necessary for modernization. Finally, lack of a credit policy hampers changes in production as well as in processing. All these circumstances lead relentlessly to passiveness on the part of the industry.

In summary, the loss of milk and manufactured dairy products due to bad practices is serious. Unfortunately, statistical data to determine the magnitude of these losses are lacking, but in the face of qualitative facts the conclusion is inevitable.

## SINGLE-CELL PROTEINS

Throughout history many foods have been prepared by the activities of microorganisms. Examples are bread, beer, wine, cheeses, soy sauces, vinegars, cocoa, coffee, and yogurt. In some, the responsible organisms are consumed with their products and contribute their quota of nutritional materials, particularly in the form of protein and vitamins.

Single-cell protein is a general term applied to protein sources of microbial origin such as bacteria, yeast, fungi, and algae. One main reason these sources receive so much attention is that large yields of these microorganisms can be obtained and the generation times needed for

multiplication in fairly simple media are brief. Another reason is that some species utilize inexpensive raw materials from plant and animal sources and yield a variety of useful by-products.

Since protein availability appears to be the most limiting of man's dietary needs, single-cell protein manufacture will certainly be a factor in meeting human food requirements in the future. In addition to increasing agricultural production to maximum and increasing protein availability from oil-seed meals and marine sources, single-cell proteins also function as important supplementary sources of human dietary requirements. However, unlike the production of animal protein or the production of plant protein sources such as oil seeds, the production of single-cell protein does not necessarily require agricultural land. In contrast to improved agricultural production, the growth of single-cell microorganisms is not limited by the literacy or training of the general population.

One argument for single-cell protein production even now is that in areas where a large portion of the population is undernourished, raw materials are often available for microbial use; it is often possible to use waste materials from plant, animal, or marine sources. Furthermore, economic gains are very promising because of technical developments in continuous cultivation of microorganisms resulting in savings of time, labor, and production space and in use of waste materials now presenting problems in disposal and environmental pollution. The ability of microbes to produce food for animals or humans has been recognized since the turn of the twentieth century; today, the main potential lies in proteins, lipids, and vitamins.

MARINE FOOD TECHNOLOGY

The marine food industry in Argentina has a vast, virtually untapped, potential.* The fisheries part of food technology is at an earlier stage of development than is agriculture. The annual fish catch in Argentina is far below the average of other nations with an equivalent potential or coast line. For example, in 1962 the catch was 100,000 metric tons; in 1965, 200,000; in 1966, 250,000; in 1968, 220,000; in 1969, 203,000. Because of this undeveloped state, a separate effort should be made to analyze the potential of the Argentine fisheries industry and to coordinate marine-food exploitation with the overall national food program.

Estimates of the fisheries' potential vary from one to several million metric tons, not including, however, the vast krill (a small shrimp-like animal) potential in the extreme southern waters of Argentina.

1. Present state of the marine industry

Almost half the fisheries catch is reduced to fishmeal. For example, in 1965 46 percent was destined to be fishmeal, 31 percent canned, and 23 percent fresh or frozen.

Almost all the present fisheries are centered around Mar del Plata and Necochea. The factories can produce up to 70,000 tons of fishmeal per year (350,000 tons of fresh fish). At present, they are working far below their capacity. For example, in 1966 21,300 tons of fishmeal were produced from 101,073 tons of fresh fish.

---

*This section was prepared by George M. Pigott.

Fishmeal Production in Argentina, 1964 - 69

| | Thousand Metric Tons |
|---|---|
| 1964 | 10.6 |
| 1965 | 14.7 |
| 1966 | 21.3 |
| 1967 | 23.0 |
| 1968 | 17.8 |
| 1969 | 14.4 |

At present there is, essentially, no fisheries-technology program in Argentina. Universities are training few technical people for this field, and the attitude seems to be that qualified fisheries technologists and engineers are brought in from other countries, should the need arise.

Little or no cooperation and coordination exists among the catching effort, the processing industries, and the technological back up to maintain quality and standards that are so important, especially if a country wishes to export products.

Industrial Potential

The principal fish now landed along the Argentine coastline are papamoseas and hake. In 1966 they accounted for about one-third of the total catch. Both fish migrate from the southern coast of Uruguay to the central and southern coasts of Argentina. Argentina also has a large resource of shrimp and other shellfish. The krill fishery has been estimated to be as much as 480,000,000 metric tons, a figure six or seven times that of the total present world catch of fish and shellfish. Although never adequately surveyed, its total fisheries potential could make Argentina a world leader in catching, processing, and exporting fishery products.

Industry Development

Marine science related to biological products is so fragmented that initial maximum effort must be made to coordinate and integrate the potential subareas. A consortium of U.S. universities could participate in an Argentine study on the development of a national program.

Beginning a technological program in fisheries should be coordinated with a broader program for marine fisheries, as follows:

Organization of program. The various biological and oceanographic groups associated with biological production from marine waters should coordinate their efforts in studying sources of raw materials, outlining long-range planning for the fisheries industry, and utilizing joint facilities such as vessels and shore installations. A sound technological program can be developed and carried out only if interested universities, government, and private organizations all take part in the initial organization.

Preliminary studies. A study of the present fisheries industry is necessary to learn how techniques and practices are related to the quality and condition of raw materials landed at shoreside plants. The study should include a comparison of the Argentine fisheries with those of other Latin American countries that already exploit marine resources and should be coordinated with the economic aspects of this developing industry. Even with a large potential source of raw material in Argentina's marine waters, exploitation most certainly will rely on capital investment and subsequent return on that investment.

Education and research programs. Food science and technology should be taught in the universities as a broad, basic subject, not as a special

industry-by-industry food resource. Fishery technology should be integrated into an overall food science and technology program so that university-trained personnel could enter any phase of the food industry--fisheries, dairies, fruits and vegetables, etc. Furthermore, university-trained personnel should have a general background that enables them to enter different phases of an industry--research, operations, or marketing.

Two separate areas of research associated with the fisheries industry must be recognized: (1) research that can be carried out in conjunction with the academic environment (e.g., development of scientific and technological methods of obtaining fish-protein concentrates for human consumption with adequate organoleptic, chemical, and nutritional values); and (2) pilot-plant commercialization of proven techniques best carried out in the government and private laboratories that have facilities near the source of raw materials. Hence, the development of a viable fisheries industry in Argentina must be a well-coordinated effort encompassing education of well-qualified scientific and technical personnel, modern harvesting techniques, and commercialization of processes to meet international standards of sanitation and quality control.

Multiuse pilot plants should be developed for food technology so that they are not restricted to one food product. For example, a pilot plant for the production of oil from oil-seed proteins should also be capable of extracting wet proteins such as fish from protein and oil products. Furthermore, in many of these areas various products might be interrelated; for example, fish-protein concentrate and other agricultural proteins could be co-precipitated, giving an end product that

is better balanced nutritionally and greatly decreasing production costs.

Allied with academic programs for graduating fisheries scientists and technologists, extensive continuing education programs should be developed by the universities specifically for (1) foremen and actual operating people who need periodic education and information on the sanitation and quality-control standards and techniques in their specific jobs, and (2) technological personnel associated with the industry who need short courses for occasional updating of their knowledge in the fisheries field.

The pending international shortage of proteins includes not only inert ingredients that provide nutritional constituents, but also functional proteins that can be used in compounding prepared foods that have properties adaptable to the specific end product. However, most of the past research carried out on fish-protein concentrates has culminated in products with few functional properties, that is, the ability to absorb water, swell, etc. Academic research should concentrate on the development or refinement needed before functional protein products can be produced to enter the world market at prices competitive with other materials. This means that conventional solvent-extraction techniques to produce nonfunctional proteins should be modified or varied. Acqueous extraction, fermentation, and enzyme hydrolysis should be studied as techniques for converting wet proteins such as marine fisheries products into functional high-protein concentrates. Of course, the development of these new techniques must include studies on the nutritional properties of the various products.

## ARGENTINE - U.S. SEMINAR ON FOOD TECHNOLOGY

### Members from Argentina

PEDRO CATTANEO, Professor of Food Science, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires, Chairman

RODOLFO J. ERTOLA, Professor of Industrial Microbiology, Facultad de Ciencias Exactas, Universidad de La Plata, La Plata

JUAN C. SANAHUJA, Director, Department of Food Science and Nutrition, Facultad de Farmacia y Bioquímica, Universidad de Buenos Aires, Buenos Aires

### Members from the United States

C.O. CHICHESTER, Department of Food and Resource Chemistry, The University of Rhode Island, Kingston, Rhode Island, Chairman

HAROLD E. CALBERT, Department of Dairy and Food Industries, University of Wisconsin, Madison, Wisconsin

MARTIN W. MILLER, Department of Food Science and Technology, University of California, Davis, California

GEORGE N. PIGOTT, Department of Food Science, College of Fisheries, University of Washington, Seattle, Washington

### Other Participants

ANTONIO P. BALATTI, Faculty of Exact Sciences, Department of Technological Chemistry, National University of La Plata, La Plata

CARLOS M. CUEVAS, Faculty of Exact Sciences, Department of Technological Chemistry, National University of La Plata, La Plata

MAXIMO BOCKLET, Faculty of Agrarian Sciences, National University of Cuyo, Mendoza

EZIO EMILIANI, National University of the Litoral, Santa Fe

ROBERTO HALBINGER, Faculty of Agronomy and Veterinary Medicine, National University of Buenos Aires, Buenos Aires

ERNESTO KASDORF, Director, Kasdorf and Company, Buenos Aires

Other Participants (Cont'd)

JORGE J. RONCO, Faculty of Exact Sciences, Department of Technological Chemistry, National University of La Plata, La Plata

RAUL E. TRUCCO, Institute of Chemical Sciences, National University of Córdoba, Córdoba

APPENDIX B

# PRELIMINARY ASSESSMENT OF SOME PROBLEMS OF THE HYDROGEOLOGY OF THE DRY PAMPAS IN BUENOS AIRES PROVINCE, ARGENTINA

Trip Report

September 1970

by

Dr. Stanley Davis

Dr. John Winslow

Under the Auspices of the

National Academy of Sciences (USA)

Consejo Nacional de Investigaciones Científicas y Técnicas (Argentina)

In fulfillment of
Agency for International Development Contract csd-2584
Task Order #3

(Reproduction of 1971 Report)

## TABLE OF CONTENTS

Page

INTRODUCTION ..... 47

BACKGROUND INFORMATION ON THE PAMPA SEMIARIDA ..... 47

PROPOSED STUDY OF THE PAMPA SEMIARIDA ..... 52

PROPOSED PROCEDURE ..... 53

WORK TO BE ACCOMPLISHED ..... 54

RELATED STUDIES ..... 57

SELECTION OF PERSONNEL ..... 57

PROBLEMS OF FINANCING ..... 58

CONCLUSIONS ..... 60

# Preliminary Assessment of Some Problems of the Hydrogeology of the Dry Pampas in Buenos Aires Province, Argentina

## Introduction

This report describes a preliminary assessment of some problems of the hydrogeology of an area of the dry Pampas (Pampa Semiarida) of western Buenos Aires Province, Argentina made by the authors in September 1970. The trip was made in accordance with an agreement between the U.S. National Academy of Sciences (NAS) and the Argentine Consejo Nacional de Investigaciones Científicas y Técnicas (CONICT) and was financed in part by the U.S. Agency for International Development (AID). The report is based upon 1) data and information made available by Argentine hydrogeologists, particularly the group working under Dr. Luis E. Arigós, 2) conferences with Ing. José S. Gandolfo and Drs. Oscar Ruiz Huidobro, Amilcar Galván and Dr. Luis E. Arigós, 3) a short, but highly informative, trip to the Pampa taken August 25 through 28, 1970 and 4) discussions held during the 1969 Argentine-U.S. Workshop on Science and Technology in Economic Development held in Mar del Plata, Argentina.

## Background Information on the Pampa Semiarida

The area visited is in the cattle-raising region of the dry Pampa in the western part of the Province of Buenos Aires, roughly between longitude 61-63 west and latitude 34-36 south. The problems of water supply are representative of those in much of the Pampean region of central

Argentina.

The area is virtually flat and without evidence of surficial drainage. In the southern part, in the vicinity of Trenque Lauquen, low sand dunes provide local relief of a few meters. In the northern part, relief is seldom discernable. In all of the area the slight depressions are points of ground-water discharge by evaporation, and these are marked by small playas or salt-crusted soils. The southeast regional gradient is so slight (about one foot per mile) that ground-water movement is principally in response to local factors such as pumping, ground-water recharge from precipitation and discharge by evapotranspiration.

Water supply for domestic and stock use is from wells except for precipitation collected from the roofs of buildings and stored in cisterns (aljives) for human consumption. Storage volumes of the aljives commonly exceed 50,000 liters but the fresh water supply is often depleted during periods of drought.

The aquifer consists principally of silt and sand of Pleistocene age. It ranges from 20 to 70 meters in thickness, with an average thickness of about 50 meters. The surficial materials are at least in part the result of eolian action. The underlying clays of Tertiary age are reported to be about 500 meters in thickness, and are not a source of water to wells.

Water in the aquifer is generally saline, being progressively more saline with depth. However, in some local areas the water in the upper part of the aquifer is of sufficiently low salinity to be acceptable for human and/or stock consumption. In a small area of sand dunes southwest

of Trenque Lauquen, the aquifer zone containing acceptable water is about 50 meters thick, but generally such potable water zones are much thinner. In one area near the northern boundary of Buenos Aires Province, the water produced by windmill-powered wells becomes too saline for use after about two days pumping, but if the wells are then turned off for several days, the water is of more acceptable quality on the resumption of pumping. This indicates either lateral movement of saline water as a result of pumping or, most likely, that more saline water moves up from lower zones. It has also been observed that if a given amount of water is produced by a number of very shallow wells, rather than a single well, the quality of water deteriorates more slowly. Scavenger wells have been considered impractical because of lack of areas to place scavenged saline water.

Water generally is considered potable for human consumption when the dissolved-solids concentration is less than 2,000 mg/l (milligrams per liter), and for cattle when less than 4,000 mg/l; however, much of the water used exceeds these limits. The ionic constituents in the water are principally sodium, calcium, sulfate, chloride and carbonate, but it also contains nitrate, fluoride and arsenic in significant amounts.

Recharge to the aquifer is from precipitation which averages about 800 mm per year. The range in annual precipitation is from about 500 mm to about 1,100 mm (Trenque Lauquen). Winter is the dry season. Evaporation is about twice the average precipitation. Over most of the area the water table is within a few meters of the surface so that ground-water discharge

is by evapotranspiration from the water table as well as from evaporation and playas and other low areas. Because of the delicate balance between recharge and discharge and the shallow water table, importation of water will require similar exportation of saline water.

Municipalities initially presumably developed in areas of the more potable water. Generally water supply is from individual shallow wells and sewage disposal by means of individual septic tanks. The quality of the water probably has deteriorated with time. In about 18 months, Trenque Lauquen (population about 30,000) will receive water from supply wells from a potable-water area southeast of town. However, if present sewage disposal methods continue without pumping, water levels beneath the town should rise. Water supply for cattle generally is pumped from shallow wells by windmills into open-topped storage tanks from which it is metered into watering troughs by float valves. Attempts have been made to locate these wells in areas of potable water, but many yield water of marginal utility, or water which is virtually unusable. Unfortunately, cattle-watering troughs generally are close to wells so that it is possible for animal wastes to percolate to the water table and pollute the aquifer, thereby worsening an already difficult situation. One cattle-raising area near the boundary between the provinces of Buenos Aires and Santa Fe previously was supplied by seven wells which in time became too saline for use. Now water is piped in from an area nearby. The deterioration in quality of the initially acceptable water may have been caused either by pollution or by removal (mining) of potable

water in the upper part of the aquifer.

The method of finding areas where the upper part of the aquifer contains water of unusable quality has become largely a matter of trial. Over the years, the inhabitants have learned to recognize that certain types of areas are better than average for finding potable water. Relatively higher areas, especially in stabilized sand dunes, are favored for exploration. Here, the depth to water is slightly greater and discharge of ground-water by evapotranspiration is probably slightly less than average. Perhaps, also the infiltration capacity of the soils is better than average in the higher areas. A second favored location is near roads where the manner of road construction favors better-than-average ground-water recharge. The roads generally are built slightly above the general land level, and are flanked by ditches. Apparently, a fair proportion of the water that stands in the ditches after a rain percolates to the water table. In other places the presence of potable water areas has no easy explanation on the basis of present data.

A large amount of data on the ground-water resources of the Pampean region has been collected by Argentine scientists. Thousands of wells have been inventoried for water level and construction details; thousands of water samples have been analyzed. Test wells have been drilled to study aquifer materials and the change of water quality with depth. Electrical resistivity surveys have been made in certain areas with some apparent success in delineating areas of potable water. Grouped together, these

studies provide a large body of information from which plans can be developed for further investigation of the ground-water resources of the area as well as for further development of the water resources.

## Proposed Study of the Pampa Semiarida

The authors recommend a study of the hydrogeology of the Pampa Semiarida 1) to elucidate specific immediate steps which must be taken to maintain and, if possible, increase the agricultural productivity of the region and 2) to provide more basic data for a clearer understanding of scientific questions underlying ground-water resources in the area.

The objectives of the proposed study will be to 1) determine as accurately as possible the origin of waters of both low and high salinities, 2) determine the hydrogeologic controls which serve to localize waters of various qualities, 3) determine the origin of minor and trace constituents that occur in the water in unusual amounts and 4) develop exploration criteria which will enable future studies of water quality to progress more rapidly over a wide area. Despite the lack of specific practical objectives, data needed for the theoretical work will allow parallel or later studies to develop answers to problems of well construction, estimation of the quantity of available fresh water, economics of salt-water conversion and construction of drainage systems which are necessary with all water importation and/or recharge projects.

Proposed Procedure

The following procedure is offered only as a starting point for future discussions. The program should always be as flexible as possible to take advantage of new knowledge as it becomes available. An emphasis is placed on investigations which will yield a maximum amount of information for the time and money invested. Although of some potential use, caution should be exercised in embarking on costly analog models, full-scale geophysical exploration, and the like before full use is made of inexpensive procedures which are commonly more productive from a scientific standpoint.

Needless to say, all available data should first be collected and analyzed. We understand that the Direccion Nacional de Geología y Minería has made some preliminary studies of the fresh water-salt water problems of portions of the Pampa Semiarida. Although these studies are not as extensive as needed, every effort should be made to incorporate the data into the proposed research program. Likewise, a comprehensive literature search of studies in other areas of the world having similar fresh water-saline water problems should be made to incorporate whatever findings may be judged useful to the Pampa Semiarida.

Four test areas should be selected for intensive investigation in Argentina. The selection should be based on hydrogeological variations which are present. As an example, one area could be a region of sand dunes, another a region with salt-water lakes or ponds, another of extremely poor water but without surface topography, and the last region might be on the

eastern boundary of the Pampa Semiarida. About 100 $km^2$ might be a convenient size. The exact boundaries should be determined by hydrogeologic considerations together with existing boundaries of estancias rather than making the areas conform to latitude and longitude lines.

The bulk of the work will involve drilling and sampling shallow test holes and placing semi-permanent casing in the holes. A limited number of deeper holes, perhaps 100 to 200 meters deep, should be drilled in order to sample areas in which unusually high or unusually low salinities are encountered.

The excellent inventory and survey already accomplished by Dr. Arigós will form a good basis for provisional selection of test areas. As Drs. Huidobro, Arigós, and others have emphasized, however, the probability exists that many wells which have been sampled may be contaminated by humans, and to a larger degree by cattle. Much of the contamination will be localized around watering points which are also near the wells that have been sampled. The need for new test holes at least 300 m, preferably up gradient, from existing or abandoned wells cannot be emphasized too strongly. The exact number of test holes needed will vary from one locality to another, depending on the variability of water quality between sampling points. One hole per $km^2$ might be a reasonable suggestion for planning purposes.

## Work to be Accomplished

The following list gives the actual work which should be accomplished

after the test areas have been selected. The list is given in the approximate order of importance but not in chronological order. A preliminary work chart is also included which gives some indication of the sequence which might be followed. Again, it should be emphasized that this list is intended to promote discussion and an exchange of ideas rather than serve as a basis for final planning.

1. Inventory existing wells within the test area and collect water samples for laboratory analyses. This will serve to pinpoint changes which may have occurred since the last inventory. Estancia owners and foremen should be interviewed in order to determine location of abandoned wells and areas which have had human or animal concentrations in the past. Such areas should be noted as areas of possible artificial contamination.

2. Auger test and observation wells, collect geologic and water samples, install casing, measure water levels, and make short-term pumping tests. A poor alternative would be to make slug tests. Although slug tests are not very reliable, a comparative value can be obtained provided the design and construction of the wells are standarized. If time and money are available, low discharge aquifer tests should be made of all test holes.

Make laboratory analyses of water and sediment samples. Particular attention should be paid to trace constituents in the water and to stratigraphic markers in the sediments. A number of determinations should be made of $H^3$ and $C^{14}$ concentrations in the water samples.

4. Make leaching tests of surface soil and auger samples. Make chemical analyses of leachate.

5. Run second-order level lines to all observation wells. Owing to the low gradients, as much precision as possible should be achieved in order to determine local ground-water gradients.

6. Drill deep wells in areas of fresh and saline water. Water and sediment samples to be processed the same as samples from auger holes. If rotary drilling is used, special care should be taken to obtain good samples. This is particularly difficult under most circumstances unless special coring tubes and packers are available. Rotary drilling has the advantage, nevertheless, of allowing electrical logging as well as a number of other "wire-line" methods.

7. Establish several automatic as well as manual monitoring stations. Some items to measure are water levels, salinity, air and water temperatures, rainfall, soil moisture at various depths, and evapotranspiration. This phase of the work will probably take at least two years.

8. Continue and expand study of exising air photographs. Details obtained in test areas may be correlated with features shown on photographs.

9. Establish programs to study special techniques for surveying fresh and salty water. Such programs might include low-cost surface geophysics as well as false-color, near infrared photography. If remote sensing programs are planned by other Argentine agencies, it may be possible to have the test areas surveyed at little or no extra cost.

10. Write final report. It is essential that enough money be budgeted so the final report can be finished, printed and widely distributed. The work will most likely uncover new facts and principles which will be of wide interest in the scientific community as a whole.

Related Studies

Hydrogeologic studies already planned and underway in the Province of Buenos Aires should be continued and perhaps expanded. This work is an important complement to the research proposed for the test areas.

Selected studies of a more practical nature could also be started before the test-area research is completed. Effects of water importation, methods of determining the "safe yield" of an area, well-design problems, and many other items must be considered before water supplies of the Pampa region are fully developed.

Non-hydrogeologic topics also need investigation. Argentine scientists interested in the water-supply problems have all emphasized the need for a thorough review of existing information on the relation of water quality to growth of cattle. If the existing information is not sufficient, as appears likely, field tests under careful statistical controls should be made. Water-supply utilization cannot be planned intelligently unless the above information is available.

Selection of Personnel

As visualized in this report, the research will be carried out by

Argentine scientists who will be selected by the proper local agency. Conferences and reports will involve other Argentine researchers as well as people from outside the country. In addition, the NAS of the United States may establish a more formal basis of cooperation and exchange of information between selected specialists in Argentina and their counterparts in the United States. If so, the NAS will undoubtedly consult with the appropriate Argentine agency (presumably the CONICT) concerning individuals under consideration.

Types of specialists to be considered include:

1. A general hydrogeologist with Latin American experience who is interested in research as well as practical applications of scientific work.

2. A hydrogeochemist who is acquainted with analytical techniques as well as theoretical physical chemistry. Perhaps two men will be needed in this category.

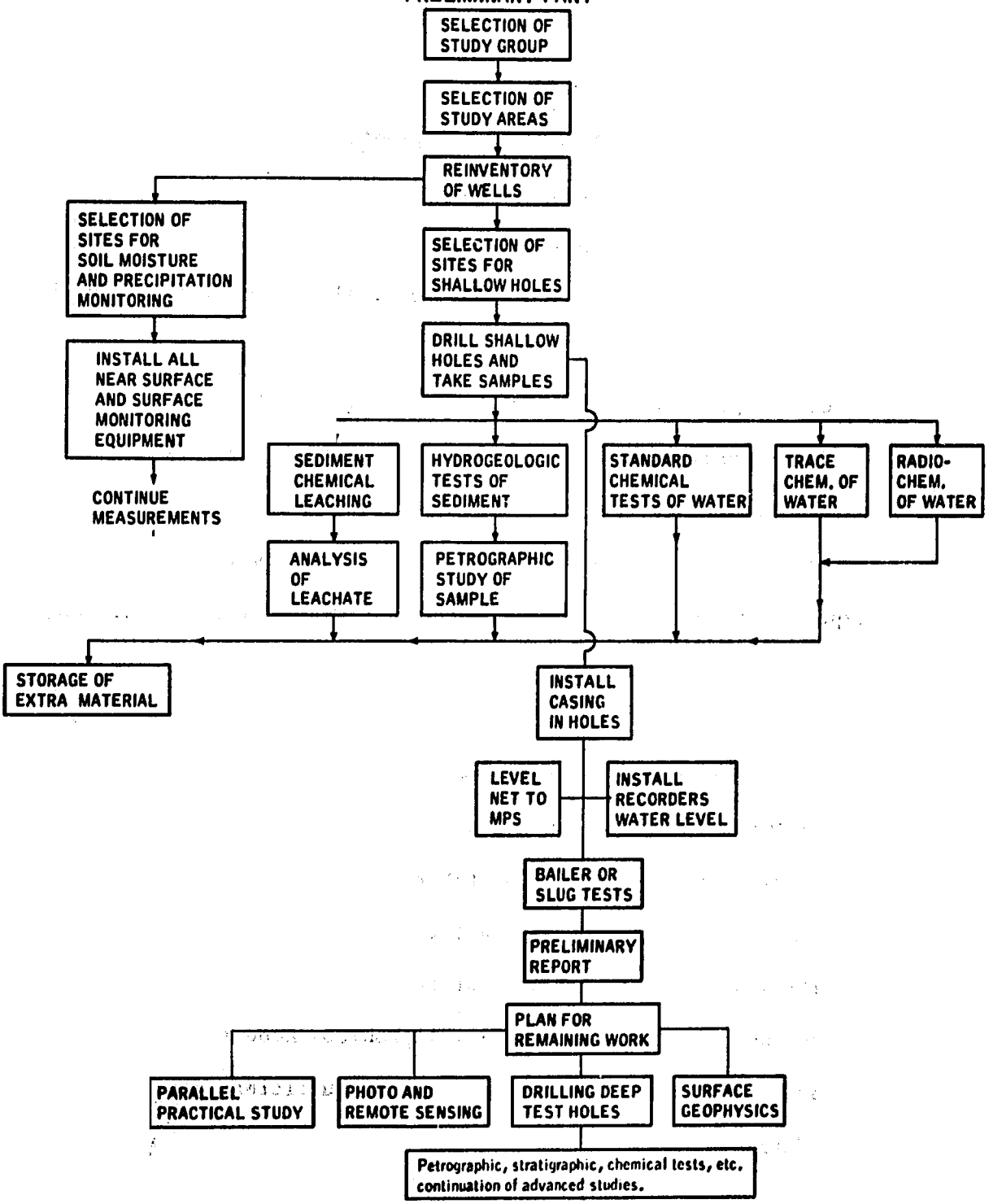
3. A geophysicist who is familiar with the broad problems of ground-water exploration. This man will be needed about midway through the project.

4. An expert in remote sensing if some activity in this field is contemplated.

## Problems of Financing

Financing the proposed project is of great concern to the Argentine scientists. Although much of the basic equipment is available for the

## TIME SEQUENCE IN WATER QUALITY RESEARCH PRELIMINARY PART



survey work, the following are some of the items which may need to be purchased:

1. Special coring tubes.
2. Soil moisture measuring equipment, possibly a neutron probe.
3. Water-level recorders.
4. Inexpensive rain gages.
5. Special chemical equipment for field measurement of pH, iron, and bicarbonate.
6. Temperature probes and read-out equipment.
7. Special equipment for trace constituent analyses.
8. Plastic casing for observation wells.

If technical assistance of foreign scientists is deemed desirable, the expenses of these persons should be included in the cost estimate.

## Conclusions

Argentine hydrogeologists are interested in a research project in the Pampa Semiarida where quality of ground-water is of great practical importance as well as theoretical interest. A brief reconnaissance has indicated that such a project is feasible through an intensive investigation of a small number of test areas that typify the hydrogeologic variations of the region. Staffing and financial problems need to be resolved, but the importance of the project suggests that sufficient governmental interest will be developed to insure success.

## ARGENTINE - U.S. GROUNDWATER HYDROLOGY STUDY GROUP

### Members from Argentina

JOSE S. GANDOLFO, Argentine Academy of Exact, Physical, and Natural Sciences, Buenos Aires, Chairman

OSCAR RUIZ HUIDOBRO, Department of Geology, Faculty of Exact and Natural Sciences, University of Buenos Aires, Buenos Aires

AMILCAR GALVAN, National Service of Geology and Minerals, Buenos Aires

### Members from the United States

STANLEY N. DAVIS, Department of Geology, College of Arts and Science, University of Missouri, Columbia, Missouri

JOHN D. WINSLOW, Staff Hydrologist, U.S. Geological Survey, Mineola, Long Island, New York