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INDUSTRIAL RESEARCH INSTITUTES:
Their Role in the Application of Appropriate Technology and Development

COLOMBIA:
The Composite Flour Program

James M. Miller

A series prepared by the
University of Denver
Denver Research Institute
Office of International Programs
under the sponsorship of the
U.S. Agency for International Development
Office of Science and Technology

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FOREWORD

This case history has been written to assist development planners, personnel of industrial research institutes, and USAID mission personnel in understanding the role that IRIs can and do play in the application of technology to development. This case history is one in a series of eight prepared by the Denver Research Institute under the sponsorship of USAID/Office of Science and Technology (contract AID/ta-C-1337).

The cases in this monograph series first appeared in another DRI publication, Appropriate Technology for Development: A Discussion and Case Histories, edited by Donald D. Evans and Laurie Nogg Adler (Boulder, Colorado: Westview Press, 1979). This book was sponsored by the USAID Office of Science and Technology in preparation for the United Nations Conference on Science and Technology for Development (UNCSTD).

INTRODUCTION

INDUSTRIAL RESEARCH INSTITUTES

In many countries the creation of a viable indigenous industrial sector has long been considered one of the key elements to economic development. Consequently, an industrial research capability is of significance in defining the industrial needs and priorities of a country or region and matching them with appropriate technologies. An industrial research institute (IRI) has been defined as a technical organization established to make direct contributions to industrial development in the private and public sectors[1]. In this context an IRI differs from private research entities which have no proclaimed mandate or responsibility in the practical application or adaptation of technology to their countries' development needs. Frequently industrial research institutes are in some manner government funded and are therefore closely allied to the economic, social and political climate of that government. Ideally, IRIs play a supporting role in the design and implementation of national policies that reflect economic development and growth, while functioning autonomously. In reality, however, government usually plays a substantive role in research institute operations. In any case, compatibility and cooperation among government agencies should be preserved, and selection of industrial research programs should reflect needs of both the public and the private sector.

In many instances, the IRI acts as liaison between government and industry. Ideally and particularly in less developed countries (LDCs), the IRI acts as an intermediary in determination of the need for and the subsequent creation, adaptation or transfer of technology. In fact, the study of technological opportunities or the choice of appropriate technology for development is one of the major functions of the industrial research institute.

In comparison to other technologies, appropriate technology represents the social and cultural dimensions of innovation[2]. As a mediator in an innovation process, a research institute's task is to identify the real needs of the local community, develop or introduce technologies and organizational means which can meet these needs and initiate a process of development based on the internal innovative forces of the local community[3]. In this manner, the IRI addresses the issue of appropriate technology and its role in the development process.

However, opportunities for innovation do exist in areas other than just industrialization--increasing agricultural productivity, developing

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[1] United Nations. Industrial Research Institutes, United Nations Publication No. E.70.II B.21. New York: UN, 1970, p. vii.

[2] Nicolas Jequier, Appropriate Technology: Problems and Promises. Part I, The Major Policy Issues, 1976, Development Center of the Organization for Economic Cooperation and Development (OECD). p. 9.

[3] Ibid., p. 36.

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rural technologies, and offering incentives for small industrial projects are also duties that a research institute is likely to perform.

The methods by which IRIs assess technological choice and stimulate innovation are varied. Most often development strategies would include a combination of the following:

- Survey, study and develop uses for local raw materials.
- Develop new processes and improve existing ones.
- Develop new products and recognize new uses for existing ones.
- Improve industrial and agricultural productivity.
- Study the technological and socioeconomic feasibility of industrial and agricultural projects.
- Develop standards and specifications.
- Determine choice of technology and scale of operation.
- Determine industrial location and site.
- Conduct marketing research[4].
- Acquire and disseminate scientific and technological information.
- Systems design and management of development programs.
- Evaluate a chosen technology and its relationship to local economic and cultural traditions.

To establish solutions to identifiable problems, the research institute often adapts foreign technologies to suit local conditions and offers incentives to small industries to create new technologies. Technological innovation is accomplished in a variety of ways from actual adaptation of a chosen technology to training of researchers and engineers for institution building and infrastructural support, to establishment of extension services to help define and fulfill needs.

The creation of linkages between research institutes has allowed increased communication and the transfer of information and technologies, not only between developed and developing countries, but among developing countries as well. In a few instances, regional research

[4] United Nations. Proceedings of the Interregional Seminar on Industrial Research and Development Institutes in Developing Countries, Beirut, Lebanon, 30 November-11 December, 1964. Vol. 1, New York: UN, 1966. p. 45.

institutes or networks of institutes have been established to facilitate development in common geographic and cultural areas. (ICAITI in Guatemala representing Central America is such an example.) Similarly, an international IRI organization called WAITRO (World Association of Industrial and Technological Research Organizations) has been created.

Industrial research institutes tend to become the foci for national S&T development and have offered essential infrastructural support. Research institutes, therefore, may play a very important role in mapping the future economic growth and development of a country. With this increasing responsibility, an IRI's task becomes more complex and difficult, particularly when original development goals are overwhelmed by other considerations. Factors such as politics, financial risk, societal or cultural considerations, legal restrictions, staffing problems, marketing problems, fear of change, and sheer inertia may impede or block the transfer process and thus weaken or negate its economic effect[5].

CASE HISTORIES

Much can be learned about development from the investigation and analysis of industrial research institutes. The Office of International Programs (OIP) at the Denver Research Institute (DRI) has initiated linkage activities with a variety of research institutes worldwide over the last decade under the sponsorship of USAID's Office of Science and Technology. Through these linkage activites, choice and adaptation of technology, training of researchers and engineers, exchange of information and help in the management of research institute affairs have occurred. A dynamic process of communication has been established through DRI's relationship with each research institute, and much knowledge has been gained about the development process by all those involved.

Realizing the value of imparting research institute experiences to others in the development field, DRI has gathered several case histories of industrial research institutes' endeavors in the area of technology transfer. The cases were collected for the most part by OIP staff (often assisted by IRI colleagues) who acted as impartial reporters when collecting the information. The goal of the research was not to select cases that showed only successful adaptation of technology, but to show ways and means by which IRIs must operate to encourage and achieve progress in the development scheme. There are, in fact, examples where a transfer of technology is considered unsuccessful or unsatisfactory.

In the case Colombia: The Composite Flour Program, written by James M. Miller, efforts made by the Instituto de Investigaciones Tecnológicas (IIT) to reduce imports of wheat by substituting locally available flours, e.g., defatted soya and rice, particularly in breads

[5] James P. Blackledge, The Industrial Research Institute in a Developing Country: A Comparative Analysis. Washington, D.C.: USAIS, 1975. p. 19.

and totally in pastas. The pasta program has succeeded in its goals, but the bread program still needs initiative from the Colombian government.

COLOMBIA:
THE COMPOSITE FLOUR PROGRAM

James M. Miller

BACKGROUND

The Instituto de Investigaciones Technológicas (IIT), in Bogotá, Colombia, began work in 1966 on the idea of replacing wheat in commercial food products. This initiative was made by Dr. Norton Young, then the institute director. The technology involved research into the substitution of wheat with locally grown cereals, first in alimentary pastas, then in bread. The first question was to what degree wheat could be replaced: possibly 100 percent in pastas and to a lesser degree in the composite flours used in the two basic breads consumed in Colombia. Breads and pastas were critical because they ranked highest with meat as the food recommended by the institute. The objective was to improve nutrition in products readily acceptable to consumers and was aimed primarily at increasing submarginal nutrition among the poorest group of the nation. Also, since wheat was and is a major food import, the project sought to reduce wheat consumption and thereby decrease the balance of payments problem that Colombia was experiencing.

The Colombian population is divided into five income groups; the lowest group comprises 30 percent of the total population (see Figure 1). This group obtains only 62 percent of the protein and 65 percent of the calories recommended by the Colombian Family Welfare Institute (see Figure 2). In the most economically depressed areas, 50 percent of the population receives only one-half of the recommended protein and calorie allowances.

Wheat production in Colombia dropped from 142,000 tons in 1960 to 54,000 tons in 1970 and then to 38,000 tons in 1978. Imports increased from 116,000 tons in 1960 to 326,000 tons in 1970, and by 1978 they reached 500,000 tons. The FOB value of imported wheat by 1978 was $63 million in U.S. dollars, or $126 per ton. The National Institute for Marketing of Agricultural Products (IDEMA) projected wheat imports for 1979 of 430,000 tons at a cost of $80 million, or

FIGURE 1
PERCENTAGE OF RECOMMENDED ALLOWANCES OF CALORIES AND PROTEINS MET BY FOOD PURCHASED BY THE TWO LOWEST INCOME GROUPS OF COLOMBIAN POPULATION

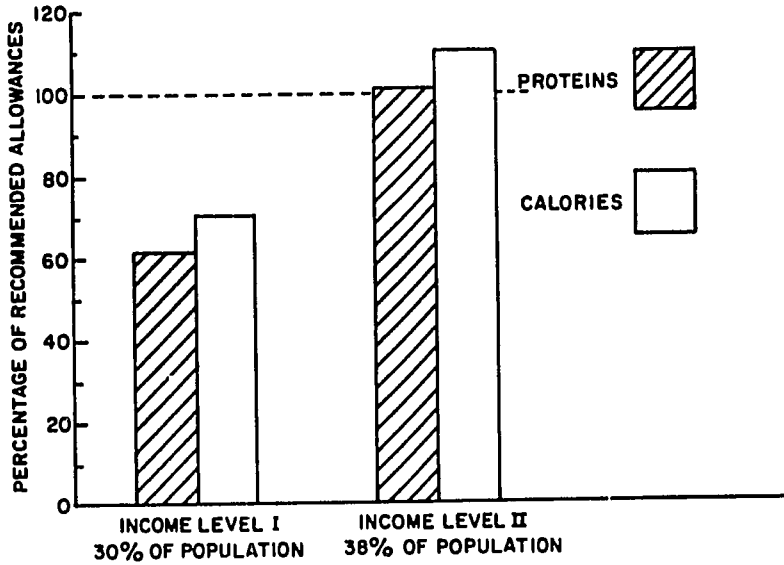
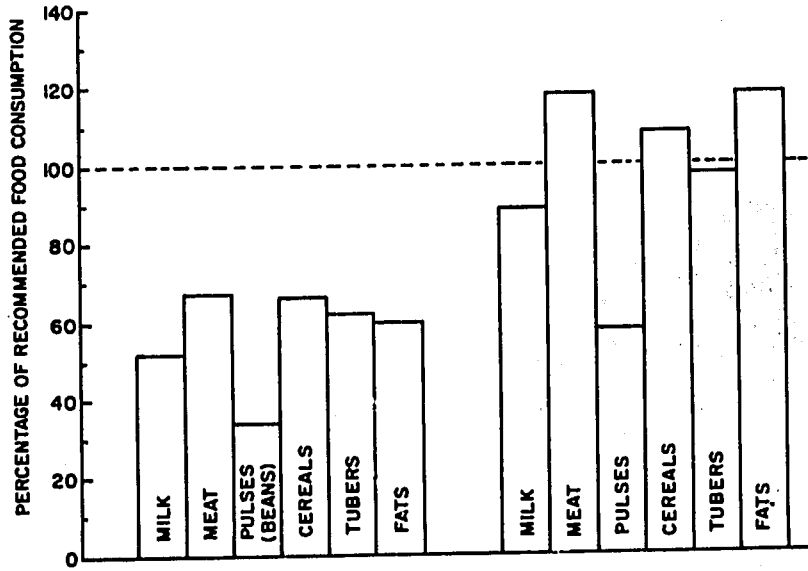


FIGURE 2
PERCENTAGE OF RECOMMENDED FOOD CONSUMPTION MET BY FOOD PURCHASED BY THE TWO LOWEST INCOME GROUPS OF COLOMBIAN POPULATION



$186 per ton; however, the price had risen by August 1978 to $245 per ton. Wheat is now predicted by Dr. Teresa Salazar de Buckle, project supervisor, to reach $350 per ton by 1980. However, even at the old price of $186 per ton, a 20 percent replacement of imported wheat, using the standard 70 percent wheat, 27 percent rice flour, 3 percent soya and flour formula, taking 70 percent of the imported wheat for breadmaking would equal a balance of payments savings of $11 million.

In addition to obtaining higher protein cereals for better nutrition and an improved balance of foreign trade, another advantage of wheat substitution would be an increase in local crop production with a corresponding increase in the need for labor. The program also would guarantee the availability of raw materials to millers.

TECHNICAL SOLUTIONS

Technical solutions to the problem can be divided between alimentary pastas, the composition of which was undertaken by IIT, and breads. In pastas the composite substitutes were easily achieved and readily accepted. This was not the case in breads.

Eight formula options for pastas were studied by IIT between 1965 and 1975 (see Table 1). When first-grade wheat was being imported, IIT concluded that formula VII, composed of 50 percent precooked normal corn, 25 percent soya, and 25 percent semola, was superior. This pasta contained 19 percent protein and had a Protein Efficiency Ratio (PER) of 2.69 compared with semolina pasta, which contained 12 percent protein and had a PER of 0.91 (casein 2.79). With the change to second-grade wheat imports, formula VIII, composed of 15 percent soya and 85 percent semola, temporarily became the preferred product. Each of the two formulas, in turn, was adopted by the Colombian Plan for Food and Nutrition (PAN). In 1978, 750 tons of pasta were distributed to the very poor under a PAN coupon system.

TABLE 1
COMPOSITE FLOUR FORMULAS

Flour Formulations	I	II	III	IV	V	VI	VII	VIII
Normal corn		50%						
Precooked white corn				30%			50%	
Precooked opaque corn					30%	50%		
Cassava			50%					
Rice	50%							
Soya	25%	25%	25%				25%	15%
Semola of wheat	25%	25%	25%	70%	70%	50%	25%	85%

It had great acceptance. IIT also showed at the pilot level that substitution of corn or rice flours to levels up to 75 percent was technically feasible. One oil miller[1] currently is producing good-quality defatted soybean flour because of the pasta and composite flours research.

Regarding the precooking process using extruders,[2] tests indicate that scaling down extruders from plants producing 10,000 tons of corn per year at a capital outlay of $1.5 million is very feasible. For example, two inexpensive types of extruders producing 100 kilograms per hour have been compared. The first is one built by the Meals for Millions Foundation, (U.S.), and the second is an extruder designed and built in Colombia originally for corn snacks. The first could be used without design modification; the second requires the building of a prototype that will improve the feeding system and control temperature. Present prices are CIF (cost, insurance, and freight)--between $20,000 and $22,000.

The second solution concerns composite flours for bread. Goals for this research were to have flour produced in commercial mills and the product sold to Bogotá bakers. The first phase, 1970-1972, demonstrated the feasibility of substituting some wheat by adding rice flour, soya flour, and other local products for bread equal to regular commercial bread as judged by consumer acceptance. Rice, corn, soya, cassava, bananas, and sorghum were tested. The standard formula finally determined was composed of 70 percent wheat flour, 27 percent rice flour, 3 percent defatted soybean flour, 0.5 percent calcium steaoryl lactylate (CSL), and 50 parts per million of potassium bromate ($KBrO_3$). Rice flour, cassava starch, cassava flour, and corn starch or corn grits flour were found to be interchangeable in composite flours provided that adjustments were made in corresponding percentages of soybean flour to keep the protein at the same level as wheat flour. Owing to the importation of second-grade wheat, the composite flour recently manufactured was 80 percent wheat flour, 17 percent rice flour, 2.75 percent defatted soybean flour, 0.25 percent CSL, and 50 parts per million of $KBrO_3$. This flour was produced in thirty-ton batches (see Tables 2 and 3).

In all the composite flour formulas, CSL was added because of the lower gluten content. CSL, in turn, must be imported. Milling of wheat with broken rice was found to

[1]An extractor of edible oils.

[2]A process in which materials are heated while mechanically passing through a compression screw and extruded through a die or other restriction.

TABLE 2
NUTRITIONAL CHARACTERISTICS OF ONE I.I.T. PASTA FORMULATION AND A STRAIGHT SEMOLA PASTA

COMPOSITION	PROTEIN (%)	CHEMICAL SCORE FAO 1973	PROTEIN GRAMS 100 CAL.	PROTEIN EFFICIENCY RATIO
Semola 25[1] Soybean 25[2] Corn 50[3]	10.9	73[4]	5.6	2.7[5]
Semola 100	10.7	39[4]	2.9	0.5[5]

[1]Wheat Semola
[2]Defatted Soybean Flour
[3]Pre-cooked Corn Flour
[4]Lysine, limiting amino acid
[5]Protein Efficiency Ratio of reference case in 2.8

TABLE 3
NUTRITIONAL CHARACTERISTICS OF RAW MATERIALS USED IN COLOMBIA FOR COMPOSITE FLOURS

PRODUCT	PROTEIN (%)	CHEMICAL SCORE*	LIMITING AMINO ACID
Wheat Flour	10.9	38	Lysine
Rice Flour	7.5	66	Lysine
Defatted Soybean Flour	46.0	80	Sulfur Content
<u>Composite Flour</u>			
Wheat Flour 70% Rice Flour 27% Soy Flour 3%	11.0 11.0	52 52	 Lysine
Wheat Flour 80% Rice Flour 17% Soy Flour 3%	 10.8 10.8	 50 50	 Lysine Lysine

*FAO protein and calories requirements, 1973

work well (see Figure 3). Only the premix function must be done elsewhere.

The second phase of the technology in breadmaking is to achieve widespread production of composite flours in commercial mills and at a price that will induce bakers to purchase these products. Without public endorsement by the Colombian government and possibly subsidy to achieve the economic advantage, the program regarding this country for the time being is static. Governmental policy could change as wheat prices continue to rise and because the government admits that both importation of wheat as well as consumption of bread are increasing at the rate of 5 percent annually.

FINANCIAL AND ORGANIZATIONAL ASPECTS

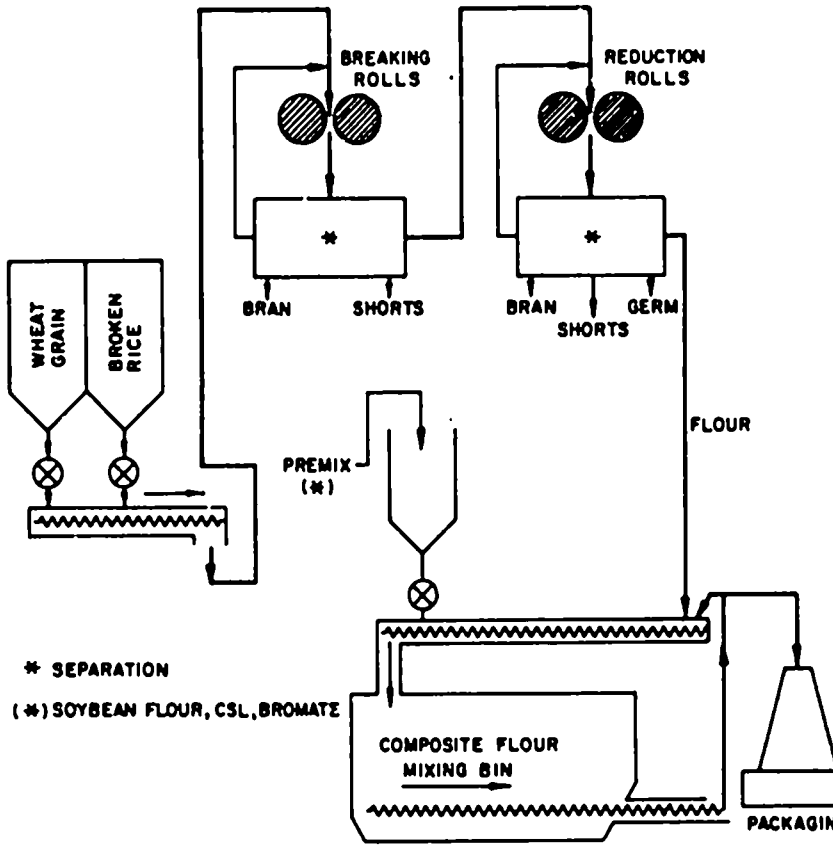
The pasta development program originated in IIT with support from the Colombian government and by 1970 was being funded by the Organization of American States (OAS). This project also received funding in its latest stages through the Denver Research Institute Grants Program. Total expense in the pasta portion was estimated at two million pesos or, in terms of 1975 dollars, approximately $67,000. The entire program was managed and operated by IIT. It is now endorsed by PAN.

The composite flour program for breads was and still is more complex. In the early days IIT, encouraged by laboratory findings in 1967, requested funding assistance from the United Nations Development Program (UNDP). The plan included in Phase 1: a technological feasibility study; marketing studies; and economic studies. On the basis of recommendations made by a UNDP/Food and Agriculture Organization (FAO) mission that visited Colombia in 1967, the undertaking proceeded because of promising results achieved in feasibility studies made by the Institute for Cereals, Flour, and Bread, Organization for Applied Scientific Research (TNO), Wageningen, The Netherlands.

The project was initiated with a bilateral agreement between the Colombian and Netherlands governments in 1970, an administrative agreement, and a plan of operations. The Colombian Executive Agency (IFI) assigned the operations to IIT. The Netherlands Executive Agency, Directie Internationale Technische Hulp of the Ministry of Foreign Affairs requested TNO's Institute for Cereals, Flour, and Bread (IGMB) to undertake the technical advisory task.

A separate agreement between TNO and FAO arranged for FAO to provide marketing services related to the testing and introduction of composite flours. TNO's Bureau of International Projects (BIP) prepared an appraisal of the economic aspects. IIT contracted with Interamerican Research Ltd., Bogotá, to assist in the marketing studies.

FIGURE 3
FLOWSHEET OF MILLING OPERATIONS IN MAKING COMPOSITE FLOURS



The project was conducted by a managing board, with Jorge Beltran of IIT acting as president, and was assisted by an advisory board that had as its president Dr. Norton Young, director of IIT. Between August 1970 and December 1972, the managing board met twenty times and the advisory board once. The project manager at IIT was Dr. de Buckle, chief of the program division.

In Phase I of this joint program, the Netherlands government appropriated $302,330, which included Dutch experts, raw materials, and equipment. The Colombian government appropriated $338,820, consisting of a physical plant with a bakery, Colombian equipment, and raw materials, plus technical and administrative staff.

Phase 2 under joint agreement between The Netherlands and Colombia began in June 1977 and ended in January 1979. The final report is being written by W. Vander Sluys of TNO, assigned to IIT, Bogotá. This phase involved appropriations of $350,000 by The Netherlands and $90,800 by the Colombian government. The general scope involved, as previously mentioned, the achievement of commercial production of composite flours by a mill and its sale to bakers in Bogotá.

ECONOMIC CONSIDERATIONS

Based on IDEMA projections of wheat imports at $186 per ton, although the cost is now predicted to reach $350 per ton by 1980, a 20 percent composite flour would result in savings in foreign currency of $11 million. Dr. Norton Young, former director of IIT and president of the joint agreement advisory board, states that generalized use of 20 percent composite flour would save $16 million, and 30 percent would save $25 million.

The balance of payments issue presents compelling arguments for composite flours, according to the Netherlands/Colombian joint report. The report also points out a previous Colombian government subsidy of 50 percent to millers on wheat purchases. This stopped in 1974. The report cites other determinants not easily estimated, such as price advantages to bakers regarding composite flour and public support, trade relations, and promotional activities.

Young referred in 1978 to the reluctance of the government to force the use of composite flours in breadmaking, probably because of the uncertainty about composites becoming more costly. PAN already endorses composite flours in pastas, but this is not as complex an issue since it does not involve bakers' economics. Also, the pasta utilization is clearly advantageous nutritionally.

Other criteria mentioned in the joint report but that appear to be met easily are: production and supply of local

cereals; attractiveness of the product to the buyer; development of trade channels and storage and mixing facilities; and technological support, e.g., extension services to millers and bakers to guarantee adequate quality of the composite flours.

SOCIAL IMPACT

In terms of nutrition, Young reports pasta composite flour (formula VII) to be 19 percent protein compared to wheat flour, which is 10.7 percent. In breads this difference is less pronounced, namely, a composite flour protein range of 11.7 percent to 11.9 percent against 10.7 percent. Young reports the PER of pasta flour (VII) to be 2.7 versus 0.91 for wheat flour (reference casein 2.75).

The joint report reached the following conclusions: the Bogotan consumer fully accepted the bread; the bread can be made readily in all bakeries subject to some training of bakers and carefully controlled mixing; and the bread can be marketed within the existing trade structure and under prevailing commercial conditions as normal wheat bread.

Mentioned previously is the PAN program, which endorses the IIT composite flour formulas in pastas. Seven hundred and fifty tons went to the very poor under the PAN coupon system.

In terms of bakeries for bread, there are an estimated fifteen thousand in Colombia, most of which are small producers of from ten to one hundred kilograms per day. The millers initially opposed the research in Phase 1, but with the success of pastas, they now readily accept it.

RELATIONSHIP OF COMPOSITE FLOUR TO THE NATIONAL GOAL

This program: (1) provides improved nutrition, especially for the very poor; (2) already is improving the balance of payments situation, at least in the pasta area: all interviewees agreed that expansion into the breadmaking area is inevitable, although at present it is static; (3) provides expansion of local crops (for example, rice and soya), which increases employment and farm income; (4) would guarantee availability of raw materials to the millers of flour; and (5) calls for an absolute minimum of capital outlay, such as small extruders for rural production to meet the needs of the poor people.

REFERENCES

"Interpan--Joint Report of the Colombian-Netherlands Composite Flour Project" carried out in Bogotá 1971-72. This report issued by: IIT, Avenida 30 No. 52-A-77,

Bogotá; Institute for Cereals, Flour and Bread, TNO, P.O. Box 15, Wageningen, The Netherlands; Bureau of International Programs, TNO, P.O. Box 778, The Hague, The Netherlands; FAO, United Nation Food Policy and Nutrition Division, Rome, Italy.

Young, Norton. "The Composite Flour Program for Bread and Pasta Making in Colombia." Presented in Winnipeg, Canada, August 1978.

de Buckle, Teresa, and Carlos Pardo. Annotations to "The Composite Flour Programs in Colombia." IIT (Spanish).

de Buckle, Teresa et al. "Production of Pre-Cooked Corn Flours in Small-Scale Extruders." Presented at the Second International Low-Cost Extrusion Cooker Workshop, Dar es Salaam, Tanzania, 15-18 June 1979.

IIT Technical Report No. 98, November/December 1975.

PERSONS INTERVIEWED

Dr. Teresa Salazar de Buckle, head of programs, IIT, and project supervisor of composite flour program.

Jorge Beltran, head of information services, IIT.

Dr. Norton Young, former director, IIT, and president of joint program advisory board.

Dr. W. Van der Sluys, chemical engineer, IIT; assigned by TNO to Phase 2.

Luis O. Giraldo, Havenera del Valle (flour mill), Cali, Colombia.