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# INSTITUTE OF NUTRITION OF CENTRAL AMERICA AND PANAMA



# ANNUAL REPORT

January 1st – December 31st 1981



**INSTITUTE OF NUTRITION  
OF CENTRAL AMERICA AND PANAMA  
(INCAP)**

**ANNUAL REPORT**

**January 1st – December 31st 1981**

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## **PREFACE**

*This report presents the activities of the Institute of Nutrition of Central America and Panama (INCAP) for the period January 1 to December 31, 1981. The document has been divided into three main activities, that is, training and development of human resources, technical cooperation to the Member Countries, and research activities.*

*Since its foundation in 1949, INCAP has had as its main objective the solution of the nutritional problem in the Central American area. Because this problem is in itself multidisciplinary, the approach to the solution has also been multidisciplinary. Thus INCAP, through its research activities in the fields of biomedics, food and agricultural chemistry, applied nutrition and evaluation of nutritional interventions, has collected information that can help solve this ubiquitous problem in the underdeveloped areas of the world. The Institute is in a position, therefore, to help Member Countries implement their activities not only in the public health sector, through its nutrition programs, but also in the food production area, through the implementation of agroindustries at the cooperative level. These activities are being carried out by the Technical Cooperation Program of INCAP.*

*Equally important are the activities related to the training of personnel from the Member Countries and the research activities carried out by the different programs which are detailed in this report. The coordination of the three activities mentioned makes it possible to attack the nutritional problem from different angles, in an effort to find a solution to this problem in the near future.*

*This, we believe, is a good opportunity to express our appreciation to those agencies and institutions which, financially or otherwise, have provided assistance for the development of the Institute's activities during 1981.*

  
Luis Octavio Angel  
Director, a.i.

July, 1982



Paramedical personnel are trained in the delivery of simplified health services and in the use of appropriate technologies  
(San Juan Sacatepéquez, Guatemala)

# **DEVELOPMENT OF HUMAN RESOURCES**

*Coordinator: Dr. G. Arroyave*

The area of Development of Human resources has the following objectives:

1. To collaborate in determining the human resource needs in food and nutrition, and in programming their development in the Member Countries.
2. To develop programs of specialization in the fields of nutrition and food sciences, as well as tutorial training programs in related fields, at all levels.
3. To collaborate in the training of professional, technical and auxiliary personnel in nutrition and food sciences, not only at the Institute's facilities but also in the different sectors of the Member Countries.
4. To cooperate in the food and nutrition training of in-service personnel in the countries of the area.

In order to attain these aims, the following programs were developed:

- School of Nutrition (undergraduate level)
- Course in Public Health with Emphasis on Nutrition and Mother and Child Health (graduate level)
- Course in Food Science and Technology (graduate level)
- Course in Biochemistry and Human Nutrition (graduate level)
- Tutorial Training in Specific Methodologies for Food and Nutrition Studies and Programs (undergraduate and graduate level)
- Advance Tutorial Training of the Institute of Nutrition of Central America and Panama/United Nations University (INCAP/UNU)

Following is a description of each one of the aforementioned Programs:

# PROGRAM I

## SCHOOL OF NUTRITION

*Director: Dr. L. O. Angel*

During the year covered by this report, Dr. Luis Octavio Angel continued as Director *ad interim* of INCAP. In view of this, Lic. Colbert Bruña Miranda acted as Assistant to the Director of the School.

A total of 66 students enrolled in the School of Nutrition during 1981: 14 students in the second year, 14 in the third, 11 in the fourth, and 27 were doing thesis work.

Table I details the distribution of these students by academic level and by country.

TABLE 1  
STUDENTS ENROLLED IN THE SCHOOL OF NUTRITION IN 1981

Country	Years				Total
	II	III	IV	Thesis	
Costa Rica	1	1	0	1	3
El Salvador	0	0	0	1	1
Guatemala	8	9	5	9	31
Honduras	5	3	3	3	14
Nicaragua	0	1	0	3	4
Panama	0	0	3	9	12
Other countries	0	0	0	1	1
Total	14	14	11	27	66

The Fourth-Year students carried out their Supervised Professional Practice (EPS) in Guatemala and in Panama. Seven students did their practices in Institutional Dietetics in the Roosevelt Hospital, in the General Hospital of the Guatemalan Social Security Institute (IGSS), and in the Pediatric Hospital "Rafael Ayau", all located in Guatemala City.

The professional practice in Public Health Applied Nutrition was carried out in the Guatemala health areas of Escuintla, Suchitepéquez and Retalhuleu, and in the health district of Amatitlán in the department of Guatemala.

Three students carried out their Supervised Professional Practice in Panama. As for their practice

in Institutional Dietetics, they worked in the following institutions of the Public Health Sector: "Cecilio Castellero Hospital" in the Province of Chitré, "Marco A. Robles Hospital" in Aguadulce, and the Integrated Hospital "El Vigía", also in the Province of Chitré.

The practice in Public Health Applied Nutrition was carried out by these students in the Health Centers of Santiago, Province of Veraguas, and in the Health Center of San Isidro in Corregimiento Belisario Porras, in the City of Panama.

TABLE 2  
THESES COMPLETED IN 1981

Student's name	Country of origin	Thesis topic
Aguilar Manzanares, Eduardo Alberto	Honduras	Nutritive value of the diets and assessment of the nutritional status of children attending the day-care centers in the city of Tegucigalpa, Honduras.
Alvarado Hernández, Ulises Bayardo	Nicaragua	Food practices of pregnant women living in the Department of Guatemala, determined at the beginning of the prenatal control, in the clinics of the Guatemalan Institute of Social Security.
Ariza Solís, Luis Ismael	Guatemala	Evaluation of the level of nutrition knowledge of the health promoters working in the Department of Chimaltenango, Guatemala.
Arosemena Del Rosario, Carmen Clemencia	Panama	Food habits of mothers of preschool children attended by the integrated health area of Penonomé, Province of Coclé, Republic of Panama
Castillero Hernández Verónica	Panama	Dietary patterns and nutritional status determined by height and weight indicators in infants under one year of age, in rural and urban areas of the District of Chorrera, Republic of Panama.
De Gracia, Elda Rosa Peñaloza de	Panama	Influence of the community gardens on the food patterns and practices of food production in the health area of La Chorrera, Republic of Panama.
De Obaldía Valdés, Niria Itzel	Panama	Nutritional status and dietary patterns of preschool children 1 to 5 years of age attending the Health Center of Tolé, Republic of Panama.
Fischer Josefovic, Magdalena Verónica	Guatemala	Between-meal snacks consumed by third-grade school children of San Martín Jilotepeque, Department fo Chimaltenango, Guatemala, and their relation to the total diet.
Lainfiesta Soto, Luz Elizabeth	Guatemala	Influence of the parents on the food preferences of second-grade school children attending the national experimental primary schools in Guatemala City.

SCHOOL OF NUTRITION  
STUDENTS GRADUATED DURING 1981



Julieta Quan  
Guatemala  
August 7, 1981



Carmen Arosemena  
Panama  
July 31, 1981



Clark E. Mac Donald Blanco  
Guatemala  
August 7, 1981



Lydia Graciela D.L. de von Ahn  
Guatemala  
November 20, 1981



Luis Ismael Ariza  
Guatemala  
February 20, 1981



Aída Maradiaga de Villeda  
Honduras  
July 31, 1981



William Yau M.  
Panama  
August 28, 1981



Elda Rosa P. de De Gracia  
Panama  
July 31, 1981



Adis Idelda Pinzón  
Panama  
June 19, 1981



Graciela Tejada de Rosales  
Guatemala  
July 31, 1981



Kimberly A. H. de Macal  
Guatemala  
April 24, 1981



Ulises Bayardo Alvarado  
Nicaragua  
June 5, 1981



Rodolfo Spear Smith  
Nicaragua  
April 3, 1981



Magdalena V. Fischer  
Guatemala  
February 27, 1981



Luz Elizabeth Lainfiesta  
Guatemala  
June 19, 1981



Verónica Castellero  
Panama  
April 24, 1981



Elwell Humberto Robinson  
Panama  
May 22, 1981



Niria Itzel De Obaldía  
Panama  
May 15, 1981



Ana Cristina Mejía  
El Salvador  
November 20, 1981



Eduardo Alberto Aguilar  
Honduras  
February 20, 1981



Ana Luisa Ordóñez  
Honduras  
August 21, 1981

Student's name	Country of origin	Thesis topic
Macal, Kimberly Ann Haydon de	United States	Nutrition knowledge of the hospital nurses in Guatemala City.
Mac Donald Blanco, Clark Eduardo	Guatemala	Food habits and nutritional status of children born prematurely at the Gyneco-Obstetrics Hospital of the Guatemalan Institute of Social Security, Guatemala City, during 1979.
Mejía Pérez, Ana Cristina	El Salvador	Evaluation of the special diets of the Roosevelt Hospital.
Ordóñez Velásquez, Ana Luisa	Honduras	Food Habits of pregnant women attending the control clinic at the Health Center of Las Crucitas, Comayagüela, Honduras.
Pinzón Martínez, Adis Idelda	Panama	Food habits and evaluation of the diet of the diabetic patients attending the Dietetic Clinic of the Santo Tomás Hospital of the City of Panama.
Quan Lau, Julieta	Guatemala	A study of the food served to the children attending the Nutrition Education and Recuperation Centers (SERN) run by the government office for Social Welfare in Guatemala City.
Robinson Caldas, Elwell Humberto	Panama	Evaluation of the school cafeterias in the Province of Veraguas, Panama.
Rosales, Graciela Tejada de	Guatemala	Distribution of the funds budgeted for the purchase of foods for the patients and employees of the National Hospitals and the Hospitals of the Guatemalan Institute of Social Security, Guatemala City.
Spear Smith, Rodolfo	Nicaragua	Evaluation of the nutrition knowledge of the Auxiliary Nurses in the Department of Chimaltenango, Guatemala.
Villeda, Aída Esperanza Maradiaga de	Honduras	Food practices in children under 2 years of age attending the Health Center of the Municipio El Paraíso, Honduras.
Von Ahn, Lydia Graciela de León de	Guatemala	Teaching Health Auxiliary personnel how to measure accurate body weights through a programmed instruction system.
Tari Murillo, William	Panama	Evaluation of the nutrition knowledge of the Home Education Teachers who work in the primary schools of the District of Panama, Republic of Panama.

### Occupation of the graduates

Of a total of 154 students who have completed the four years of study (140 graduates and 14 pending completion of their theses), 68 work in public health programs in their countries, 19 in teaching programs, 9 in institutional dietetics, 8 in research, and 4 in private food industry enterprises (see Table 3).

### Teaching staff

The teaching activities of the School of Nutrition were the responsibility of professionals of INCAP, professors of the University of San Carlos de Guatemala, as well as some visiting professors from other academic institutions. Lic. Carmen A. Dárdano S. and Lic. Colbert Bruña Miranda were in charge of the supervision of the professional practice of the fourth-year students in Guatemala. In Panama, this supervision was the responsibility of Lic. Gloria Alonso, Lic. Odilia C. de Bermúdez, Lic. Viodelda G. de Castillo and Lic. Denia Tem de Gordon. This group of Panamanian nutritionists was coordinated by Lic. Artemia J. de Pinto.

### Technical cooperation to other Schools of Nutrition in the region

During the year covered by this report, Dr. Luis Octavio Angel participated in several working meetings with the staff of the University of San Carlos de Guatemala and the Autonomous University of Honduras, in order to determine the bases for the establishment of a School of Nutrition in each one of these two universities.

As a result of these important meetings in Guatemala, a "Proposal for a New Curriculum for the School of Nutrition of the University of San Carlos" was approved by the Board of Directors of the School of Chemistry and Pharmacy of this University. This new curriculum will be submitted to the University Council for its consideration and approval early in 1982.

### Other activities

Lic. Carmen Dárdano, Lic. Lilliam de González, Lic. Gloria Alonso and Lic. Denia de Gordon, members of the teaching staff, participated in the First Seminar on the Teaching of Dietetics in Schools of Nutrition and Dietetics of Latin America. This seminar took place in Guatemala City and was organized by the Regional Program of Nutrition Education of the Pan American Health Organization. Lic. Carmen Dardano attended a Seminar on Teaching of Food Services Administration in Schools of Nutrition of Latin America, which took place in Panama City.

Dr. Luis Octavio Angel, Director of the School of Nutrition, attended the X Congress of Nutrition and Dietetics of Central America and Panama, and the First Honduran Congress of Nutrition. Dr. Angel gave a lecture entitled "New alternatives for the participation of INCAP in the formation of nutritionists in Central America and Panama". Lic. Colbert Bruña also participated in this congress, acting as moderator in the round table "Formation of Professionals in the Field of Nutrition in the Central American Area". He also gave a lecture entitled "The School of Nutrition of INCAP/Universidad de San Carlos de Guatemala".

TABLE 3  
ACTIVITIES OF THE GRADUATES FROM 1969 TO 1981

Activities	Graduate							Sub-total	Thesis in preparation						Sub-total	TOTAL
	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama	Other countries		Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama		
1. Clinical Nutrition	2	—	—	—	—	—	—	2	—	—	1	—	—	—	1	3
2. Institutional dietetics	1	1	2	—	1	4	—	9	—	—	—	—	—	—	—	9
3. Public health	4	12	13	5	3	21	5	63	—	—	—	1	4	—	5	68
4. Agriculture	—	1	—	—	—	—	—	1	—	—	1	—	—	—	1	2
5. Teaching	2	5	2	3	3	1	2	18	—	—	—	—	1	—	1	19
6. Food industry	—	—	1	1	1	1	—	4	—	—	—	—	—	—	—	4
7. Research	2	1	4	—	—	—	1	8	—	—	—	—	—	—	—	8
8. Graduate studies	—	4	5	—	1	—	1	11	—	—	—	—	—	—	—	11
9. Planning	—	—	2	2	—	—	—	4	—	—	—	—	—	—	—	4
N. Not working	—	—	9	4	—	2	3	18	1	—	2	—	1	2	6	24
D. Deceased	1	—	—	—	—	1	—	2	—	—	—	—	—	—	—	2
<b>TOTAL</b>	<b>12</b>	<b>24</b>	<b>38</b>	<b>15</b>	<b>9</b>	<b>30</b>	<b>12</b>	<b>140</b>	<b>1</b>	<b>—</b>	<b>4</b>	<b>1</b>	<b>6</b>	<b>2</b>	<b>14</b>	<b>154</b>

## PROGRAM II

### GRADUATE COURSE IN PUBLIC HEALTH WITH EMPHASIS ON NUTRITION AND MOTHER AND CHILD HEALTH

*Director: Dra. A. M. de Fernández*

The main objective of this Course is to contribute to the training, at the graduate level, of Latin American professionals of the health sector in the fields of maternal-child nutrition and health, so as to enable them to return to their country of origin to participate effectively in the planning and development of service, teaching, and research programs.

The course lasts eleven months, from January to November, and leads to the academic degree of Master (*Magister Scientifcae*) in Public Health with Emphasis on Nutrition and Mother and Child Health. The participants are physicians, nurses, nutritionists, dentists, and other professionals who work in health services or as health and/or nutrition educators in the countries of the area.

#### Curriculum

The study plan developed in 1981 was the following:

Code	Courses*	Credits
H-10 (G)	Introduction to Public Health	1
M-20 (G)	Statistics	4
H-71 (G)	General Epidemiology	2
S-70 (G)	Social Anthropology	2
H-86 (G)	Fundamentals of Public Health Planning and Administration	2
N-30 (G)	Basic Nutrition	6
N-72 (G)	Nutrition Problems	2
N-73 (G)	Nutritional Diagnosis of Population Groups	1
N-76 (G)	Nutrition in Public Health	2
H-20 (G)	Mother and Child Health I	2
H-25 (G)	Mother and Child Health II	1
H-30 (G)	Environmental Sanitation	1
P-33 (G)	Teaching and Communication	2
P-34 (G)	Education in Health and Nutrition	1
N-77 (G)	Field Work: Diagnosis of Health and Nutrition Status	3
H-90 (G)	Field Work and Term Paper	6
<i>Electives</i>		
M-31 (G)	Introduction to Electronic Data Processing	1
H-22 (G)	Family Health Workshops	2
M-99 (G)	Bases of Scientific Research	1
N-95 (G)	Clinical Nutrition	1

\* The only changes introduced in 1981 were: a) *Biochemical Bases of Nutrition* was merged with Basic Nutrition. The latter became, therefore, a 6-credit course; b) a new elective course was offered to teach the students the Bases of Scientific Research [code N-99 (G)].

During 1981 the students visited various institutions and programs concerned with health and nutrition in Guatemala. They also participated in a workshop carried out by the Ministry of Health of Guatemala with the collaboration of INCAP, for the evaluation of the program "Integrated System of Nutrition and Primary Health Service of Guatemala (SINAPS)". The Graduate Course organized a visit of all the students and two professors to the Universidad del Valle, Cali, Colombia, in order to study the programs being carried out there on Primary Health Services, Integrated Development, Maternal-Child Health, and Epidemiological Surveillance.

#### Participating students

Thirty-two applications were received, of which 15 were accepted as follows: El Salvador 1, Honduras 1, Guatemala 7, Mexico 3, Panama 2 and Peru 1.

Of the fifteen students admitted, 10 received the academic degree at the end of the school year, 2 have a few academic requirements pending, 2 did not qualify for the degree, and one did not continue for personal reasons. Two students from the previous academic year completed their requirements and graduated in 1981.

The twelve students who were awarded the master's degree were:

Name	Country of Origin	Profession
Arévalo Ochoa, Jorge Raúl	Guatemala	Physician
Carredano Moreira, Jaime Emilio	Guatemala	Physician
Garrera Tersoglio, Graciela María	Argentina	Physician
López Juárez, Efraín	Guatemala	Physician
Méndez, Silma Elizabeth Castillo v. de	Guatemala	Nurse
Osorto Izaguirre, Rosa Dilia	Honduras	Nurse
Quevedo Samudio, Mariela	Panama	Nutritionist
Rivera Nicolella, Gloria	Panama	Nutritionist
Rojas Dueñas, Raúl	Mexico	Physician
Sélem Solís, Jorge Enrique	Mexico	Physician
Vaquera, Martha Vásquez de	Mexico	Physician
Zamora Castañeda, Rosa María	Perú	Physician

As the culmination of their activities, the students presented the following term papers:

Student	Topic of term paper
Dr. Jorge Raúl Arévalo Ochoa	A model of health services for school children 7-14 years of age based on the "teacher-physician" team, developed for the Northern Health Area of Guatemala.
Dr. Jaime Emilio Carredano Moreira	Knowledge, attitudes and practices of the health personnel of District No.1 (Sololá, Guatemala) regarding Oral Rehydration.
Dr. Graciela María Garrera Tersoglio	Program of maternal and child primary health services for marginal urban areas of the City of Rosario, Argentina.
Dr. Efraín López Juárez	Manual for the implementation of the Integrated System of Nutrition and Primary Health Service (SINAPS) in a health district of Guatemala.

CENTER FOR ADVANCED STUDIES IN NUTRITION AND FOOD SCIENCES  
(CESNA)

GRADUATE COURSE IN PUBLIC HEALTH WITH EMPHASIS ON NUTRITION  
AND MOTHER AND CHILD HEALTH  
1981



AREVALO, Jorge Raúl  
Guatemala



BROOKS, Graviola  
Guatemala



CARREDANO, Jaime  
Guatemala



GUERRERO, Edmundo  
Guatemala



HERNANDEZ, José M.  
México



LARA, Edwin Rolando  
Guatemala



LOPEZ, Efraín  
Guatemala



MENDEZ, Silma v. de  
Guatemala



OSORTO, Rosa Dilia  
Honduras



QUEVEDO, Mariela  
Panamá



RIVERA, Gloria  
Panamá



ROJAS, Raúl  
México



VAQUERA, Marta de  
México



ZAMORA, Rosa María  
Perú

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Student	Topic of term paper
Silma Elizabeth C. de Méndez	Design of a nutrition and health education program for pregnant women.
Rosa Dilia Osorto Izaguirre	Methodology to evaluate the education component and activities of the primary health services in Honduras.
Mariela Quevedo Samudio	Analysis and interpretation of energy and nutrient intakes at the family level, from the 1980 National Nutrition Survey, Panama.
Gloria Rivera Nicoletta	Analysis and interpretation of food consumption family data from the 1980 National Nutrition Survey, Panama.
Dr. Raul Rojas Duenas	A program for teaching Nutrition in the School of Medicine of the University of Guadalajara, Mexico.
Dr. Jorge Enrique Sèlem Solís	A model for the nutritional diagnosis of the rural population of Yucatán, Mexico: basal data before the implementation of a sugar enrichment program with micronutrients.
Dr. Martha Vázquez de Vaquera	A program for teaching Nutrition in the School of Medicine of the Autonomous University of Guadalajara, Mexico. Analysis of obstacles and possible solutions for its implementation.
Dr. Rosa Maria Zamora Castaneda	The dietary score method as an indicator of the dietary situation.

Including the professionals that graduated, the number of graduates to date is 127, the majority of which are working at present in mother and child nutrition and/or health programs (48.8<sup>0</sup>/o), university teaching (30.7<sup>0</sup>/o), international counseling (4<sup>0</sup>/o), and research (3.2<sup>0</sup>/o).

#### Persons responsible for the Program

The Course is developed under the direction of Dr. América Mazariegos de Fernández, and the classes are offered by the professional staff of INCAP and the University of San Carlos de Guatemala, as well as by invited professors from the Health Services.

#### Promotion and selection of new students

For the year 1982, twenty eight applications were received of which seventeen were accepted: 2 nutritionists from Bolivia, 2 nutritionists from Chile, 2 physicians and 1 nutritionist from Ecuador, 1 physician and 1 nurse from El Salvador, 6 physicians from Guatemala, 2 nurses from Honduras, 1 nutritionist from Panama, and 1 nurse from Peru.



Graduation of students of the Course in Public Health with Emphasis on Nutrition and Mother and Child Health. Presiding over this act, which took place at INCAP's auditorium in November, 1981, were authorities of the University of San Carlos de Guatemala and of CESNA/INCAP

## PROGRAM III

### GRADUATE COURSE IN FOOD SCIENCE AND TECHNOLOGY

*Director: Dr. J. E. Brabam*

The objective of this Course is the training of high level students in the Food Sciences and Food Technology disciplines. The professionals will then be able to collaborate in the solution of the nutritional problems related to the availability and improvement of food processing. They will also be prepared to develop academic activities at the university level in their fields of specialization. The Course, which was instituted in 1971, is open to graduates from all the countries of Latin America, and up to date forty-four students have received the academic degree of *Magister Scientiæ* (M. S.). During 1981, eight admission applications were received, and the following research activities were carried out by the students to fulfill their academic requirements :

#### Finished thesis work

Name	Country of origin	Thesis topic
Bautista, Mayela	Mexico	Chemical, biological and functional characterization of the protein of <i>Candida utilis</i> with a low nucleic acid content.
Berrios, José de Jesús*	Nicaragua	Cottonseed, cassava and cassava leaf flours as substitutes for soybean flour, corn and pigments in rations for broilers.
Ortiz, Miguel Angel*	Guatemala	Productivity in a dairy herd under intensive management in the tropics.
Penaloza, Walter	Ecuador	Solid fermentation of coffee pulp.
Rizo, María Eugenia	Nicaragua	Studies on the use of NaCl solution for the control of hardening and insect attack in common beans ( <i>Phaseolus vulgaris</i> ) and cowpea ( <i>Vigna sinensis</i> ).
Romero, José Arturo	Colombia	Evaluation of the physical, chemical and biological characteristics of eight quinoa ( <i>Chenopodium quinoa</i> , Willd) varieties.

\* Student from the Graduate Course in Food Science and Animal Nutrition.

## Thesis research projects in progress

Name	Country of origin	Thesis topic
Alanis, Guadalupe	Mexico	Effect of several treatments on the nutritive value of moldy corn, and nutritional evaluation of insect-damaged corn.
Estrada, César Antonio	Guatemala	Effect of corn type and storage on the chemical and nutritional quality of tortillas prepared from different types of corn.
Mora, Deydamia R. de	Panama	Effect of polyphenols on bean digestibility.
Muñoz, María de Jesús	Mexico	Feasibility of production at the community level of poultry meat sausages extended with an extruded mixture of corn: soybeans.

## Students promoted to second year

Name	Country of origin
Araya, Adriana de	Costa Rica
Jiménez, María del Socorro	Mexico
Lacera, Armando	Colombia
Paredes, Mario Antonio	Ecuador

The Admission Committee met on November 26, 1981 and selected the following candidates for 1982:

Name	Country of origin
Calderón M., Geraldina	Guatemala
Calvo, Juan Edgar	Peru
Céspedes, María Asunción	Dominican Republic
Espinoza, Domingo	Panama
González, Jovinda	El Salvador
Morón, Stahel	Bolivia

The curriculum followed in this Course during 1981 is as follows :

Semester	Food Science and Technology	Credits
1st (1st trimester)	Basic Nutrition	3
	Nutrition Problems	2
	Statistics	4
	Food Science and Biochemistry I	2
1st (2nd trimester)	Basic Nutrition	3
	Food Sciences and Biochemistry II	2
	Nutritional Technology	1
2nd	Nutritional Technology	1
	Instrumentation	3
	Food Science and Biochemistry II	4
	Unit Operations	3
	Research	2
3rd	Food Technology	4
	General Microbiology	3
	Production and Economics	1
	Research	5
4th	Industrial Microbiology	4
	Applied Technology	3
	Research	6
	Seminar	1

## PROGRAM IV

# GRADUATE COURSE IN BIOCHEMISTRY AND HUMAN NUTRITION

*Director: Dr. O. Pineda*

This program has been offered at INCAP since 1972, and eight students have obtained their *Magister Scientifiae* since then. The objectives of this graduate program are: 1) to prepare professionals in Biochemistry and Human Nutrition, capable of developing teaching programs in this field at the university level; 2) to carry out research in the biochemical aspects of the nutritional alterations which affect the populations of the area; and 3) to give the students the opportunity to learn about the contribution that this type of biochemical research and teaching can offer for the correct implementation of applied programs in Latin America.

During 1981, the regular activities of the program were continued with the four students enrolled, namely :

Cecilia de Plata	Colombia
Benjamín Caballero	Argentine
Eduardo Sainz	Argentine
Samuel Flores-Huerta	Mexico

Of these students, Dr. de Plata and Dr. Flores-Huerta successfully presented their qualifying examinations and are now actively involved in their respective thesis research.

Doctor Caballero and Mr. Sainz will present their qualifying examinations during the first two months of 1982 and will continue with their thesis investigations.

After finishing his graduate studies at INCAP, Dr. Caballero will travel to Boston, Mass., to enroll in MIT to continue graduate work in nutrition for a Ph.D. degree.

Mr. Sainz is currently at the Department of Biochemistry of Johns Hopkins University and will return to INCAP in the first semester of 1982 to render his qualifying examinations and thesis.

As part of their academic teaching program, this group of students planned, developed and carried out a course in Biochemistry for the Universidad del Valle in Guatemala City. The course lasted 16 weeks and was successfully completed in November, 1981.

It is expected that all four students will finish their graduate work at INCAP during the first semester of 1982.

As a result of decisions taken regarding the new program of INCAP, this course will not be offered in 1982, but it probably will open again at the beginning of 1983, with a new orientation, as a "Graduate Course in Biology and Human Nutrition".

## PROGRAM V

# TUTORIAL TRAINING IN SPECIFIC METHODOLOGIES FOR FOOD AND NUTRITION STUDIES AND PROGRAMS

*Persons responsible: Professional Staff of INCAP*

For several years, the Institute of Nutrition of Central America and Panama (INCAP) has been offering tutorial training in a diversity of field and laboratory methods and techniques, necessary for the adequate execution of studies in the food and nutrition area. These have covered diagnosis of nutritional status, follow-up and evaluation of the impact of nutrition programs; determination of the composition and nutritive value of foods and feeds, including the monitoring of the changes that these products may suffer during the technological and conservation processes; food quality control both from the chemical and microbiological points of view; and microbiological studies applied to the study of the interrelationship between infection and nutrition.

Up to now, this type of training had been offered at INCAP, without a programmatic structure, to professional and technical persons who had incidentally known about the work being done at INCAP and applied for this training either individually or recommended by their institutions. During the first part of 1981, training was still offered on this "case-to-case" basis; a total of 58 students enrolled. Table 1 shows the country of origin of these students and the area of discipline of interest in which they received the training.

During 1981, the Division of Education carried out an analysis of this tutorial training activity, which revealed the integrated potential of the Institute to develop training areas in various methodologies and techniques applicable to Food and Nutrition studies and programs. This analysis resulted in a definition of five training areas and the development of norms determining the length of the training period for each unit, admission requirements and cost of the studies including tuition.

Both professionals and technicians have option to participate. The only requirement is that the interested parties have an adequate general knowledge and/or experience in the pertinent area.

The brief tutorial courses offered pursue the training of such personnel in the correct handling and application of the different methods and techniques. They also pretend to give proper orientation to the student in localizing pertinent and relevant information sources in the available scientific literature. Their structure is based on teaching methodology of "in-practice training" at the individual level and under the supervision of an assigned tutor. Following is a list of the training areas included in this program.

### 1. Food science and technology

Evaluation of foods for human consumption is carried out by means of determining their chemical composition and through the study of their nutrient availability and utilization. The complementarity of both approaches permits the best estimate of the nutritive value of a given food. Furthermore, in the developing countries there are nutrient sources that —because they are not the conventional ones— have not been studied as contributors to the diet. By the same token, the chemical and biological evaluation of feeds and

TABLE 1

NUMBER OF STUDENTS IN TUTORIAL TRAINING IN SPECIFIC METHODOLOGIES  
FOR FOOD AND NUTRITION STUDIES AND PROGRAMS, BY COUNTRY OF ORIGIN  
AND AREA OF STUDY, 1981.

Country	Area of study					Total
	Biology and human nutrition	Food sciences	Human development	Food quality control	Others	
<i>Central America</i>						
El Salvador	1	2	—	—	1	4
Guatemala	7	16	1	5	—	29
Nicaragua	—	—	—	—	1	1
Panama	—	—	—	—	1	1
<i>Other Latin American Countries</i>						
Argentina	3	—	—	—	—	3
Colombia	2	1	1	—	1	5
Ecuador	—	1	—	—	—	1
Peru	—	1	—	—	—	1
Venezuela	—	—	—	—	1	1
Dominican Republic	—	1	—	1	—	2
<i>North America</i>						
United States	1	—	2	—	—	3
Mexico	—	—	—	—	2	2
<i>Others</i>						
Egypt	—	1	—	—	—	1
Bangladesh	1	2	—	—	—	3
Philippines	—	—	1	—	—	1
Total	15	25	5	6	7	58

forages is a necessary contribution for the development of animal industry. On the other hand, the processing and conservation methods induce changes in the foods that must be known in order to make decisions as to the best technologies to be applied, eliminating variables that affect negatively the quality of the product, not only in single natural foods but also in mixtures of them, especially when they have been submitted to severe processing or prolonged storage. These concepts are also applicable to feeds, such as pastures and forages, since their nutritive quality influences the resulting animal product.

The purpose of this area of training, therefore, is to provide the student the necessary skills to undertake chemical determinations of nutrients, perform physical and chemical measurements of the quality of raw materials, determine the nutritional utilization of nutrients through biological assays, and learn the most pertinent basic methods in food technology for use in the developing countries. Similarly, this type

of training enables the student to localize readily the most pertinent information sources in the available scientific literature.

## 2. Quality control of foods

In modern times, the mass production of food and the need for its conservation, processing, and extensive distribution, have resulted in circumstances and factors which very often affect negatively the quality of the foods consumed. Among these are the generation of toxic compounds, the introduction of contaminants, both chemical and microbiological, and the incorporation of additives. All of these facts result in risk for the consumer.

Furthermore, technification of industry and agriculture has led to the use of substances such as pesticides, which are also incorporated into foods, making them inadequate and dangerous for the consumer.

Consequently, laboratories of food quality control have become an absolute technological and social necessity. These laboratories are essential for the protection of the health and economy of the consumer. Even in developed societies, the public at large does not have the necessary knowledge to judge the nutritive value, hygiene, wholesomeness and relative value of many processed foods.

The objective of this training area is to prepare technical personnel in this methodological field.

## 3. Biology and biochemistry of nutrition

Numerous biochemical analyses and physiological tests, when adequately interpreted in their metabolic context, are a very important mean of evaluating the nutritional status of individuals or populations. They are also essential for the estimation of the degree of biological utilization of nutrients.

Deficiencies or excesses of specific nutrients result in metabolic alterations, often detectable by biochemical methods. The measurement of the altered biochemical parameters is basic for a complete diagnosis of the nutritional status in relation to these specific nutrients. This approach requires the selection of appropriate methods and the ability to interpret them. This area of training aims at providing the student with a more ample vision of the different biochemical and physiological indicators susceptible of measurement, as well as a better understanding of their biologic-nutritional interpretation. Furthermore, the student shall learn the limitations of the methods as well as how to modify or adapt them in accordance with the actual conditions in the site of application.

## 4. Diagnosis of nutritional status, design, implementation and evaluation of nutritional interventions

The magnitude of the nutritional problem and the economic constraints prevailing in developing countries demand a more efficient investment of the existing resources and have created the necessity of trained personnel for the diagnosis of the food and nutritional situation, and for the identification, planning, implementation and evaluation of programs oriented to reduce malnutrition.

The formal food and nutrition courses do not cover in depth such aspects. Therefore, INCAP identified the need to provide short-term practical training that will thoroughly concentrate on techniques for the collection of nutritional data and information on the associated factors, particularly in regard to recording, flow, processing and analysis of such data. Furthermore, training is required in the transmission, handling and use of data at the different levels of the technical structures in charge of food and nutrition programs. The human resources thus trained are capable of participating in their own countries in: evaluation of the nutritional impact of nutritional interventions as well as economic and agricultural development programs; nutritional research activities in the field; diagnosis of the nutritional status; establishment of permanent data collection systems for monitoring the nutritional conditions; and teaching activities involving nutritional research at the field level.

## 5. Nutrition-infection studies. Microbiological techniques

The synergistic effect of infections and malnutrition as a determinant of the health status of individuals and populations is widely recognized. To better understand the infection-immunodepression-malnutrition cycle, it is necessary to diagnose and identify the infectious agents, as well as to evaluate the consequences that infections may have on the defense mechanisms. It is also indispensable to study the effects of nutritional deficiencies on the immunologic defense mechanisms. To undertake research and evaluation of intervention programs related to the nutrition-infection complex, it is necessary to have technical personnel trained in the specific methodologies required. The Institute of Nutrition of Central America and Panama has approached these aspects and has the capacity to provide training in these basic methodologies.

### Observations

A brochure is available giving information on the types of training units offered, their duration and cost, as well as the admission procedures and requirements. This pamphlet may be obtained upon request from the Division of Education, INCAP, P. O. Box 1188, Guatemala, Central America.

## PROGRAM VI

# ADVANCED TUTORIAL TRAINING OF THE INSTITUTE OF NUTRITION OF CENTRAL AMERICA AND PANAMA/UNITED NATIONS UNIVERSITY (INCAP/UNU)

*Resident Coordinator: Dr. G. Arroyave*

As is evident from the present Report, INCAP continued a sustained effort to enroll fellows in the Advanced Tutorial Training Program of 1981. Counting those who finished, began or continued training, the Program had 14 students, as follows: 2 from Argentina, 2 from Peru, 1 from El Salvador, 1 from Colombia, 2 from Mexico, 1 from Egypt, 3 from Bangladesh, 1 from Ecuador, and 1 from the Philippines.

The distribution by training area was: 7 in the Subprogram "Hunger and Technology" and 7 in the Subprogram "Hunger and Health".

The process of programmatic revision and change instituted by the new UNU Rector resulted inevitably in some uncertainty to INCAP as an Associated Institution. It is hoped that the new program is finally agreed upon and sanctioned, in order that INCAP's responsibilities may be clearly defined and an effective program based on revised guide lines may be designed.

In the meantime, we continue basing our work on the premise that well-trained scientific and technical human resources, "mission-oriented" to serve humanity, are an asset for any country or region, especially if they are well utilized by the given sociopolitical systems.

Another change which occurred in the program in the Western Hemisphere was the appointment of Dr. M. A. Tagle as Regional Coordinator, in place of Dr. Guillermo Arroyave.

### FELLOWSHIP PROGRAM

#### Fellows who finished their training

Five fellows finished their advanced training program during 1981. Following is a listing of their names, countries of origin, present academic or technical position and other relevant information.

*Name:* Vicente Chauvin

*Country:* Ecuador

*Date fellowship ended:* 15 March 1981

*Research at INCAP:* Utilization of rice by-products in the elaboration of food for human consumption

*Subprogram:* Hunger and Technology

*Present position:* Food Technologist at the Ministerio de Salud Pública, Quito, Ecuador.

*Tutor:* Dr. Ricardo Bressani

*Name:* Walter Rios

*Country:* Peru

*Date fellowship ended:* 30 June 1981

*Research at INCAP:* Preparation of foods based on young-tender corn and pigeon pea (*Cajanus cajan*) and design of a plant for their production at a rural level

*Subprogram:* Hunger and Technology  
*Present position:* Food Technologist at the Instituto de Investigaciones Agro-Industriales, Lima, Perú.  
*Tutor:* Dr. Ricardo Bressani

*Name:* El-Sayed Hegazi  
*Country:* Egypt  
*Date fellowship started and ended:* 30 January through 6 June 1981  
*Research at INCAP:* Evaluation of the nutritional quality storage stability and acceptability of various low-cost high-quality food supplements for infant feeding  
*Subprogram:* Hunger and Technology  
*Present position:* Professor of Food Sciences, National Research Centre, Dokki, Cairo, Egypt  
*Tutor:* Dr. Ricardo Bressani

*Name:* Gerardo Merino  
*Country:* El Salvador  
*Date fellowship ended:* 31 December 1981  
*Research at INCAP:* Preparation of "tortilla" and weaning foods from precooked corn flour  
*Subprogram:* Hunger and Technology  
*Present position:* He is being considered for his incorporation to the Food Engineering Department of the Catholic University, San Salvador, El Salvador.  
*Tutor:* Dr. Ricardo Bressani

*Name:* Roushan Ara Samad  
*Country:* Bangladesh  
*Date fellowship started and ended:* 10 September through 11 December 1981  
*Research at INCAP:* Formulations of weaning food and its nutritional evaluation  
*Subprogram:* Hunger and Technology  
*Tutor:* Dr. Ricardo Bressani

#### Fellows who began training during the year

During 1981, six new fellows joined the Program. Following is the list of these new fellows, their initiation dates, the research being carried by them and other relevant information.

*Name:* Martha Vázquez de Vaquera  
*Country:* Mexico  
*Initiation date:* 2 January 1981  
*Subprogram:* Hunger and Health  
*Research topic:* Design of a program of nutrition for implementation at the School of Medicine, Universidad Autónoma de Guadalajara  
*Division at INCAP:* Division of Education/Division of Human Development  
*Tutors:* Dr. América de Fernández/Dr. Aaron Lechtig

*Name:* Rosa Maria Zamora  
*Country:* Peru  
*Initiation date:* 2 January 1981  
*Subprogram:* Hunger and Health  
*Research topic:* Design and testing of a Dietary Score System to evaluate the dietary situation of communities  
*Division at INCAP:* Division of Education/Division of Human Development  
*Tutors:* D. América de Fernández/Dr. Víctor Valverde

*Name:* Roquea Siddiqua  
*Country:* Bangladesh  
*Initiation date:* 30 January 1981  
*Subprogram:* Hunger and Health  
*Research topic:* Study on protein-energy requirement using traditional foods of Guatemala. Studies of energy absorption in children  
*Division at INCAP:* Div. of Biology and Human Nutrition  
*Tutor:* Dr. Benjamin Torin

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**Name :** Samuel Flores-Huerta  
**Country :** Mexico  
**Initiation date :** 1 March 1981  
**Subprogram :** Hunger and Health  
**Research topic :** Chemotaxis of leukocytes as an indicator of immunoresponse during treatment of protein-energy malnutrition  
**Division at INCAP :** Biology and Human Nutrition  
**Tutors :** Dr. José Ramiro Cruz and Dr. Benjamín Torún

**Name :** Stella Velasco-González  
**Country :** Philippines  
**Initiation date :** 25 April 1981  
**Subprogram :** Hunger and Health  
**Research topic :** Design and organization of nutritional information systems and methods to evaluate the impact of health and nutrition interventions  
**Division at INCAP :** Div. of Human Development  
**Tutors :** Dr. Víctor Valverde and Dr. Hernán Delgado

**Name :** Abdul Kibaleque  
**Country :** Bangladesh  
**Initiation date :** 6 October 1981  
**Subprogram :** Hunger and Technology  
**Research topic :** Studies on the preparation and evaluation of a baby food from plant protein sources  
**Division at INCAP :** Div. of Agricultural and Food Sciences  
**Tutor :** Dr. Ricardo Bressani

#### **Fellows who continued their training during the year**

**Name :** Dr. Benjamín Caballero  
**Country :** Argentina  
**Initiation date :** 20 March 1980  
**Termination date :** 15 March 1982  
**Subprogram :** Hunger and Health  
**Research topic :** Carbohydrates, calcium and iron metabolism and utilization. Application of the results to the development of guide lines for the treatment and prevention of malnutrition  
**Division at INCAP :** Biology and Human Nutrition  
**Tutor :** Dr. Benjamín Torún

**Name :** Leonardo Larco  
**Country :** Colombia  
**Initiation date :** 28 July 1980  
**Termination date (at INCAP):** 31 January 1982 (he will continue at CFTRI)  
**Subprogram :** Hunger and Technology  
**Research topic :** Feed and protein production for human consumption from *Eichhornia crassipes* (Mart.) Solms-Laubach  
**Division at INCAP :** Agricultural and Food Sciences  
**Tutor :** Dr. Ricardo Bressani

**Name :** Graciela Garrera  
**Country :** Argentina  
**Initiation date :** 1st October 1980  
**Termination date :** 31 May 1982  
**Subprogram :** Hunger and Health  
**Research topic :** Early detection and prevention of malnutrition in poor marginal urban areas, with emphasis on maternal and child care  
**Division at INCAP :** Biology and Human Nutrition  
**Tutor :** Dr. Benjamín Torún

### Fellows admitted to begin in 1982

Four new fellows were admitted to begin training in 1982: Mr. Erick Díaz, from Chile; Mr. Celedonio Loayza, from Peru; Dr. Horacio Toro, from Bolivia; and Dr. Ahmed El-Madhy, from Egypt.

### Activities aiming at the comprehensive formation of the fellows

In addition to the direct responsibilities of the fellows regarding their corresponding scientific research projects, their program included participation in various institutionalized academic activities at the Associated Institution, which transported them to a broader frame of thought in relation to the food and nutrition problems of the world. Among these activities is the participation of the fellows in the Literature Review weekly session; this year, there were 37 presentations.

The fellows also participated throughout the year in the weekly scientific meeting that is held at INCAP. In this activity, they have the opportunity to listen to scientists of the Institute, as well as visiting scientists or professors; at the same time, they are able to take advantage of this activity for presenting their scientific projects and progress reports, or final reports of their research. Ten of these scientific meetings were the responsibility of the UNU fellows this year.

### Research derived from the fellows' activities

A number of scientific and technical reports have resulted from the research carried out by the INCAP/UNU fellows. Some of these have already been published in current scientific journals, while others are in the process of publication. Below is a list of these reports. (The name of the fellow is underlined).

- INCAP/UNU-2\* Landicho, Brenda, Aaron Lechtig & Robert E. Klein  
Anthropometric indicators of low birth weight. *J. Trop. Pediat.* In press.
- INCAP/UNU-3 Daza, Giovanni, Aaron Lechtig & Robert E. Klein  
Tecnología apropiada para medir peso al nacer: una balanza utilizable por partes empíricas. *Bol. Of. Sanit. Panam.* In press.
- INCAP/UNU-5 Gupta, Mahesh C. & Juan José Urrutia  
Efecto del tratamiento quimioterapéutico periódico de parásitos intestinales, sobre el crecimiento de niños preescolares. *Arch. Latinoamer. Nutr.* In press.
- INCAP/UNU-8 Araya, Héctor, Bertha García & Guillermo Arroyave  
Estudio dietético en embarazadas de Santa María Cauqué, Guatemala I. Variabilidad de los indicadores proteínicos y su análisis por tiempo de comidas. *Arch. Latinoamer. Nutr.* 31(1): 108-117, 1981.
- INCAP/UNU-9 Daza, Giovanni, María Teresa Reynoso & Aaron Lechtig  
Efecto de la altitud sobre el crecimiento fetal. *Arch. Latinoamer Nutr.* In press.
- INCAP/UNU-10 Lareo, Leonardo  
Crecimiento de Jacinto Acuático (*Eichornia Crassipes* [Mart] Solms-laubach) en el trópico. *Arch. Latinoamer. Nutr.* 31(4):758-765, 1981.
- INCAP/UNU-11 Vargas, Emilio, Ricardo Bressani, Luiz G. Elías & J. Edgar Braham  
Complementación y suplementación de mezclas vegetales a base de arroz y frijol. *Arch. Latinoamer. Nutr.* 32(3): 579-598, 1982.

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\* The numbers correspond to INCAP's List of Publications.



The fellows of the Tutorial Advanced Programme of the United Nations University at INCAP discuss their work plans in an academic meeting with the Resident Coordinator, Dr. Guillermo Arroyave. They are, from left to right: Mr. Erick Díaz, from Chile; Dr. Abdul Khaleque, from Bangladesh; Dr. Benjamín Caballero, from Argentina; Dr. Graciela Garrera, from Argentina; Dr. Arroyave, Coordinator; Dr. Rosa María Zamora, from Peru; and Dr. Stella V-González, from the Philippines

- INCAP/UNU-12** Vargas, Emilio & Ricardo Bressani  
Protein quality of rice-and-bean diets with or without protein and energy supplements to estimate protein requirements in young adult humans. En: *Protein-Energy Requirements of Developing Countries: Evaluation of New Data*. Chapter 8. Benjamín Torún, Vernon R. Young and William M. Rand (Eds.). Tokyo, Japan, The United Nations University, 1981, p. 103-107. (The United Nations University World Hunger Programme *Food and Nutrition Bulletin*, Supplement 5).
- INCAP/UNU-13** Bressani, Ricardo, Delia A. Navarrete, Emilio Vargas & Olivia Gutiérrez  
Protein needs of young adult men fed common beans (*Phaseolus vulgaris*) in combination with starch, plantain, maize, or rice. En: *Protein-Energy Requirements of Developing Countries: Evaluation of New Data*. Chapter 9. Benjamín Torún, Vernon R. Young and William M. Rand (Eds.). Tokyo, Japan. The United Nations University, 1981, p. 108-114. (The United Nations University World Hunger Programme *Food and Nutrition Bulletin*, Supplement 5).
- INCAP/UNU-14** Torún, Benjamín, María I. Cabrera-Santiago & Fernando E. Viteri  
Protein requirements of pre-school children: milk and soybean protein isolate. En: *Protein-Energy Requirements of Developing Countries: Evaluation of New Data*. Chapter 19. Benjamín Torún, Vernon R. Young and William M. Rand (Eds.). Tokyo, Japan. The United Nations University, 1981, p.182-190. (The United Nations University World Hunger Programme *Food and Nutrition Bulletin*, Supplement 5).
- INCAP/UNU-15** Araya, Héctor, Marina Flores & Guillermo Arroyave  
Nutritive value of basic foods and common dishes of the Guatemalan rural populations. A theoretical approach. *Ecol. Food Nutr.* 11:171-176, 1981.
- INCAP/UNU-16** Ketiku, Ade, Delia Navarrete & Ricardo Bressani  
Protein quality of moyinmoyin and moyinmoyin with egg for human adults. En: *XII International Congress of Nutrition, August 16-21, 1981, San Diego, California. Abstracts*. San Diego, California, International Union of Nutritional Sciences, 1981, p. 68 (Abstract No.370).
- INCAP/UNU-17** Torún, Benjamín, Oscar Pineda, Fernando E. Viteri, Guillermo Arroyave, Patricio Aycinena, Cecilia Plata & Samuel Flores-Huerta  
Essential amino acid recommendations for preschool children. En: *XII International Congress of Nutrition, August 16-21, 1981, San Diego, California. Abstracts*. San Diego, California, International Union of Nutritional Sciences, 1981, p.105 (Abstract No.589).
- INCAP/UNU-18** Belizán, José, José Villar, Oscar Pineda, Aura E. González, Eduardo Sainz, Graciela Garrera & Ricardo Sibrián  
Decrease of blood pressure values in calcium supplemented individuals. En: *XII International Congress of Nutrition, August 16-21, 1981, San Diego, California. Abstracts*. San Diego, California, International Union of Nutritional Sciences, 1981, p.127 (Abstract No.726).
- INCAP/UNU-19** Torún, Benjamín, Samuel Flores-Huerta, Benjamín Caballero, Salvador García & Fernando L. Viteri  
Fulfillment of protein and energy requirements of preschool children with traditional Central American foods. En: *XII International Congress of Nutrition, August 16-21, 1981, San Diego, California. Abstracts*. San Diego, California, International Union of Nutritional Sciences, 1981 p.7 (Abstract No.3).
- INCAP/UNU-20** Caballero, Benjamín & Benjamín Torún  
Sugar fortified with NaFeEDTA to regulate iron stores of preschool children. En: *XII International Congress of Nutrition, August 16-21, 1981, San Diego, California. Abstracts*. San Diego, California, International Union of Nutritional Sciences, 1981, p. 36 (Abstract No.180)

INCAP/UNU-21 Vargas, Emilio, Marco Tulio Cabezas, Beatriz Murillo & Ricardo Bressani  
Efecto de altos niveles de pulpa de café deshidratada sobre el crecimiento y adaptación de novillos en crecimiento. *Arch. Latinoamer. Nutr.* In press.

**Activities of Dr. Arroyave as Subregional Coordinator of the WHP for Central America and Panama**

*Visit to Honduras*

On June 22-23, 1981 the Coordinator visited Tegucigalpa, Honduras on behalf of the UNU/WHP Programme in order to :

a) Carry out a site visit to the research and development center of the "Corporación Nacional de Inversiones (CONADI)", for the purpose of establishing the conditions of the fellowship to be offered to Mr. German Contreras, a food technologist who has applied for training in the utilization of solar energy for the preservation of food and food products.

b) Visit other institutions interested in establishing cooperation with the UNU Programme or in utilizing the fellowship system. In this line, the Coordinator visited the Technology Program of the School of Engineering of the National University of Honduras and gave a conference to explain the opportunities that the UNU Training Programme could offer for the development of their professional human resources. This school is particularly interested in simple appropriate technology as applied to food processing including the potential of solar energy.



Aspects of the field work carried out by the students of the Center for Advanced Studies in Nutrition and Food Sciences (CESNA), as part of the Health and Nutrition Diagnosis of the urban population of San Miguel Petapa, Guatemala, in July 1981



# TECHNICAL COOPERATION TO THE COUNTRIES

*Coordinator: Management of INCAP*

The area of Technical Cooperation to the Countries has the following aims:

1. To collaborate with the Member Countries in the study of the food and nutrition problem, as well as in the development and maintenance of surveillance systems in this field.
2. To give advice to Member Countries regarding the formulation and development of national food and nutrition policies and plans.
3. To assist the countries of the area at the various stages of planning, programming, execution and evaluation of the food and nutrition plans, programs and projects, in the different sectors.
4. To strengthen technical cooperation to the Member Countries by utilizing to the utmost the resources available in the countries as well as at the Institute.
5. To encourage the exchange of technical and professional personnel among the countries of the area.
6. To stimulate and collaborate in the technical cooperation process among the Member Countries, by setting up mechanisms for the exchange, utilization and disclosure of experiences developed by them either individually or in cooperation with the Institute itself.
7. To collaborate in the application of research findings in food and nutrition, attained by INCAP and the Member Countries.
8. To assist the health and other related sectors of the countries of the area in the organization and strengthening of the operational capacity of their nutrition technical units.
9. To cooperate, through the national authorities, with the different sectors and institutions of the Member Countries in charge of programs or activities specifically aimed at the solution of the food and nutrition problems.

In order to comply with the aforementioned objectives, the following Programs and Subprograms were developed.

# PROGRAM VII

## INTERSECTORAL FOOD AND NUTRITION PROGRAM

### SUBPROGRAM A

#### FOOD AND NUTRITION PLANNING

This Subprogram has been the responsibility of the Division of Applied Nutrition since 1972. Its main objective is to provide technical cooperation to the countries at the different stages of the food and nutrition planning process. This technical assistance is aimed at:

1. The establishment of a technical/administrative structure of the national food and nutrition program, with sufficient capability to initiate and maintain an effective planning, programming, execution and evaluation process.
2. Design of a methodology to promote and implement the incorporation of nutrition into the strategy of development, applicable in any country of the world—a methodology which has been made known through publications, seminar presentations, and formal and in-service training.
3. Establishment of nutrition information systems, identification of alternatives (technical, economic, etc.) to solve the food and nutrition problems, elaboration of methods to evaluate these problems and appraisal of solutions such as cost/effectiveness.
4. Development of mechanisms aimed at the implementation of food and nutrition intervention programs, as well as definition of the main components of a national policy for the economic and social development of the poorest segment of the countries' populations.

During the year of this Report, INCAP, in spite of having considerably reduced its human resources, managed to provide technical cooperation to the countries that requested it, especially Nicaragua, Panama and Honduras. Professionals from INCAP were assigned to these countries in a permanent manner during the whole year.

The technical cooperation offered to the countries within the Food and Nutrition Planning Subprogram is as follows:

#### Costa Rica

In connection with food and nutrition planning, this country did not request any technical cooperation from INCAP, notwithstanding the fact that since 1980, the Secretariat of the National Food and Nutrition Policy was created. This Secretariat is multisectoral and multidisciplinary, and is attached to the Ministry of Health

### El Salvador

At the request of the Ministry of Social and Economic Planning, INCAP collaborated in the preparation and development of a course on "Planning and Administration of Social Action Programs". This course was imparted to 53 high-rank professionals from 12 ministries and government institutions. It was organized by the Ministry of Planning, with the cooperation of UNICEF, the United Nations Technical Cooperation Department for Development, the U.N. Development Program (UNDP) and PAHO/INCAP. The course took place October 26-30 and INCAP was in charge of the following topics: 1) Introduction to the concept of social and economic development; 2) Models of accelerated planning; 3) Institutionalization of the process; 4) Stages in the administration of health projects, applying and adapting this methodology to various economic and social sectors.

Upon the Government's decision to make official the food and nutrition planning process, and once the Executive Bureau of the National Food and Nutrition Commission was created, professionals from INCAP held a number of conversations with the Executive Secretary, *Licda. Gladys Torres de Abarca*. She stated her interest in knowing the potentials of the technical cooperation that INCAP could offer to the country—especially regarding short-term projects—to solve the nutritional problems of El Salvador. At the end of the year, *Licda. de Abarca* visited INCAP, and once the different areas where help was needed were made known, a program was designed for providing technical cooperation to El Salvador during 1982.

### Guatemala

At the beginning of the year, a number of meetings were held with representatives from the Food and Nutrition Department of the General Secretariat of the National Economic Planning Council, for the purpose of programming the nutrition activities that will be performed jointly during the year.

INCAP cooperated in the formulation of a project for the updating of a publication on diets of minimal cost. This work was developed by the Nutrition Department of the Ministry of Public Health and Social Welfare.

On the other hand, and upon request from the World Food Program (WFP), an economic feasibility analysis and study were made regarding three projects that will be developed in Guatemala with the aid of the WFP: 1) WFP 2587, Basic food production for small farmers of Guatemala; 2) WFP 2547, Agricultural development in the Franja Transversal del Norte; and 3) WFP 2581, Training and promotion of productive activities of rural women. In each one of these projects, the WFP will provide food rations for participating families.

### Honduras

The technical cooperation provided to Honduras within the Food and Nutrition Planning Subprogram took place as follows: on one hand, through actions developed by INCAP's professional assigned to the country, and on the other, through activities performed in the country by other professionals from the Division of Applied Nutrition and from other Divisions of INCAP.

Among the most outstanding events, as far as technical cooperation offered is concerned, is the support given to the Superior Council of Economic Planning (CONSUPLANE), which received an offer from the German Federal Government for the financing of a medium-term National Plan. INCAP collaborated extensively in the formulation of the document "Food and Nutrition Program", which includes some project profiles such as: training of human resources; institutional reinforcement for the execution of the Food and Nutrition Plan; and the creation of a food and nutrition information system. In addition, some work was performed in connection with the updating of the diagnosis of the food and nutrition situation.

Collaboration was also furnished regarding the studies on the food and nutrition demand and supply relationship. In addition, help was provided in the preparation of an overall report on the National Food and Nutrition Program, which has been financed by AID/Honduras and is being developed since 1977. In

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conjunction with CONSUPLANE's Nutrition Department, an outline was prepared for the formulation of a proposal to AID for a loan extension, as well as a loan to finance the Food and Nutrition Program. INCAP participated in several meetings with representatives from SAPLAN, CONSUPLANE and the Central American Bank of Economic Integration (BCIE), to discuss some of the strategies for the development of food and nutrition planning projects which require external financing.

INCAP also participated in continuous in-service training activities on planning and development, with emphasis on nutrition. This training has been provided to technical personnel in the different sectors.

The Institute collaborated in the discussion on the establishment of a Food and Nutrition System (SANII); help was provided in the elaboration of the profiles of the project for the institutional reinforcement of the Food and Nutrition System of Honduras.

As was done in the other countries, Honduras celebrated the World Food Day, and INCAP collaborated as follows: 1) at the invitation of the Ministry of Natural Resources and of FAO's representation, INCAP participated throughout the year in the meetings held by the technical committee which was integrated for the celebration of the Day; 2) the following topic was presented at the First National Encounter: "Reflections on the Complementary Food Programs"; and 3) INCAP helped organize and develop the Second Encounter.

Upon CONSUPLANE's request, INCAP participated in the course on Social Planning offered to technicians from different institutions; the subject "Nutrition and Development" was presented.

At the request of the Government and WFP, INCAP participated extensively and full time during 12 days in the mission for the Evaluation of the Project WFP-HO/3-2283, carried out by the Ministry of Natural Resources. The Institute also participated in the elaboration of the appraisal report and in the preparation of the recommendations for the project's extension. On the other hand, support was given to the Ministry of Health in the revision and adjustment of the conditions prior to the initiation of the project WFP-HON-2325.

Jointly with the overall sector of CONSUPLANE, INCAP worked on the project on Satisfaction of Basic Needs (CLPAL); the document on analysis of the nutrition levels has been revised. Collaboration has also been lent in the revision of the basic food basket, as well as in the preparation of other alternatives for a minimal basket.

Help has been provided to CONSUPLANE's Nutrition Department in the evaluation of applications for technical support submitted to different institutions, and in the discussion of projects related to: nutrition education (CARL/SAPLAN), fish production and consumption (Ministry of Natural Resources/SAPLAN/BID), evaluation of child feeding in poor quarters of Tegucigalpa (Ministry of Public Health/SAPLAN/AID), and evaluation of the complementary food program of the area of Danli (Ministry of Public Health SAPLAN/AID).

### Nicaragua

The Government has granted high priority to food and nutrition and, accordingly, has created adequate offices such as the Viceministry of Food, under the Ministry of Agricultural and Animal Husbandry Development and Agrarian Reform, as well as nutrition units in the sectors of Education, Planning, Social Welfare, etc. Other offices have also been created, such as the Interministerial Commission for Food and Nutrition (CIPAN) and the Nicaraguan Food Bureau. INCAP has participated in several meetings with these administrative offices and discussions have been held regarding the coordination mechanisms for integrating actions of CIPAN/PAN and the sectoral food units.

The Institute has also collaborated in the preparation of the project Integrated Rural Development of the PRONORTE Region. This project was created by Decree No. 820 of the Government Junta for National Reconstruction of the Republic of Nicaragua. The project has its headquarters in the city of Ocotal and comprises the departments of Nueva Segovia, Esteli and Madriz. Its objectives are:

1. To coordinate the activities of the Executor Units of the Ministries and state offices involved in the execution of the programs of the PRONORTE project as determined by the Government Junta.
2. To elaborate the plans for the socio-economic development of the Region.
3. To administer financial resources.
4. To carry out any other activity aimed at the development of the Region.

A group of five professionals from INCAP visited the country during a period of one week, for the purpose of identifying, with the nationals, the possible areas of technical cooperation in the PRONORTE Region. The following were identified :

1. Support to the food and nutrition information/evaluation/surveillance system in:
  - design and setting-up of the system;
  - establishment of a base line of the food and nutrition status of the participating population.
2. Support to the execution process of the PRONORTE project as follows:
  - in-service training of the project's personnel in food and nutrition problems and in project execution, evaluation and follow-up techniques.
  - formulation of specific projects supported by INCAP.
3. Support of public health programs.
4. Support in the area of agroindustrial production and development.
5. Support in the area of nutrition education.

As regards food and nutrition planning, the Division of Applied Nutrition collaborated in the development of a Seminar in which the following offices participated: Viceministry of Food, CIPAN, PAN and the Center for Studies and Research of the Agrarian Reform (CIERA). In addition, specialized agencies of the United Nations and North American, Canadian, Mexican and European universities collaborated. The Seminar dealt with Agro-Food Planning. It was concluded that the country requires short-term emergency measures to: 1) increase the availability of basic grains (corn, beans and rice); 2) unify efforts in the area of food biological utilization, in order to increase the internal supply of these foods, and 3) regulate the internal demand of basic foods. For the purpose of supporting these efforts, the Land Tenure Center of the University of Wisconsin, U. S. A. has collaborated, with funds from AID/Nicaragua, in the formulation of a proposal for carrying out studies prior to the design of a food system in Nicaragua. INCAP's Division of Applied Nutrition collaborated in the revision and execution of this proposal.

## Panama

During the first months of the year, technical cooperation to this country was centered around the completion of the processing and analysis of the data collected at the National Survey on Nutrition carried out in 1980 throughout the country. Based on this information, the diagnosis of the food and nutrition situation was made. This diagnosis will be the basis for defining and formulating a Food and Nutrition Plan.

The National Bureau of Nutrition requested INCAP's collaboration in the preparation of the reference terms regarding formulation of the first formal plan on food and nutrition. This work has had the participation of officials from the following Government organizations: Nutrition Bureau of the Ministry of Health, Ministry of Agricultural and Animal Husbandry Development (MIDA), Ministry of Planning and

Economic Policy, Ministry of Education and the General Comptrollership of the Republic.

The Government's high authorities have approved the reference terms of the first Food and Nutrition National Plan and have authorized its submittal to AID for the financing of its implementation; this document also includes the six following projects: 1) Formulation of the National Food and Nutrition Plan; 2) Food and Nutrition Education; 3) Production of Basic Foods; 4) Food and Nutrition Surveillance; 5) Complementary Food Program; and 6) Nutrition in Community and Family Health. Some of these projects are already being executed and are self-financed. They are being implemented simultaneously, but will have to be incorporated into a formal food and nutrition plan. AID has shown much interest in supporting such a plan and projects, and will probably participate in their financing in 1982.

INCAP has collaborated in the revision of the project on Nutrition Education, to be supported by CARE (with \$300,000 to finance its development).

The Institute cooperated in the preparation of a definition of the family food basket. A profile of the food gaps existing in Panama was outlined. This profile was presented to the Ministry of Agricultural and Animal Husbandry Development (MIDA), who has formed a commission especially assigned to elaborate a new document on the family food basket using a suitable methodology. After the document was examined and discussed, with INCAP's cooperation, it became the subject of a Seminar-Workshop that took place in October, as part of the activities held in commemoration of the World Food Day. This Seminar-Workshop lasted one week and had the participation of more than one hundred high level officials (both political and technical) from all the sectors involved in food and nutrition problems in the country. INCAP participated in this event, and also collaborated in the preparation of a document entitled "Food and Nutrition" that the National Director of Nutrition presented at this Seminar-Workshop; this document basically analyzes the main nutrition problems existing in Panama and the results of various studies and surveys carried out in this field. In addition, this document examines the levels of extreme poverty and malnutrition and makes known the food gap that served as the basis for the different components of the basic basket and the minimal diet recommended. Some basic ideas are also outlined regarding the Food and Nutrition Plan.

## SUBPROGRAM B

### FOOD/NUTRITION SURVEILLANCE

In accordance with Resolution taken at the XXIII Meeting of the Ministers of Health of Central America and Panama, INCAP was asked to cooperate in the design, initiation and evaluation of the food/nutrition surveillance systems in the countries of the Central American area.

Cooperation in this respect has been provided in accordance with the countries' demands. The general and specific objectives of the present Subprogram are:

1. To cooperate with the countries, if they so request it, in the design and establishment of food/nutrition surveillance systems, seeking the best interministerial coordination possible, so as to maintain, in a continuous manner, an evaluation of the nutrition situation of the population.
2. To give advice to the countries at the stages of organization and functioning, and also in regard to the administrative and operational structure of food/nutrition surveillance systems, whether national or regional.

During the year, the following activities were performed :

The Head of the Division of Applied Nutrition collaborated, and also participated, in the organization and development of the International Workshop on Nutrition Surveillance which took place in Cali, Colombia, July 14-17. One more professional from the Division attended, as well as one for each country of Central America and Panama.

#### Costa Rica

Technical cooperation has been provided to this country through the Nutrition Information System (SIN), which has become a Division of the Control Office for Family Allowances (OCAF) of Costa Rica. INCAP cooperated in connection with the analysis carried out by SIN as to this organization's roll within OCAF. In addition, the Institute collaborated in the activities developed regarding the analysis of the simplified height-measuring device developed by SIN, and the revision of the standards of the National Center for Health Statistics (NCHS), which have been adopted by SIN. Collaboration has also been furnished in the design of an instruction form for the development of a weight and height project for school children.

On the other hand, terms of reference were revised in connection with an evaluation project as to the causes of mortality. One of the results of this project will be the determination of indicators for measuring cost/effectiveness.

INCAP also cooperated in the revision of the functional groups' reports, based on surveys of living quarters, population and agriculture for 1973.

## Honduras

Extensive technical cooperation was given in this country with regard to the preparation of the final report on the Survey on Food Consumption carried out in three regions of the country and in the city of Tegucigalpa. This report was under the responsibility of INCAP's professional assigned to this country. Orientation has been provided in the interpretation of the tabulations elaborated and in the manner of presentation of the final charts. The national personnel in charge of the study were trained in the detailed revision of these tabulations. INCAP's Computer Center collaborated in the processing of the complementary tabulations. This survey is very important, as it has been considered as the basis for the study on "Satisfaction of Basic Needs", especially since the results are given in accordance with economic groups of each region. The final document is ready for publication.

The food/nutrition surveillance project that is being developed in the region of Danlí as a pilot project has been evaluated, and its conclusions are of great value to the Government, who is willing to extend these experiences to other regions of the country; these regions have already been visited for the purpose of making the corresponding geographical and institutional studies. In addition, information has been furnished to the local authorities of the zone on the importance of the food/nutrition surveillance project.

## Nicaragua

In this country, INCAP has collaborated with officials from the Ministry of Education in the project Nutritional/Epidemiological Surveillance Education System (SEVEN). The personnel from the Nutrition Research Unit who are in charge of this project participated in the in-service training offered by the Institute. In addition, INCAP gave advice on: 1) functioning of the information systems; 2) selection of the sample; 3) form design; and 4) evaluation of the work. A series of recommendations were made as to how to carry out the survey and the total reformulation of the project. Help for the execution of this activity is also being received from the University of Moncton, Canada, who financed an observation trip to Canada by two national professionals.

On the other hand, INCAP participated in the development of a food/nutrition surveillance system model in the *Municipio* of Mateare, where a methodology that might prove adequate for the extension of the system to a national level has been tested. The Institute collaborated in connection with in-service training of the personnel involved, design of the sample and method of collection of the food/nutrition information. This project has received support from the Italian-Latin American Institute (IILA), which has its headquarters in Italy.

INCAP also collaborated in the revision of the forms, the preliminary analysis of the population data (socioeconomic, hematologic and parasitologic) and in aspects relative to the design of data computation programs of the clinical, dietary and anthropometric surveys carried out.

This project will facilitate utilization of the resources in terms of generated information and decision making, and it will also allow the establishment and development of coordination mechanisms, both interinstitutional and multisectoral.

The project of endemic goiter control and that of surveillance and control of salt iodization are being developed satisfactorily, from the stage of production of the salt up to the sale of the product. As far as the assessment of the biological impact of iodization on the population is concerned, the study was completed with the cooperation of INCAP's professional assigned to the country and of other specialists from the Institute. In addition, a longitudinal follow-up was carried out to evaluate the impact and to identify possible alterations in thyroid function of the population, especially as far as thyrotoxicosis is concerned.

INCAP has committed itself to carry out data analysis and contribute to the interpretation and publication of the results. Due to lack of financial resources for the analysis of thyroid hormones, steps have been taken to request funds for this purpose from AID and from the Government of Holland.

On the other hand, it is expected that studies will go on for the identification of new methods of

iodization. Follow-up activities regarding this project were completed in October, and final evaluation was made in November and December.

## SUBPROGRAM C

### NUTRITION IN PUBLIC HEALTH

The general objective of the Subprogram Nutrition in Public Health is to support and strengthen the technical capacity of the Nutrition Departments of the health sector and other akin offices of the country. The work carried out within this Subprogram has been oriented towards the following areas :

1. Participation of the health sector in the multisectoral planning of food and nutrition.
2. Incorporation of the nutrition actions in the health service coverage extension programs.
3. Design and establishment of norms and procedures for nutrition integration into maternal/child as well as adult health programs.
4. Attention and strengthening of food services in hospitals and other institutions for children, for adults and for elderly persons.
5. Training of in-service health personnel.

The technical cooperation activities of this Subprogram are carried out in coordination with those of Food and Nutrition Planning and Food/Nutrition Surveillance, and some of these activities have already been described in these Subprograms.

The most outstanding activities developed in the present Subprogram are mentioned below.

#### Costa Rica

In conjunction with officials from the Nutrition Department, Maternal/Child Division of the Ministry of Health, the National Health Research Institute (INISA) and the Children's Hospital, INCAP examined the convenience as well as the problems involved in changing the Iowa reference pattern for that of the NCHS\* in the programs of the Ministry of Health. In addition, it was necessary to revise the anthropometric information of 2,000 children for determining the convenience of the change in such programs.

On the other hand, counsel was offered in relation to the measures on nutritional recovery and recovery programs for moderately malnourished children.

#### El Salvador

At the request of the Ministry of Public Health and Social Welfare, cooperation was offered to the

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\* National Center for Health Statistics, Atlanta, Georgia, U. S. A.

Department of Nutrition for the evaluation of the food aid program that WFP has provided to this country. Jointly with this Department, the most convenient methodology for such evaluation was defined.

In addition, support was provided to the nutrition personnel of the Operative Services of the Ministry; they are responsible for the supervision of the nutrition activities in the health services of the whole country.

A professional from INCAP participated in the Medical Meeting of the Health Western Region, and presented the following topic: "Maternal Lactation and the Mother/Child Dyad".

#### Honduras

During the present year, the Department of Nutrition of the Ministry of Public Health and Social Welfare requested more technical support from INCAP, in view that the Head of said Department was granted a scholarship by OPS to study food and nutrition planning in Chile. At the same time, the Institute has continued giving technical assistance in the project Integration of Nutrition Activities in the Coverage Extension Program. Growth and development norms were revised, as well as the growth control graph proposed by the Pediatrics Unit, to be applied in health programs.

INCAP also participated in the revision and discussion of the project on a children food study in poor quarters of Tegucigalpa, to be financed by AID.

#### Nicaragua

The Ministry of Public Health requested INCAP's cooperation for the reorganization of the Area or Department of Nutrition of this Ministry, and help was given accordingly. INCAP also provided technical support as far as this Department's activities were concerned, and also in connection with coordination activities which this Department carries out with other sectors or organizations for the solution of the nutrition problems. INCAP's professional assigned to the country has his office within the Nutrition Area of this Ministry and offers technical support in the development of the Ministry's own actions and those related to other sectors or organizations.

A new project has been prepared to fortify salt with fluorine, starting in 1982. This project is under the responsibility of INCAP's representative in the country.

The Ministry of Health has also given priority to the hospital food system, and requested support from INCAP in connection with hospital food services. INCAP cooperated in the definition of a standardized dietary pattern for all hospitals, at a rational cost within the budget assigned for this purpose. In addition, INCAP collaborated in the elaboration of a manual for the organization and functioning of food services. Cooperation was also lent in the preparation of a project regarding the technical assistance which the University of Moncton, Canada, will provide to improve hospital dietary attention.

#### Panama

Within this Subprogram, the most important technical cooperation given to this country was the study of the situation of food services in 25 hospitals of the country. To this end, it was necessary that INCAP's professional assigned to this country were made responsible for this project. She traveled throughout the nine health regions of the country and visited these hospitals. A detailed report was prepared which includes, in addition, a list of recommendations. This report has already been presented to the corresponding authorities of the Ministry of Health and of the Social Security Bureau.

On the other hand, and jointly with officials of the Maternal/Child Department of the Ministry of Health, the new nutrition norms to be incorporated in the maternal/child programs were revised. The use of the new weight/height and height/age curves was also revised.

At the request of the Bureau of Nutrition, information was furnished with regard to recommended daily intakes of vitamin D for women and children. This information was necessary to extend the criterion on fortification of CARE's skim milk and the mixture CSM with vitamin D and its harmlessness for pregnant women.

The National Bureau of Nutrition, with UNICEF's support, is developing a project of family orchards in urban-marginal communities of the Metropolitan Region. INCAP collaborated in the design and formulation of the project. At its initial stage, this project will have a duration of three years, at a cost of \$ 100,000, and approximately 500 families with preschool age children will benefit from it. The families will receive nutrition education, in addition to goods for their orchards, and a food/nutrition surveillance system will be implemented for this population.

## PROJECT I

### CONTROL OF HYPOVITAMINOSIS A IN CENTRAL AMERICA AND PANAMA

This program continued its operation during the year covered by the present report. The two countries which are carrying on national programs of sugar fortification with vitamin A have taken full responsibility for their supervision and control. For that reason INCAP limited its contribution only to responding to specific consultations received from the Governments, without having any direct participation in their operation.

On the other hand, INCAP concentrated its efforts in research to support the fortification programs, both in their technological aspects and in the determination of their impact on the nutritional status of the population.

#### Subproject A PROGRAMS OF FORTIFICATION OF SUGAR WITH VITAMIN A IN CENTRAL AMERICA AND PANAMA

*G. Arroyave and L. A. Mejía*

The national programs of fortification of sugar with vitamin A continued only in Honduras and Guatemala during the sugar production period from November, 1980 through May, 1981. INCAP has not been officially informed by the Governments on the operation of these programs. Indirect information derived from the amounts of vitamin A palmitate purchased by the sugar manufacturers suggests that only around 50% of the white sugar produced for local consumption has been enriched. For this reason, there seems to be an urgent need for the Governments to enhance their efforts to supervise and control fortification programs, creating for this purpose more effective mechanisms in both countries.

Costa Rica has recently carried out a follow-up survey of the vitamin A nutritional status of the population, with emphasis in the preschool child. The results, which are still being analyzed, will be used by the Government to decide whether or not the fortification program should be reinstalled. As reported previously, this country suspended sugar fortification with vitamin A in 1979 on the basis of evidence of a marked improvement in serum levels of vitamin A and dietary adequacy of this vitamin in preschool children. At the same time, it was officially decided to determine whether the improvement observed could be maintained without the fortification program. This question will be resolved through the survey mentioned.

Panama, Nicaragua and El Salvador do not have as yet any national programs of sugar fortification with vitamin A.

## PROJECT 2

### INTEGRATED SYSTEM OF NUTRITION AND PRIMARY HEALTH CARE IN RURAL AREAS OF GUATEMALA (SINAPS)

*A. Lechtig, J. Townsend, J. F. Pineda, J. J. Arroyo, R. E. Klein and  
R. de León\**

As mentioned in the last Annual Report, the SINAPS Project is the result of the joint efforts of the Ministry of Public Health and Social Welfare, INCAP and PAHO to improve the health situation of the country. Its basic purpose is to increase the effective coverage of health and nutrition services in Guatemala at the primary care level.

The general and specific objectives of this Project have been detailed in previous Annual Reports and are based on the following hypothesis: it is feasible, within the current conditions in the country, to implement an effective and efficient primary health care system based on provision of services by non-professional personnel (auxiliary nurses, rural health technicians, rural health promoters and traditional birth attendants) with appropriate supervision.

Of the 36 months available, the first 9 months (June, 1979 - February, 1980) were dedicated to development of methodology, while field implementation began in March, 1980 and will finish in May, 1982.

The organization of the SINAPS Project entails close coordination between the Ministry of Health, in charge of service delivery and training, PAHO and INCAP, in charge of development of appropriate technology and program evaluation. The Project is administered by two Co-directors, one nominated by the Ministry of Public Health and the other by INCAP.

The Project is evaluated through periodic surveys carried out in a random sample of families in three control and six experimental health districts. Results from the base line survey indicated that both groups, control and experimental, were very similar before program implementation in terms of prevalence of malnutrition, infant mortality, vaccination coverage and prevalence of contraceptive users.

The SINAPS Project activities are focused on immunizations, food supplementation, oral rehydration, family planning, perinatal surveillance, and promotion of health and environmental sanitation with participation of the community. This reduced set of interventions is aimed to control for the most important causes of death and disease in the maternal and child group.

The rural health promoter (RHP) and the traditional birth attendant (TBA) are the persons mainly responsible for the delivery of health care services at the primary level (community and household). They are volunteers and live in the community in which they work. The RHP provides services through periodic household visits (every two months) and through community meetings at two-month intervals.

The tasks performed by the RHP include community census and mapping, vaccinations, detection and distribution of food supplements to pregnant women and preschool children at high risk of malnutrition, oral rehydration to children with diarrhea, primary curative care, encouragement of long-term breast feeding and promotion of health and environmental sanitation. The tasks performed by the TBA include care of normal pregnancy, birth and puerperium, detection of newborns at high nutritional risk and referrals of mothers at high obstetrical risk to the closer health service facility.

The results achieved in this Project during 1980, described in detail in the last Report, included:

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\* Co-director of SINAPS, from the Ministry of Public Health and Social Welfare, Guatemala. Head of the Division of Human Resources Training of this Ministry.

1) Development of all methodology required, including the models for health services delivery, training, supervision, evaluation and the administrative guide. 2) Collection of base line data in the experimental and control health districts. 3) Development of the coordination between INCAP/PAHO and the Ministry of Public Health and Social Welfare at all operational levels of the project.

Table 1 summarizes the principal results observed in the six experimental health districts where the project was implemented. No consistent effects have been observed as yet on prevalence of malnutrition and on infant mortality. However, the fact that all operational goals are being reached suggests that the impact on health indicators will increase considerably as the program advances to the period 1982-1984.

Finally, important components of the methodology developed in the SINAPS Project are now being adopted at national level in Guatemala as well as in other Latin American countries.

TABLE 1  
CURRENT STATUS OF SINAPS INDICATORS  
AS OF DECEMBER 31, 1981 \*

Indicator	Before SINAPS	Currently
Number of rural health promoters in training (% attendance)	170 (-)	405 (88%/o)
Number of traditional birth attendants in training (% attendance)	-	228 (83%/o)
Vaccination coverage		
DPT and polio (1st dosis)	68%/o	93%/o
BCG	67%/o	95%/o
Measles	58%/o	92%/o
Tetanos toxoid for pregnant women (1st dosis)	5%/o	68%/o
Measurement of pregnant women for malnourishment	-	69%/o
Measurement of children for malnourishment	-	84%/o
Homes which have received oral rehydration salts	0%/o	84%/o
Mothers who administrate oral rehydration salts to children with diarrhea	0%/o	38%/o
Knowledge of contraceptive methods	69%/o	85%/o
Use of modern contraceptive methods	10.7%/o	15.0%/o
Mortality 1-4 years of age	11.4%/o	4.9%/o
Net additional cost (per capita per year)	-	\$ 0.99 first year \$ 0.72 subsequent

\* The total population censused by the rural health promoters is 70,179.

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## PROJECT 3

## SIMPLIFIED HEALTH CARE PROGRAMS IN INDIAN RURAL GUATEMALA

*H. L. Delgado, V. Valverde, J. M. Belizán and R. E. Klein*

In 1976, two health intervention projects were implemented by the Division of Human Development, one in four Indian communities in the department of Sololá, and the other in ten coffee plantations near the town of Patulul, in Suchitepéquez. The health care programs implemented in these two projects are described in great detail in INCAP Monographs 11 (Spanish) and 12 (English)\*. The model of health services developed in these projects is presently being utilized in coffee plantations in the departments of Verapaz and Quetzaltenango.

During 1981, analyses of the impact of these projects were performed. The impact was measured in terms of the demand and the quality of the services, effects on nutritional status, effects on mortality, and side effects.

In both projects, the majority of cases were attended by paramedical personnel. The cases attended by the physicians were those referred by paramedical personnel or seen during the quality control examination. The quality control system practically eliminated the possibility of serious errors in the diagnosis, examination, treatment and follow-up of the patients. The acceptability of these projects was good, as indirectly measured by the number of visits per person per year to the health posts, which vary between three and four. In both projects, a reduction in the infant and preschool mortality rates after two years of the project was found. Finally, the costs of the project are relatively low because of the use of local paramedical personnel and the appropriate technology.

More recent analyses of the morbidity data collected at home every two weeks for each family residing in the Patulul plantations and the information on the visits to the clinics indicate that the health services were not properly utilized. Results of analyses of morbidity data and demand of services indicate that the conditional probabilities of visiting the clinic when a severe gastrointestinal or respiratory disorder occurred were below 50%. These results indicate that not all the families were properly utilizing the services and suggest a differential impact of the project in different segments of the populations even though, as a whole, the infant mortality rates were clearly reduced. More analyses are being performed based on this information.

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\* Delgado, H., J. M. Belizán, V. E. Valverde, E. M. Girón, V. Mejía Pivaral y R. E. Klein. *Programa Simplificado de Atención de Salud: Experiencias en Areas Rurales de Guatemala*. Guatemala, División de Desarrollo Humano del INCAP, 1980 (Monografía No. M-11).  
Delgado, H., J. M. Belizán, V. E. Valverde, E. M. Girón, V. Mejía Pivaral and R. E. Klein. *A Simplified Health Care Program in Rural Guatemala: The Patulul Project*. Guatemala, Division of Human Development of INCAP, 1980 (Monograph No. M-12).



**Health personnel in the Primary Health Program examine the documents used in on-the-job training (Sololá and Patulul Projects)**

## PROJECT 4

## ENDEMIC GOITER CONTROL PROGRAM IN NICARAGUA

*A. Noguera, B. Torún and F. E. Viteri*

**Subproject A EPIDEMIOLOGICAL SURVEILLANCE OF ENDEMIC GOITER AND THYROID FUNCTION**

*A. Noguera, G. N. de Noguera\*, M. I. Carballo\*, B. Torún and O. Pineda*

Salt iodization was begun in Nicaragua in June, 1978. Later on, epidemiological follow-up activities were oriented towards: 1) evaluating changes in goiter prevalence; 2) identifying clinical and/or biochemical manifestations of thyroid dysfunction; and 3) determining corrective measures, if necessary. Follow-up of the persons under study was temporarily interrupted due to the prevailing conditions in the country. Between November, 1980 and November, 1981, 6,252 persons were examined in the 16 communities included in the basal phase (pre-iodization). Of these individuals, 4,238 had been examined at that stage (longitudinal sample).

Information obtained during that year is being analyzed, and the corresponding laboratory determinations are being carried out. The results available up to this moment reveal that goiter prevalence in general (that is, in all age groups) was reduced from 33<sup>0</sup>/o in 1977-78 (see Annual Report, 1978) to 20<sup>0</sup>/o in 1981, with prevalences between 8 and 38<sup>0</sup>/o in the 16 communities studied. As shown in Table 2, the most important decrease was noted in school children and adolescents. The reduction of 14 to 3<sup>0</sup>/o in school children suggests a decrease in incidence, as the majority of the new cases of goiter appear in this age group. There was a clear reduction in goiter prevalence among adolescents, from 23 to 5<sup>0</sup>/o in men and from 36 to 14<sup>0</sup>/o in women. Reductions in the rest of the groups were less pronounced.

The most evident decrease in all the age groups corresponded to prevalence of small goiters (Grade I). This confirms the reversibility of the process with iodine administration, and supports the suggestion of a reduction in the incidence of endemic goiter, that is to say, a lesser incidence of new cases after salt iodization.

Table 2 also shows no variation in the total proportion of persons presenting suggestive signs and/or symptoms of hyper- or hypothyroidism in 1977-78 and 1981. Nevertheless, in 1981 there was a relative increment in the proportion of persons with changes in weight and three or more signs and/or symptoms, especially those suggesting hyperthyroidism. However, the lack of specificity regarding those signs and symptoms does not allow us to conclude in an unequivocal manner that there were any changes in thyroid functions. Such conclusion will have to wait until hormone concentrations in the plasma specimens collected are analyzed.

**Subproject B SALT IODIZATION CONTROL**

*A. Noguera, G. Madrigal\*\* and J. Mayorquín\*\**

During 1980 and 1981, quantitative analyses of iodine in salt were made in 438 samples collected during routine visits made to the 12 iodization plants that function in the country. Analyses revealed that 100<sup>0</sup>/o of the samples analyzed contained iodine; of these, 397 (90.6<sup>0</sup>/o) were within the limits estab-

\* R. representative from the Ministry of Health, Nicaragua.

\*\* Sanitary worker of the Ministry of Health, Nicaragua.

TABLE 2

FREQUENCY OF GOITER AND OF CLINICAL SIGNS AND/OR SYMPTOMS OF THYROID DYSFUNCTION  
BEFORE AND AFTER SALT IODIZATION (1977 - 1981)

Age (years)	Persons examined		Difuse goiter (°/o)		Nodular goiter (°/o)		Total goiters (°/o)		Symp hyperth
	1977	1981	1977	1981	1977	1981	1977	1981	1977
<b>MEN</b>									
7-10	969	229	12.7	1.3	0.5	0.4	14	3	2.8
11-15	1085	529	22.3	4.7	0.5	0.2	23	5	3.8
16-45	630	409	21.4	8.6	3.2	1	21	10	7.8
> 45	212	94	4.3	4.3	4.7	2.1			
<b>WOMEN</b>									
7-10	1388	299	13.8	3	0.7	0.4	14	3	3.8
11-15	1897	1019	35.2	13.3	1.2	0.4	36	14	5.3
16-45	6160	2773	37.2	27.9	6.9	3.5	41	32	13
> 45	1473	871	13.4	8.7	13.9	9.5			
<b>TOTAL</b>	<b>13,814</b>	<b>6252</b>	<b>28</b>	<b>17</b>	<b>5.1</b>	<b>3.4</b>	<b>33</b>	<b>20</b>	<b>9.5</b>

\* One or more signs and/or symptoms compatible with thyroid dysfunction, in addition to recent changes in weight.

lished by law (1 part iodine by 20,000 to 30,000 parts salt), 21 samples (4.8<sup>o</sup>/o) had lower concentrations and 20 (4.6<sup>o</sup>/o) were above the upper limit.

The qualitative control carried out by the sanitary workers in 1980 throughout the country showed that 96<sup>o</sup>/o of the samples tested were iodized. In 1981, qualitative analyses of iodine in the salt of 3,090 retail shops revealed that 3,068 samples (99.3<sup>o</sup>/o) contained iodine, and only 22 samples were not iodized. This demonstrates that surveillance and control of salt iodization have been effective at national level.

Every year, studies on production and marketing of the salt industry are carried out in the country. The Ministries of Interior Commerce and of Health, as well as representatives from the State and from private producers participate in these studies, for the purpose of determining costs in connection with production, transport, packing and iodization. This allows the establishment of prices that, without affecting the consumer, will leave a margin of profit for those involved in the process that goes from production to selling, thus promoting the salt industry and favoring iodization control. At the present time, the National Salt Corporation (CONASAL) has been constituted in Nicaragua. It is integrated by producers, packers, plants, sellers and carriers, involving not only private but also state enterprises, as well as the Ministry of Interior Commerce and the Ministry of Health. This degree of organization has made it possible to establish regional marketing routes that facilitate even more the control of iodization. It is important to note that CONASAL supports the Ministry of Health in the surveillance and control of salt iodization, and also helps economically so that these activities may be carried out by sanitary workers.

From the above, it is evident that the Nicaraguan experience in this type of programs may be useful to other countries that have problems with programs of this nature.

At present, studies are being carried out in Nicaragua regarding the possibility of a simultaneous fortification of salt with fluorine and iodine. Probabilities of success are high, due to the simplicity and low cost of the technology that is being explored, as well as to the degree of organization and satisfactory functioning of the salt iodization program.

## **SUBPROGRAM D**

### **FOOD/NUTRITION EDUCATION**

The Unit of Food/Nutrition Education was created on October 15, 1981, in accordance with the recommendations of INCAP's Study Group. From October to December, and in line with clearly defined objectives, the Unit developed the following activities :

1. Planning of the institutional diagnosis of the situation of food/nutrition education in the countries of the area :
  - a) Preparation of the "Guide for the Operational Diagnosis of Food/Nutrition Education at Institutional Level" and of the respective tabulation forms.
  - b) Identification of the governmental institutions through which the diagnosis would be carried out, and transmittal of the letters requesting their participation.
  - c) Use of the diagnosis form, on a trial basis, in two Guatemala Government institutions : the General Bureau of Agricultural Services (DIGESA), of the Ministry of Agriculture, Livestock and Food, and the Department of Nutrition of the Ministry of Public Health and Social Welfare.
2. Development of the food/nutrition education component in the process of multisectoral planning of food and nutrition:
  - a) Elaboration of the "Outline of the Education Component in the National Food and Nutrition Plan".
  - b) Identification of food/nutrition behavior at community level and of the corresponding indicators.
  - c) Identification of the capabilities which are necessary at the institutional level to promote changes in food/nutrition behavior, as regards exchange agent, program director or supervisor, and normative personnel.
3. Collaboration with the Teaching Division in the area of food/nutrition education:
  - a) Counsel in connection with monographs required in the Course in Public Health with Emphasis on Nutrition and Mother and Child Health.
  - b) Counsel in the development of thesis work of the School of Nutrition students.

It is hoped that the Unit will reach ample development in 1982 and will be able to participate in technical cooperation activities in the countries.

## SUBPROGRAM E

### DEVELOPMENT OF FOOD RESOURCES

#### PROJECT 1

##### PRODUCTIVITY IMPROVEMENT OF THE NATIVE PIG IN EL SALVADOR

*R. Jarquín, A. Ventura\*, M. Olivares\* and R. Bressani*

At the beginning of December, 1981, INCAP's participation in the development of the above-mentioned project took form, as a collaboration with the Government of El Salvador.

Prior to initiation of the project, a survey is to be carried out to cover the different aspects involved in the productivity of the native pig. The corresponding form has been elaborated and will be tested in the field, so that the necessary corrections may be made before its codification. It is expected that this form will aid in detecting the needs and problems that the national swine breeder faces with this type of pig, which constitutes a familiar type of exploitation.

The survey will allow the collection and processing of data which will facilitate assigning priorities in connection with the problems that need immediate attention. Also, from this experience a series of sub-projects will come out, involving research work aimed at finding practical solutions for the country's swine breeders.

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\* Representative from the Ministry of Agriculture, El Salvador.

## SUBPROGRAM F

### APPLICATION OF FOOD TECHNOLOGY SYSTEMS

#### PROJECT 1

##### VEGETABLES DEHYDRATION IN GUATEMALA

Subproject A    MICROBIOLOGICAL CHARACTERISTICS OF THE DRY PRODUCT AND THEIR INTERRELATIONSHIP WITH THE PROCESSING CONDITIONS, AND METHODOLOGY USED FOR QUALITY CONTROL OF THE PRODUCT

*M. R. Molina, M. A. Baten and R. Bressani*

Due to the variability found in the degree of microbiological contamination of dried parsley leaves produced at INCAP's pilot plant, and to the variability found when using different laboratory techniques for the preparation of the sample for microbiological evaluation, it was decided to investigate further the reasons for these variabilities. For such purposes, samples of fresh parsley were taken at the production site (Santiago Sacatepéquez, Sacatepéquez, Guatemala) and were then transported under refrigeration and washed and dried aseptically in the laboratory. Other samples of the same fresh parsley were taken after being harvested and transported to INCAP by the growers themselves. These samples were washed, and dried aseptically in the laboratory. Other samples corresponding to the same lots of parsley were taken at INCAP's pilot plant after being washed (3 times with tap water plus 250 ppm of free chlorine and once with tap water by aspersion) and both before and after drying. The samples taken before drying were dried aseptically in the laboratory. All samples were subjected to a total viable bacterial count and to a coliform test. A total of four parsley lots were subjected to the evaluation scheme outlined above and each lot was examined in triplicate. The samples for the microbiological evaluations were prepared both by the sterile water washing technique, adding sterile glass beads, and by the aseptic homogenization method using either 3 min in a sterile Waring Blender or the same time in a Polytron type liquefying aseptic machine. In the case of the washing technique as well as when the Waring Blender was used, a 10% suspension of the sample was prepared. When the Polytron liquefier was used, a 50% suspension had to be prepared.

The results (Table 1) revealed a significant difference ( $P < 0.05$ ) between the total viable bacteria found in each sample obtained at the different processing steps. Likewise, it can be noticed that the technique used for preparing the sample had also a significant ( $P < 0.05$ ) effect on the results (Table 1). All the above suggests that the establishment of drying facilities in the area of Santiago Sacatepéquez, near the parsley production site, would be of great benefit, since it would decrease the contamination occurring during the transportation of the raw material. On the other hand, these results also suggest that in order to obtain a dry product of the best microbiological quality, the sanitary conditions of the washing and drying operation carried at the pilot plant should be improved. The effect of using a higher water to raw material ratio in the washing operation, as well as the effect of a periodical disinfection of the drying cabinet and the use of filtered air for this operation are now under evaluation.

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The fact that significantly higher ( $P < 0.05$ ) total viable bacterial counts were obtained in the samples when using the Polytron type liquefying apparatus for their preparation (Table 1), as well as the fact that the same counts were significantly higher ( $P < 0.05$ ) when preparing the samples with the Waring Blender than when they were prepared by the washing technique, suggest that a bacterial growth is occurring inside the internal structure of the product (leaf or leafstalk). This possibility could be explained by a possible microbial invasion of such structures when the vegetable tissue is broken and/or damaged during the harvesting and/or transporting operations. The possible impact of these findings on modifying the present official methods for preparing vegetable samples for microbiological evaluations is evident.

Even though the present data indicated that in all cases the samples were within the maximum allowable limits of microbial contamination for dehydrated vegetables of the food sanitary standards of Guatemala, the work in this field is being continued because it is considered relevant both to obtain technological recommendations to improve the sanitary quality of dehydrated vegetable products, and to help modify the current officially approved methodology for the sanitary quality control of vegetable dehydrated products.

TABLE 1

TOTAL VIABLE BACTERIAL COUNT USING THREE DIFFERENT LABORATORY TECHNIQUES IN DRY PARSLEY LEAVES OBTAINED THROUGH DIFFERENT TREATMENTS (Col/g)\*

Treatment			Method used for preparing sample		
Transport	Washing	Drying	Washing	Homogenizing	Liquefying (Polytron)
Laboratory	Laboratory	Laboratory	1,000	6,000	7,000
Grower	Laboratory	Laboratory	10,000	15,000	17,000
Grower	Pilot plant	Laboratory	15,000	21,000	39,000
Grower	Pilot plant	Pilot plant	60,000	80,000	100,000

\* Col. = Viable bacterial colonies.

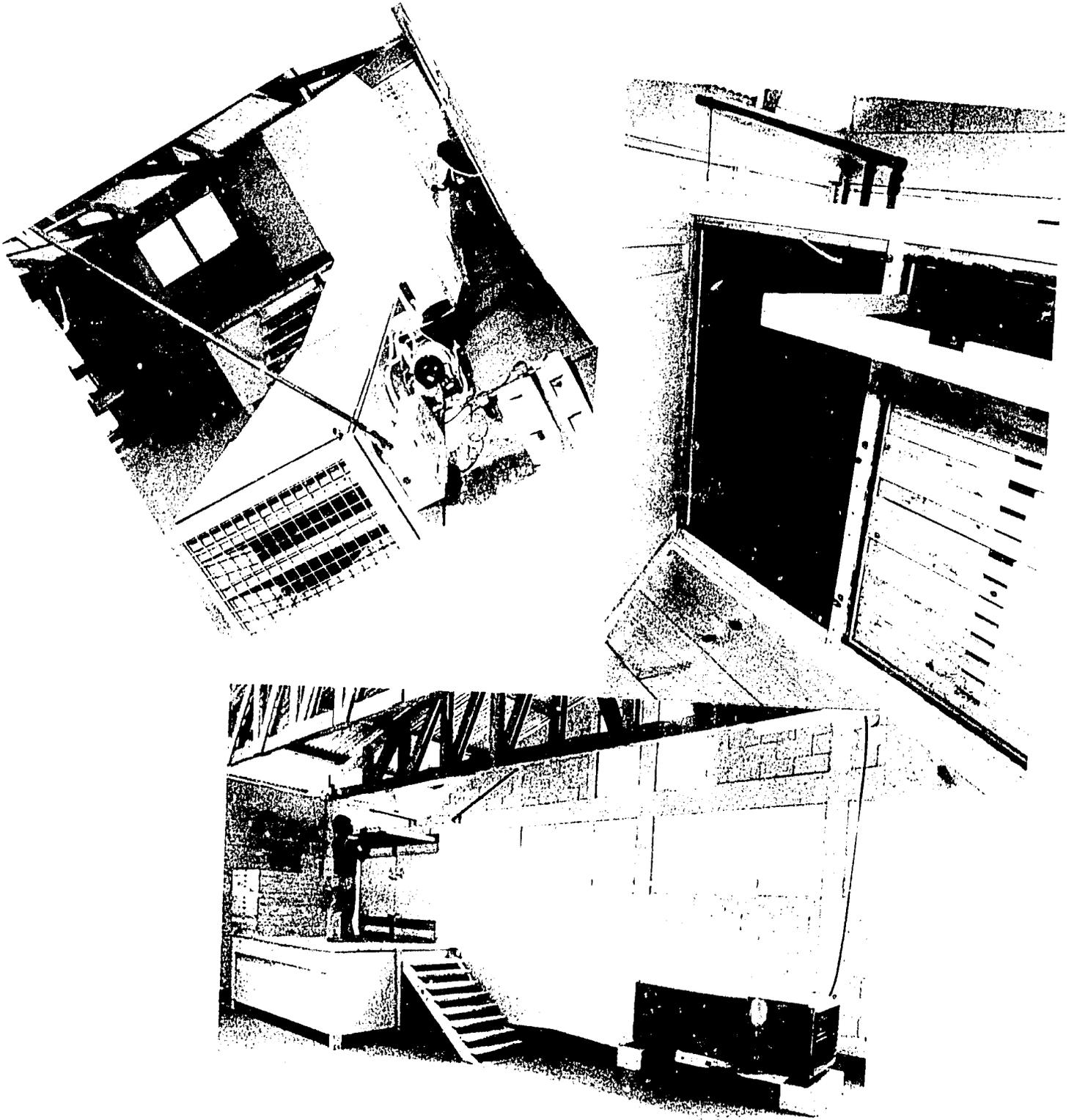
Subproject B FUNDAMENTAL ASPECTS OF THE DESIGN AND IMPLEMENTATION OF A COUNTERCURRENT AIR DRYING CABINET TO BE USED AT A RURAL AGRO-INDUSTRIAL LEVEL

*M. R. Molina, B. Axtell\*, M. A. Baten and R. Bressani*

Based on the results obtained at INCAP's pilot plant for the drying of parsley leaves (already informed\*\*), it was possible to establish that for the tray drying of these products, using a countercurrent air flow arrangement, the air velocity should be within 65 to 70 m/min with an inlet air temperature of 65 to 70°C. The feasibility study carried out for the implementation of this parsley drying process at the facilities of the Agricultural Cooperative "Cuatro Pinos", of Santiago Sacatepéquez, Guatemala (Unit of Food Technology Transfer, UTTA, INCAP, June 1980, 43 p.), recommended a daily production of

\* Food Technologist assigned to INCAP by the United Kingdom Ministry of Overseas Development.

\*\* Annual Report, 1979 (p. 30), Annual Report, 1980 (p. 35).



Aspects of the low cost drying unit designed by INCAP's technical personnel for use at the vegetable drying plant of the Agricultural Cooperative "Cuatro Pinos" of Santiago Sacatepéquez, Guatemala. The cabinet of the drying unit was constructed by the Cooperative's personnel, under the supervision of INCAP's technical staff

73 kg of dried parsley leaves, and since the load per tray ( $1 \text{ m}^2$ ) considered adequate is 5 kg of raw material, which is equivalent to 0.7 kg of dried leaves obtained in 30 min (average drying time), it was considered convenient to study the possibility of establishing two drying units. Each of these units consisted of a double cabinet of 17 trays each with a countercurrent air flow arrangement. This allows for a dried parsley leaves output of 2.8 kg/hr/drying unit equivalent to 5.6 kg/hr in the two proposed units. This yield would allow to obtain the suggested daily production output (73 kg of dried leaves) in an average of 13 hr of work, or two 8-hr shifts per day. It was decided to equip each drying unit with a Zeta (Nu-Way Benson Ltd., England) air heater-blower, model WH 88, with an average air flow of  $85 \text{ m}^3/\text{min}$  ( $3,000 \text{ ft}^3/\text{min}$ ), with an estimated velocity of 226 m/min in an outlet area of  $0.38 \text{ m}^2$ . Through calculations, it could be established that in order to obtain a homogeneous air flow in a final area of  $1.1 \text{ m}^2$  (90 cm height x 120 cm at the base) a minimum linear distance of 3 m was necessary. A 3-m long air tunnel was then constructed, giving a lateral angle of  $40^\circ 41'$  and an angle of  $30^\circ 29'$  both at the top and bottom. The air velocity measurements made at the exit of this tunnel indicated that such velocity was homogeneous, as calculated, having an average value of 147 m/min. The tunnel was prolonged in a rectilinear manner for a total of 2 m, in which distance a total of 8 baffles were distributed to deflect the air flow. Four of the baffles deflected the air flow to the first cabinet and the last four to the second one. Each cabinet had a free area (available for air flow) of  $1.1 \text{ m}^2$  ( $1.2 \times 0.9 \text{ m}$ ) and from the base to the bottom of the first tray a space 30 cm high was left to assure the homogenization of the air flow. Due to the fact that the total free cross area for air flow of the two cabinets ( $2.2 \text{ m}^2$ ) doubles that of the tunnel supplying the air ( $1.1 \text{ m}^2$ ) and also due to the friction caused by the baffle system, the average air velocity obtained in the first tray was 68 m/min. This velocity is less than half that obtained in the tunnel supplying the air to the baffle system (147 m/min), but lies between the air velocity limits cited above for the drying of parsley leaves (65-70 m/min).

In order to give a higher versatility to the drying units it was decided to supply the engine of the Zeta WH 88 air blower-heater (a triphase, 2 h.p. engine) with a total of 3 pulleys of different diameter. Since the original pulley had a diameter of 0.125 m, the other two were built with diameters of 0.10 and 0.15 m, respectively. These variable size pulleys allow for the possibility of obtaining different air velocities with the same equipment, a velocity which could be adjusted according to the specific needs of the products to be dried.

The air tunnel and cabinets for the first drying unit were built by the workers of the Agricultural Cooperative of Santiago Sacatepéquez, at a total cost of approximately CA\$ 1,500. Since the air blower-heater had a cost of CA\$ 2,300, the total cost of the drying unit was CA\$ 3,800. Due to the relatively low cost, easy manufacture and high efficiency, it is considered that drying units such as the above can be very adequate for rural agroindustrial installations that require a drying operation.

It is expected that this agroindustry, considered as a model, will be in full operation in April, 1982.

#### Subproject C      TRAINING OF PERSONNEL OF AN AGRICULTURAL COOPERATIVE IN THE TECHNICAL ASPECTS OF VEGETABLE DRYING

*M. R. Molina, B. Axtell, M. A. Balen and R. Bressani*

Taking into account that a vegetable dehydration system considered by us to be adequate for rural areas is to be implemented in the facilities of the Agricultural Cooperative "Cuatro Pinos" of Santiago Sacatepéquez, Sacatepéquez, Guatemala, and considering that trained personnel are among the key factors needed to assure the success of any venture of this type, it was decided to train the key staff (named by the Cooperative) who would be in charge of the enterprise.

Since January, 1980 up to the present, the two persons appointed by the Cooperative as production managers for the agroindustry have been trained at INCAP's pilot plant in all aspects of the process. Such aspects involved the selection, washing, preparation, drying, selection of the final product, packaging and storage operations. Furthermore, these persons have been trained in material balance calculations and moisture and similar estimations. Their names are Tomás Yaguí Max and Simón Yucute Pec.

Other ten persons were selected by the Cooperative to be in charge of the selection, washing and

preparation operations. These persons, considered as possible helpers in such operations, have received the corresponding training at INCAP's facilities. They are: Petrona Yucute, Pabla Yucute, Petronila Quel, Evarista Pec Itzol, Victoria Quel Bucu, Luisa Bucu Jolón, María Ignacia Yaquí, Vidal Chiroy, Cecilio Chicop, Gabino Choxin Sun.

All of them received their training using different raw materials such as parsley, onion, garlic, and similar vegetables.

From September, 1980 onwards, the two persons considered as possible production managers of the enterprise (Messrs. T. Yaquí Max and S. Yucute Pec) were trained in servicing and detecting possible mechanical faults in the Zeta air blower-heater (Nu-Way Benson Ltd., England). Also, they began to be trained in recording the diesel consumed by the machine and relate it to processing costs.

Presently, a practical course in marketing surveys and marketing estimations for dehydrated vegetable products is being planned, together with the administrative body of the Cooperative, and it is to be given to selected participants of the enterprise during 1982.

Since the quality control (sanitary and chemical) of the final dehydrated products is to be the responsibility of the Government Food Quality Control Laboratories, which give this service to all food industries, not much effort is being made to train Cooperative personnel in this regard.

It is considered that all this assistance in the training of personnel is a necessary key factor for the success of any rural agricultural cooperative that may wish to undertake any agroindustrial venture.

## PROJECT 2

### TECHNICAL AND ECONOMIC FEASIBILITY STUDY "DRYING PLANT, STORAGE OF STAPLE FOODS, BALANCE FEEDS, AND DEVELOPMENT OF POULTRY FARMS", IN HONDURAS

*A. A. Andrade\*, C. Talavera, R. Alvarado\*\* and B. Ramos\**

A survey carried out by the Bureau of Cooperative Development (DIFOCOOP) in the Jamastrán Valley disclosed the need to build the adequate infrastructure to market the high volumes of basic grains produced by the *Cooperativa Agropecuaria Regional Alianza de Oriente, Limitada (CARAOL)*.

As a result of this survey, the Government of Honduras assigned in 1978 the amount of L. 150,000<sup>●</sup> to DIFOCOOP for the first stage in the silos installation. In 1979, an amount of L. 400,000 was allotted for that project and it was recommended that the Cooperative should secure additional financing to execute the second stage of the project, which consisted in the industrialization of its production.

A later survey indicated that the installment of the silos was very expensive and that a warehouse was more in line with the needs of the Cooperative. Consequently, the Honduran Institute of Agricultural Marketing undertook the engineering studies and demonstrated that it was feasible to build the warehouse and acquire the necessary equipment all with the allotted funds.

The market for the balanced feeds will be mainly the poultry farms that the Cooperative will develop.

With respect to the market for the product from those poultry farms, the survey indicates that

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\* Personnel from the Bureau of Cooperative Development (DIFOCOOP), Honduras.

\*\* Personnel from the National Resources Section, Ministry of Planning, Honduras.

● L: *lempira*.

internal demand will continue to expand, and that the demand for eggs from five municipalities of the department of El Paraíso alone will absorb the production goals of the project.

Considering that one of the main objectives of the project is to supply CARAOL with the necessary infrastructure to handle its own production, it is obvious that the size of the facilities will be conditioned by the volume of its harvests, as well as by the availability of financial and marketing resources.

Based on the above-mentioned factors, the following subprojects were designed:

*Basic staples.* The storage capacity is 64,800 hundredweights approximately. The dryer has a capacity of 15 MT/hr, and the pre-cleaner, 55 m<sup>3</sup>/hr.

*Balanced feeds:* The equipment of the agroindustry will have a production capacity of 1 MT/hr (22 hundredweights), which would yield 31,000 hundredweights during the first year, and will reach 45,000 hundredweights in the fifth year.

*Poultry farms.* Five poultry farms will be set up, in equal number to the basic units at CARAOL. At the end of the third year, the total population of layers will be 45,000.

*Location.* The storing plant for basic staples and the plant for balanced feeds will be located at the village of El Benque, municipality of Danlí, department of El Paraíso.

For implementing the poultry farms, the following basic units were selected: Dos Naranjos, La Libertad, Ideas en Marcha, Los Almendros and Los Peregrinos.

#### Financing and economic aspects

The estimated investment per subproject is the following:

Storage facilities (warehouse) for basic staples	L. 560,000
Balanced feeds plant	227,146
Poultry farms	769,818
	<hr/>
Total	L. 1,556,964

Financing will be based on funds provided in the following manner: Cooperative, L.10,000; European Economic Community, L. 600,000; loan from the Honduran Government, L. 550,000; and loans from commercial banks, L. 421,964.

The Cooperative will have a new organizational structure, in line with the different activities involved. This organization will have to abide by the Law of Cooperative Associations of Honduras and other legal provisions in the country.

The internal rate of return is calculated at 42<sup>0</sup>/o, which is higher than the present capital cost in the country.

The project will generate important socioeconomic benefits. It will:

- improve the nutritional status of the associates and their families;
- be an incentive in the production of basic staples, which will generate more income and improve the living conditions of the associates;
- be a source of employment in activities thus far not developed in the area;
- decrease post-harvest losses;

- intensify the use of agricultural land and, therefore, increase food production;
- decrease imports of basic staples and poultry products to the zone;
- consolidate the Cooperative organization, with the consequent positive effect on agricultural production, due to the introduction of improved production practices replacing the traditional technology.

On the other hand, DIFOCOOP has had the cooperation of INCAP in the elaboration of the technical and economic feasibility study, which will be presented to the European Economic Community for the purpose of securing part of the financing required to execute the project.

The feasibility study includes sections on marketing, size and location of the facilities, economic and financial aspects, organization and justification of the project.

The marketing study indicates that the growth of the demand for staple foods in the country, as well as the projections of regional production and of the Cooperative itself, assure an adequate utilization of the cleaning, drying and storage facilities at CARAOL.

On the other hand, the demand for balanced feeds will increase, since it is expected that the prevailing tendency during the last 15 years will continue. During this period, a dynamic growth of the poultry industry was observed.

### PROJECT 3

#### ACCEPTABILITY OF HIGH NUTRITIVE VALUE, RELATIVELY LOW COST FOOD ITEMS FOR CHILDREN AND PREGNANT AND LACTATING WOMEN IN NICARAGUA

*M. R. Molina, C. Talavera, M. A. Baten and R. Bressani*

A marketing study was carried out in the western region of Nicaragua for the production of high nutritive value and relatively low cost food items for children between 6 months and 6 years of age and pregnant and lactating women. This study was carried out with the full support of the Nicaraguan Ministry of Agriculture, through its Agroindustry and Agricultural Reform Section (AGROINDRA). Among other findings, the study revealed that, in Nicaragua, a national production of this type of food items does not exist, but there is a demand for them. In 1979, considering only the state of León (rural and urban areas), there were reported 7,145 children and 6,245 mothers (pregnant and/or lactating) showing symptoms of malnutrition. Based on the present offer data for raw materials, the marketing study concludes that the most suitable ingredients for this type of product are maize, rice, dry milk (whole or skimmed) and hydrogenated vegetable oil. As regards presentation of the final product, the marketing survey revealed that the best alternative would be a precooked flour form, with a high cold water dispersibility, that could be ingested as a cold drink. The Nicaraguan Public Health Ministry personnel stationed in León recommended the following basic formulas for such a product: a) 70 parts of cereal (maize or rice) and 30 parts of dry whole milk; and b) 70 parts of cereal (maize or rice), 23 parts of skim milk powder and 7 parts of hydrogenated vegetable oil.

Based on this information, two alternative formulations were prepared at INCAP using white and yellow maize and broken (3rd. grade) rice. These cereals were precooked by extrusion, using the relatively low cost Brady Crop Cooker Extruder and an average temperature of 165°C. A total of 25 kg were prepared of each of the six types of products (two formulations using the three types of cereals cited). With the collaboration of the staff of the Chemical and Pharmaceutical Sciences Faculty of the National University of Nicaragua (UNAN), located at León, all the mentioned products prepared as described in Table 2 were subjected to acceptability trials. These trials were carried out both by the triangle and the rank method, the former to detect differences among products, and the latter to estimate the degree of prefer-

ence among them. The results (Table 3) revealed that the panel (staff members of the UNAN University) were able to distinguish differences between the products formulated with whole milk powder and those containing skim milk powder and hydrogenated vegetable oil. Such differences were statistically significant ( $P < 0.001$ ). Furthermore, the panel was able to detect differences between the product containing yellow maize and that formulated with white maize (both with whole milk powder), and between the latter product and that prepared with broken rice (also with whole milk powder). The rank tests revealed, however, that there is a clear preference, statistically significant ( $P < 0.05$ ), for the product containing whole milk powder only when such product contains yellow maize (Table 4). The same tests also revealed that the product containing white maize is significantly ( $P < 0.01$ ) more acceptable than the one prepared with yellow maize (both with whole milk powder), and that the former is equally acceptable as that containing rice (both with whole milk powder).

TABLE 2

INSTRUCTIONS FOR THE PREPARATION OF BEVERAGES BASED ON MIXTURES OF EXTRUDED-COOKED CEREAL (TWO TYPES OF MAIZE OR RICE) AND DRIED MILK (WHOLE OR SKIMMED) WITH AND WITHOUT HYDROGENATED VEGETABLE OIL\*

Steps	Pertinent instructions
1	Weigh 1 kg of the dry mix.
2	Add 21 kg of tap water and 1-1/4 kg of sugar.
3	Boil for five minutes.
4	Let cool and serve as a refreshment.

\* For the present study, the vitamin and mineral mix planned to be added to the final product was not included in the sample; neither was any flavoring and/or coloring agent added to the product.

Based on all the above, it is considered that the feasibility study for the establishment of an agro-industry intended for the production of highly nutritive, relatively low-cost food products for children (6 months to 6 years of age) and lactating and pregnant women of Nicaragua, should be continued further using as a basis the formulations suggested by the Nicaraguan authorities.

The cereals which can be considered are white maize and broken (3rd grade) rice, formulated either with whole milk powder or skim milk powder with hydrogenated vegetable oil.

TABLE 3

ORGANOLEPTIC DIFFERENCES DETECTED BY THE NICARAGUAN PANEL  
BETWEEN THE BEVERAGES PREPARED FROM THE DIFFERENT MIXES OF EXTRUDED-COOKED  
CEREAL (TWO TYPES OF MAIZE OR RICE) AND DRIED MILK (WHOLE OR SKIMMED)  
WITH AND WITHOUT HYDROGENATED VEGETABLE OIL (TRIANGLE TEST)

Products compared		Panelists reporting difference (%)	Level of significance (%)
Rice:whole milk vs.	Rice:skim milk:hydrogenated vegetable oil	58	5.0
White maize:whole milk vs.	White maize:skim milk:hydro- genated vegetable oil	73	0.1
Yellow maize:whole milk vs.	Yellow maize:skim milk:hydro- genated vegetable oil	64	5.0
Yellow maize: whole milk vs.	White maize: whole milk	80	0.1
White maize:whole milk vs.	Rice: whole milk	80	0.1

TABLE 4

DEGREE OF ORGANOLEPTIC PREFERENCE REPORTED BY THE NICARAGUAN PANEL  
FOR BEVERAGES PREPARED FROM MIXES OF EXTRUDED-COOKED CEREAL  
(TWO TYPES OF MAIZE OR RICE) AND DRY MILK (WHOLE OR SKIMMED)  
WITH OR WITHOUT HYDROGENATED VEGETABLE OIL (RANK TEST)

Products compared and percent preference			
Product 1	Preference	Product 2	Preference
Rice: whole milk	50	Rice: skim milk:hydrogenated vegetable oil	50 ..
White maize: whole milk	53	White maize: skim milk:hydro- genated vegetable oil	47 ..
Yellow maize: whole milk	71	Yellow maize:skim milk:hydro- genated vegetable oil	29 5.0
Yellow maize:whole milk	8	White maize: whole milk	92 1.0
White maize: whole milk	50	Rice: whole milk	50 ..

# RESEARCH

*Coordinator: Dr. M. A. Guzman*

In the area of Research, the Institute has the following objectives:

1. To collaborate with the Member Countries in carrying out operational research studies that may result in the development and transfer of appropriate technologies in nutrition, to be applied to health programs, especially at the primary attention level.
2. To investigate in the countries of the area the possibilities of developing appropriate technologies on basic foods and food technology.
3. To collaborate with the Member Countries in carrying out research to evaluate the process and impact of the food and nutrition programs at field level.
4. To develop, in the countries of the area, research studies that may lead to new alternatives for the solution of the food and nutrition problems, such as new sources of nutrients, new food technologies, interaction infection-nutrition, control of specific nutritional deficiencies and other pertinent studies.

In accordance with these aims, INCAP developed, during the year of the Report, the Programs and Subprograms described in the following pages.



## **PROGRAM VIII**

### **FOOD AND AGRICULTURAL SCIENCES**

The nutritional status of a population is the reflection of several factors among which foods play a very important role. Therefore, the objective of the research carried out by the Division of Agricultural and Food Sciences is to identify the chemical, nutritive and functional characteristics of foods, whether isolated or as components of diets or of combined products. Special attention is given to basic foods as main components of the diet, as well as to other sources of nutrients contained in natural or formulated foods; in the latter case, they serve to improve the nutritive value of the diet.

It is well known that foods are biologically active entities which, if not stored and processed under adequate conditions, soon perish. Therefore, the activities involved in taking foods from production to the dining room table are important and imply storage, processing and utilization studies which must not interfere with the acceptability of a particular food, and which must take into consideration aspects related to taste, texture, concentration of nutrients and price. Finally, diets are more varied, acceptable and nutritive if they include animal products. The latter, however, have a low availability due to their high price, which depends mostly on the price of feed. Conscious of this, the Division of Food and Agricultural Sciences has been making efforts to identify, increase and improve the nutritive value of agroindustrial by-products for animal feeding. These activities are intimately associated with the academic program of the Division and are necessary to build a solid base that will allow the Division to offer adequate technical assistance and scientific participation, which are so important for institutional development.

## SUBPROGRAM A

### BASIC FOODS

#### PROJECT 1

##### CEREALS

**Subproject A AN EXPERIMENTAL MODEL TO ESTABLISH NUTRITIONAL GOALS FOR MAIZE  
(*Zea mays*)**

*R. Bressani, L. G. Elías and L. Lareo\**

The agricultural genetic selection programs, especially at the international level, are interested in including among their activities aspects related to the nutritive value of basic foods. There are two possible ways to accomplish this: one is the improvement of the intrinsic nutritive quality of the basic food when considered as the only food eaten, which in itself has already presented difficulties; the second one, which is easier, consists in establishing the nutritional goal of the basic foods in relation to the diet consumed by man. Although the latter possibility could be established through the analytical values of nutrient content and of the levels of recommended intake, these are not well established as yet, and it is therefore necessary to reach the nutritional goals through biological evaluations. The research presented here represents an experimental model to define the nutritional goal regarding the amino acids in maize in food systems of maize:beans. For this purpose, groups of 8 rats were fed diets based on 100:0, 90:10 and 70:30 maize:beans, respectively. Four cultivars of common maize and 3 of high-lysine maize (one white, one yellow and a mixed one) were used. In the assay where only maize was used, two groups were studied, one fed the common maize cultivars and the other the high-lysine cultivars. In the study with the 90:10 ratio the groups were kept stable; however, the increase in quality was higher for common maizes than for those with a higher nutritive value. When the 70:30 ratio was used, the improvement of common maizes was still high, while those with a higher nutritive value showed lower results as compared to the 90:10 mixture. With common maize, the use of 0 to 30% beans resulted in a constant increase in protein value, due to the increase in lysine afforded by beans. With the high-quality maizes, the best results were obtained with the 90:10 ratio; these values decreased when the 70:30 mixture was fed, which is attributed to a methionine deficiency.

From the above-mentioned results, and taking into consideration the lysine content of the raw materials and mixtures, it has been estimated that the level of lysine in maize would be about 0.33% (3.67 g lysine/100 g protein). On this basis, the amount of sulfur-containing amino acids would be approximately 0.33% (3.38 g/100 g protein). The amount of lysine in opaque-2 maize is 4.2 g/100 g protein.

**Subproject B EFFECT OF THE ADDITION OF CORN FLOUR WITH A HIGH PROTEIN VALUE ON  
BREAD DOUGH AND QUALITY**

*G. Merino\* and R. Bressani*

Studies carried out in Brazil on the substitution of wheat flour for defatted corn (flinty) flour indi-

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\* INCAP/United Nations University (UNU) fellow.

cated that 20<sup>0</sup>/o substitution with maize flour resulted in a bread which was no different than that manufactured with 100<sup>0</sup>/o wheat flour. In the present study, the technology developed by the Brazil group was applied in panification trials, in order to provide another use for the production of flinty-maize of high nutritive value. The grain was dehulled with a loss of 17<sup>0</sup>/o by weight, then it was ground and extracted with hexane to remove the oil. The latter by itself could cover all costs of the application. Wheat flour was replaced in 10, 20, 30 and 40<sup>0</sup>/o by defatted maize flour. Water absorption was the same as that of whole wheat flour up to 20<sup>0</sup>/o substitution. The specific volume of bread was 94.4, 98.9, 91.7 and 74.9 from that of the control for the 10, 20, 30 and 40<sup>0</sup>/o substitution, respectively. The nutritive value of whole wheat bread measured as net protein ratio (NPR) was 1.80, equal to the 30<sup>0</sup>/o defatted maize flour substitution, in spite of the fact that defatted maize flour resulted in a value of 3.33, and whole wheat flour was 2.21. On the basis of 10 kg of flour, the cost of the wheat:maize bread at the 30<sup>0</sup>/o substitution level was US\$5.54, while that of whole wheat flour was US\$6.41.

**Subproject C EFFECT OF THE SOWING SYSTEM ON YIELD AND NUTRITIVE QUALITY OF SORGHUM IN TWO GUATEMALAN LOCALITIES**

*A. A. García\*, J. Fuentes\*, L. G. Elías and R. Bressani*

For the purpose of evaluating the influence on yield and on protein quality of sorghum sown by two systems (drill and hill planting), two experimental trials were carried out at Monjas and San Pedro Pinula, in the department of Jalapa, Guatemala.

For the planting systems under study, grain yield data were collected for four varieties and one hybrid of white sorghum, and analyses of dry matter, crude fiber, ash, protein and tryptophan were performed.

The yield data for Monjas showed no differences among varieties. Nevertheless, it was established that for each planting system, varieties Guatex Blanco and ICTA 777 were superior; ICTA 777 was best when drill planted and Guatex Blanco performed better when hill planted.

Regarding protein and dry matter, the variety Guatex Blanco showed the best yields, and it was observed that for the drill planting, the hybrid ICTA 777 presented a protein yield only surpassed by the improved Criollo; regarding dry matter, its yield was higher. The tryptophan content for this locality was higher for all varieties when drill planting was used; variety 7504 had the highest content in the hill planting system and the lowest content in the drill system.

For the San Pedro Pinula locality, variety Guatex Blanco was the highest in yield and protein and dry matter content when sown by either of the systems. The tryptophan values were statistically the same between sowing systems, 0.058 g<sup>0</sup>/o for hill and 0.059 g<sup>0</sup>/o for drill planting. There were statistically significant differences among varieties, with the Soricta variety showing the highest value under either of the two systems.

Regarding protein quality, it can be said that in Monjas the planting system does not affect protein content, while in San Pedro Pinula the drill system results in better quality. According to the results obtained, it is confirmed that the variety Guatex Blanco has a high degree of adaptability both to different environments and to different planting systems. Hybrid ICTA 777 is recommended for the Monjas region only.

**Subproject D EFFECT OF THE SOURCE OF MATERIAL ON THE PROTEIN QUALITY OF SORGHUM GRAIN GROWN IN GUATEMALA**

*A. A. García, J. Fuentes, L. G. Elías and R. Bressani*

It has been known for some time that the institution where seeds are obtained does exert an effect

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on the agronomic behavior of sorghum. The present work was designed to determine whether the source of seeds affects the quality of the grain harvested in Guatemala, under the ambient conditions of the department of Jutiapa of that country.

One hundred and six cultivars from the University of Texas and from the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) were sown in the same locality and under the same agronomic conditions. Samples of the grain harvested were then analyzed for their crude fiber, protein, ash and dry matter content.

The results revealed that, in regard to yield, there were no significant differences between the seeds obtained from Texas University and from ICRISAT materials—8.9 to 12.6<sup>o</sup>/o, with an average of 10.7<sup>o</sup>/o—and the Texas materials—7.5 to 11.3<sup>o</sup>/o, with an average of 9.7<sup>o</sup>/o.

Tryptophan content of the ICRISAT samples varied between 0.052 and 0.075 g<sup>o</sup>/o, with an average of 0.067 g<sup>o</sup>/o, while the materials from the University of Texas varied between 0.042 and 0.068 g<sup>o</sup>/o, with an average of 0.054 g<sup>o</sup>/o. When the tryptophan content in the protein was used as a protein quality indicator, the materials from ICRISAT showed a better protein quality (0.62 g tryptophan/100 g protein) than those from Texas (0.55 g tryptophan/100 g protein).

It can be concluded that the source of seeds does affect the quality of the grain harvested under the conditions prevailing in the eastern Guatemalan departments, in a similar fashion as the agronomic characteristics of these grains are affected. This may be due to the conditions under which these materials were developed; therefore, it is always important to take into account the source of seeds.

## PROYECT 2

### GRAIN LEGUMES

#### Subproject A CULINARY AND CONSUMPTION CHARACTERISTICS OF BEANS AT THE RURAL HOME LEVEL

*D. Navarrete and R. Bressani*

The understanding of the qualitative aspects of beans, as well as their production and ways of consumption, can be the basis for the development of an adequate technology to make this product highly acceptable. For the purpose of obtaining information regarding the selection procedure, culinary preparations and consumption of beans in the rural home, a survey among housewives of rural bean-producing areas was carried out in 4 departments in the northeast of Guatemala. The study sample consisted of 10 families selected at random in 18 municipalities. The questionnaire used had been tested in two rural communities not included in the sample. As shown by other INCAP surveys of this nature, it was found that all families consumed black beans and on rare occasions beans of another color or variety. Bean broth is consumed by adults and children, and in this case a thick broth is preferred since it is considered more nutritious and better tasting. Children begin to take bean broth at 6 months on the average and they eat beans at 14 months. The average amount of broth taken was 62 g, and 78 g of whole cooked beans. The mothers surveyed indicated that broth was given to children because it was nutritious (56<sup>o</sup>/o of the mothers), in order to teach children to eat (13<sup>o</sup>/o of the mothers), or because of its taste (8<sup>o</sup>/o of the mothers). Likewise, it was found that the manner of consumption was cooked whole, strained and fried, ground and fried, cooked and fried, and fried. The most common ways of consumption were cooked whole and strained and fried. Regarding cooking practices, it was found that beans are not usually soaked prior to cooking, and few housewives add salt at the beginning of the cooking period. With respect to the causes of the hard-to-cook phenomenon in beans, 35<sup>o</sup>/o of the housewives indicated that storage time was responsible, while 25<sup>o</sup>/o of them ascribed the phenomenon to bad seeds and 10<sup>o</sup>/o to sun drying or inadequate post-harvest or other practices in the preparation.

In conclusion, it was observed that beans are a main component of rural diets, since they are the

first food in the household diet that is offered to children. For this reason, it is of great importance to have high quality bean cultivars, especially as regards nutritive value, taste, softness and thickness of broth, besides a high availability of the product.

Subproject B EFFECT OF SOAKING AND COOKING TIMES ON THE PROTEIN VALUE OF COMMON BEANS (*Phaseolus vulgaris*)

R. Bressani and L. G. Elías

Previous studies have demonstrated that the cooking process to which legumes are subjected prior to their consumption affects their nutritive value, particularly their protein quality. In some cases the process involves a soaking stage followed by heat treatment until the seeds are softened.

The present work was carried out to determine the effect of soaking time and cooking time on the protein quality of common beans (*Phaseolus vulgaris*). For this purpose, cultivars of black and red beans were subjected to different soaking times (0, 6, 12, 18 and 24 hr) and cooking times (10, 15, 30, 45 and 60 min), and the samples were bioassayed to determine their protein quality by the protein efficiency ratio (PER) technique and their *in vivo* protein digestibility. The results obtained for red beans will be presented here. In general, the findings indicated an adverse effect of soaking time and cooking time on the digestibility and protein quality of the samples. As can be seen in Table 1, a tendency to lower PER values was observed as soaking time of the samples increased. Likewise, independent of soaking time, a decrease in protein quality after 15 min of cooking was detected. In the samples which were also soaked, similar tendencies were observed regarding protein apparent digestibility values. It is important to indicate that in those samples that were not subjected to steeping, the values were not affected by cooking time.

TABLE 1  
PROTEIN QUALITY (PER) AND APPARENT DIGESTIBILITY (AD)  
OF COMMON BEAN SAMPLES SUBJECTED TO DIFFERENT PROCESSING CONDITIONS

Cooking time* min	Soaking time**				
	0	6	12	18	24
0	—	—	—	—	—
15	0.89 (73.2)***	0.77 (72.2)	0.71 (71.1)	0.68 (75.4)	0.73 (70.1)
30	0.82 (72.2)	0.69 (72.7)	0.62 (67.8)	0.57 (71.3)	0.64 (69.2)
45	0.61 (70.8)	0.60 (70.3)	0.74 (68.9)	0.60 (72.2)	0.50 (68.1)
60	0.52 (71.5)	0.52 (67.5)	0.72 (68.7)	0.49 (69.3)	0.58 (67.3)

\* Cooked in autoclave at 121°C and 16 psi.

\*\* Steeping in tap water at ambient temperature.

\*\*\* Values in parentheses are coefficients of apparent digestibility (AD). It was not possible to obtain PER and AD values for raw samples, since all animals died in these groups.

The effect of the possible interaction between soaking and cooking time on bean protein digestibility and utilization observed in the present study is very interesting, since the nutritive value of this food is associated with the processing conditions used previous to consumption by the population. The adverse individual effect of a prolonged cooking time on PER can be explained on the basis of a decreased amino acid availability, especially that of lysine. As demonstrated in previous studies, however, the isolated effect of soaking time on PER and AD seems to be influenced also by the presence of polyphenols in legumes. As is well known, these compounds are water-soluble and have been singled out lately as one of the causes for the low protein digestibility in beans. It is possible, therefore, that a prolonged soaking time may result in a higher water solubility of phenolic compounds which, in turn, will react with bean protein during heat

treatment, thus decreasing the digestibility of protein in an inverse ratio to cooking time. This study will be continued, in order to corroborate this hypothesis.

Subproject C EFFECT OF STORAGE TIME ON THE TECHNOLOGICAL AND NUTRITIONAL CHARACTERISTICS OF COMMON BEANS (*Phaseolus vulgaris*)

*L. G. Elías and R. Bressani*

Previous studies in our laboratories have shown that one of the most visible damages that beans suffer during storage under inadequate ambient conditions, is the development of hardness of the seed, which results in a prolonged cooking time. This problem is of special importance for Latin America, and particularly for Central America, since beans are, after corn, the most important basic food source of protein and calories in these countries. Aside from the nutritional problem involved, hardening of beans has serious economic consequences since market losses are high, due to the fact that housewives reject hard-to-cook beans, not only because of their extended cooking time, but also because in most cases the hard-to-cook beans develop off flavors. This phenomenon—possibly of a biochemical nature—has been studied, and several hypotheses have tried to explain the damage and give some recommendations to avoid the problem. Independent of the physical damage of the grain, however, it is important to learn also about the effect that hardening of the beans may have on their nutritive value. Thus, the objective of the present study was to establish the protein quality of a bean sample which had shown a tendency to become hard-to-cook through a long storage period. For this purpose, lots of this sample were subjected to a fixed soaking time (18 hr) and to different cooking times (1, 2, 3 and 4 hr) at atmospheric pressure. One lot was cooked under the same conditions but without previous soaking. All cooked samples were dried and ground and evaluated biologically for protein quality and digestibility. The results obtained (Table 2) were very interesting in several aspects. First of all, there was a tendency for NPR and protein digestibility values to increase as cooking time increased. The initial values for these two parameters, however, clearly reflect the adverse impact of storage on the nutritive value of the seeds. In the second place, the results indicated also that unsoaked samples showed higher NPR and digestibility values, with the exception of the sample cooked for 60 min. These data confirm previous results obtained in bean samples which had been soaked, indicating again the adverse effect of this process on the protein quality of the food. Although this effect had been previously explained on the basis of a higher penetration of pigments (polyphenols) of the seed

TABLE 2

PROTEIN QUALITY AND DIGESTIBILITY OF HARD-TO-COOK COMMON BEANS

Cooking time min	Soaking	Protein in diet g	Weight gain g	Net protein ratio (NPR)	Digestibility, %	
					Apparent	True
60	sí	9.6	-3	0.90	48.2	52.8
120	sí	10.3	7	1.50	55.7	59.6
180	sí	9.9	8	1.56	58.3	62.1
240	sí	9.3	9	1.65	57.3	61.0
60	no	9.9	-4	0.92	53.8	58.6
120	no	9.8	19	1.81	53.2	56.7
180	no	9.7	19	1.87	60.9	63.8
240	no	10.6	15	1.62	62.9	65.8
-----						
Casein control	—	9.9	68	3.31	91.1	93.0

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coat to the cotyledons —favoring thus a higher reaction of the pigments with protein, which would result in a lower digestibility of the latter—, there is no information regarding the effect that storage *per se* has on this parameter. It is possible, however, that this effect may be associated with the presence of polyphenols, which have been pointed out as one of the causes of the development of the hard-to-cook phenomenon in beans. This would occur through a polymerization process of these compounds present in the seed coat, which would change their structure, interfering with the normal absorption of water during the cooking process. It is therefore possible that, during storage, this polymerization involves also protein reactions in the seed which would decrease protein utilization by the organism. This project will also be continued in order to corroborate this hypothesis.

**Subproject D EFFECT OF COOKING ON THE CONTENT AND DISTRIBUTION OF POLYPHENOLS IN COMMON BEANS (*Phaseolus vulgaris*)**

*L. G. Elías and R. Bressani*

During the last years, there has been an increasing interest in the role that polyphenols (PP) play in legume seeds, particularly in beans (*Phaseolus vulgaris*). This interest is due to the possible effect that these compounds exert on the agronomic, technological and nutritional characteristics of this basic food, from the technological point of view. This effect could be related to an increased cooking time developed during storage and to the acceptability of stored beans by consumers. Nutritionally, it has been found that this is one of the factors that interfere with protein digestibility. An important aspect to be taken into account in this sense is the effect of the cooking process on polyphenols. The present work studied the content and distribution of PP in common beans subjected to different cooking processes. Cultivars of white, black and red beans were used for this purpose; polyphenols were determined as tannic acid (TA) and as catechin equivalents (CE). The results obtained indicated that PP expressed as TA decreased between 30 and 49% during cooking. This loss was higher when PP were expressed as CE, reaching values as high as 98%. It was also found that, during cooking, the highest loss in CE in beans was observed at 14 min, remaining stable thereafter up to 60 min and increasing slightly at 150 min, which was the total time allowed for the cooking process. Regarding distribution of PP, the data showed that of the total PP expressed as TA present in raw beans, 60.4, 66.7 and 37.4% remained in black, white and red beans, respectively. Bean broth contained 19.1, 15.5 and 11.7% of the total PP for the same varieties of beans, in the same order. The data suggest that if there were destruction of PP during cooking, it could be assumed that 40.5, 17.8 and 50.9% of the total PP was bound. This term defines those PP which react with the amino groups of the protein and are, therefore, not detected by the available analytical methods. It is important to establish the nature and role of the PP during cooking, so as to understand better their effect on the digestibility of bean protein.

**Subproject E PROTEIN VALUE OF BROAD BEANS (*Vicia faba*) AND THEIR UTILIZATION IN FOOD SYSTEMS FOR HUMAN BEINGS**

*R. Bressani, L. G. Elías and R. Gómez-Brenes*

*Vicia faba* is cultivated in the highlands of Guatemala as a crop associated with maize. Annual production is about 9,000 metric tons and is marketed as fresh, dry and toasted beans; the latter are also marketed as broad bean flour. There are few agronomic and nutritional studies in Guatemala on this legume, and the present work is an attempt to foster production of this legume in the area.

The samples for the study were collected in the local markets; the average protein content was 24% on a dry-weight basis. Cooking in water or toasting did not induce any major change in the main nutritional components. Biological tests indicated that the uncooked bean has a protein value (NPR) of 1.38, which does not change significantly with cooking (NPR = 1.52) or by toasting (NPR = 1.62). Like all grain legumes, broad bean amino acid content indicates that the protein is deficient in sulfur-containing amino acids, and that it is a rich source of lysine. Addition of methionine increased the NPR to 3.00 - 3.10.

The results of protein complementation studies between wheat and broad beans indicated that broad bean protein complemented that of wheat, resulting in a maximum value when the ratio of wheat to broad bean was 70:30. This combination gave PER values of 2.76 as compared to 1.62 for broad beans alone and 1.92 for wheat alone. The mixture is deficient in lysine and methionine, and addition of the two amino acids increased significantly the protein value. On the basis of these results, a mixture was formulated for human beings, especially for children, of a good nutritive value and high acceptability, containing toasted broad beans, wheat and milk.

Subproject F      **PRODUCTION CHARACTERISTICS AND POST-HARVEST HANDLING OF BEANS  
IN BEAN PRODUCING REGIONS IN GUATEMALA**

*A. A. García, R. Jarquín, L. G. Elías and R. Bressani*

In order to improve a food crop it is necessary to know about the factors that determine its productivity.

Legumes play an important role in the diet of a population and it is therefore necessary to improve the quality of these foods for their optimum utilization.

As was previously informed, a survey was carried out in bean producing regions regarding cultivation and production characteristics of this product. A second survey was carried out to cover the aspects related to production, post-harvest handling, storage and marketing. In this report, the main results are presented on the characteristics of production and post-harvest handling.

The species cultivated by the majority (95%) of growers is *Phaseolus vulgaris*, other species such as *P. coccineus*, *P. lunatus*, *P. calcaratus*, and *Vigna sinensis* were also cultivated. *P. vulgaris* is grown in all regions and exclusively in regions 5 and 7 (see Table 3); *P. coccineus*, in regions 1, 2 and 5B, *Vigna sinensis*, in regions 2 and 5A; *P. lunatus*, in region 2; and *P. calcaratus*, in region 3.

Regarding variety sown, the highest percentage corresponds to unknown varieties and genetic materials obtained by the farmers. Only 5.4% of the farmers grow improved varieties, and these are found in regions 3, 6 and 7.

The type of beans mostly grown was of the bush type, since 70% of the farmers grow it; climbing beans were important only in regions 1 and 5B.

The color of beans grown by the majority of farmers was black (95%), and a very low percentage cultivated white or red beans.

TABLE 3

DEPARTMENTS INCLUDED IN THE DIFFERENT BEAN PRODUCING ZONES IN GUATEMALA

ICFA Region	Departments
1	Quiché
2	Alta Verapaz
3	Petén
5A	Baja Verapaz
5B	Chimaltenango
6	Santa Rosa, Jalapa, Jutiapa
7	Izabal, Zacapa, Chiquimula

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The determination of available lysine is important in the evaluation of food protein quality

In 69<sup>0</sup>/o of the farms it is the farmer who harvests the crop and, in a low percentage, his children and wife (4 and 3<sup>0</sup>/o, respectively). In the rest of the farms, hired hands are in charge of the harvest.

Of the seven regions, 48<sup>0</sup>/o of the farmers harvest less than 500 lb; the lowest yields were found in regions 1 and 5B.

At the national level there are two harvests, the main one (when 59<sup>0</sup>/o of the farmers harvest) from November to December, and the harvest from August to September. Harvest time for region 2 is from April to June.

The post-harvest handling of the crop can be described as follows: the grain is separated from the pod by threshing in 96<sup>0</sup>/o of the cases; drying of the grain is by sun exposure in 75<sup>0</sup>/o of the surveyed farmers. In region 2, this technique is used by a very low number of growers. Fifty-two percent sun dry the beans in the pod, and in regions 2 and 7 this practice is not used very often. Thirty-two percent dry the beans from one to two days; in region 2, however, a minimum of four days is used.

Seventy-four percent reported no losses during the post-harvest handling, with regions 2 and 5A showing the highest number of farmers which did not report losses. The highest loss (40<sup>0</sup>/o of the surveyed farmers) occurred from shelling, followed by humidity; in regions 6 and 7 the losses due to humidity are more important. The reported losses vary according to region, the highest loss occurring in region 6 and the lowest in 5A.

If one considers legumes as basic foods, their improvement must take into account aspects of production, such as better knowledge and utilization of the varieties used by the farmer, and other species, besides *Phaseolus vulgaris*, should be studied.

On the other hand, it is necessary to consider post-harvest losses caused by the farmer, such as drying by sun exposure, to determine aspects of conservation and quality of the grain for consumption; likewise, losses during the post-harvest period should be minimized.

#### Subproject G STORAGE AND MARKETING CHARACTERISTICS OF BEANS IN BEAN PRODUCING AREAS IN GUATEMALA

*A. A. García, R. Jarquín, L. G. Elías and R. Bressani*

Storage of foods is very important when it affects their quality and consumption characteristics, as in the case of beans.

Beans consumed by rural families come, in the majority of cases, from their own harvest. In order to preserve them, the farmer uses storage conditions which in some cases are very inadequate. This results in physical and nutritive loss of quality.

A survey was carried out in seven bean producing regions to determine conditions, storage and marketing at the rural level. The results of this survey can be summarized as follows:

At the national level, 98<sup>0</sup>/o of the producers store beans; area 5A has the lowest number of farmers storing beans; in the rest of the regions, more than 90<sup>0</sup>/o of the producers store them. Eighty-one per cent store beans for consumption at the national level; only in regions 2, 3 and 5A, beans are stored for seed.

The amount of beans stored for consumption is up to 4 hundredweights by 52<sup>0</sup>/o of the farmers.

Of the total of the seven regions, 59<sup>0</sup>/o of the surveyed growers store clean beans; this practice is more generalized in regions 1 and 5B, while in regions 3 and 7, storage with pod and other plant residues is more wide-spread; in most cases, this practice has the purpose of preventing insect infestation.

Storage in the pod is used by only 3<sup>0</sup>/o of the growers, especially in regions 2 and 5A.

The containers most used for storage are vegetable fiber sacks, which are used by 52% of the farmers. There was a great number of other containers used such as metal drums, paper bags, plastic bags, wood crates, glass flasks, etc.

Fifty per cent of the surveyed farmers keep the containers inside the house. For the preservation of the grain for household consumption, 44% do not apply any chemical treatment or addition of other substances, 22% use phostoxin or carbon bisulfide; this practice is more generalized in region 6. Other substances such as wood ashes, oil, hot pepper, etc. were added to improve conservation of the grain. Sixty per cent of the surveyed growers reported losses during storage; 4% indicated they were due to the humidity, 49% to insects and 34% to hardening of the grain.

The regions where the higher losses due to humidity were reported were 3, 5B and 7. Losses from insects were higher in regions 5A, 6 and 2, while losses due to hardening were more frequently encountered in regions 3, 5A, and 7.

At the level of the seven regions, beans become hard after 8 and 12 months, according to the highest percentage of the growers; hardening is faster in regions 3 and 7. It was found that in regions 1 and 5A the hardening process is slower.

Twenty-six percent of the farmers store beans for 12 months in all regions surveyed; 3 and 7 were the regions where this food is stored less time.

Regarding marketing, 40% of the growers of the 7 regions sell beans at harvest time and mainly in the market place, with the exception of region 5B where beans are sold six months later or when the price is better, but always in the market place.

From the above, it can be concluded that bean storage practices for consumption differ according to region, and any effort directed toward improving storage conditions must take also into consideration ecologic characteristics, availability of adequate facilities and ways and practices of storage by the farmer, so as to achieve a better conservation of this food.

Regarding the losses during this stage, it is necessary to acquire more knowledge on adequate conditions of storage, in order to reduce to the minimum the present losses which greatly affect the availability of this food for the family.

## PROJECT 3

### DIETS

Subproject A    **EFFECT OF THE LEVEL OF CALORIES ON PROTEIN INTAKE TO REACH NITROGEN EQUILIBRIUM IN YOUNG ADULTS CONSUMING THE MAIZE:BEANS RURAL GUATEMALAN DIET**

*D. Navarrete and R. Bressani*

The energy and protein recommended daily allowances have been estimated in the past by metabolic studies carried out in individuals in developed countries. These evaluations have been conducted mostly with proteins of good quality and high digestibility, and with an adequate energy intake. At present no differences are established for individuals of different ethnic groups or living in different environments, most of them consuming diets of vegetable origin. The existing information is limited or insufficient to demonstrate whether there are differences in protein requirements.

The Central American rural diet, based on a combination of maize or other cereal and small amounts of beans, is a diet with a low protein digestibility and energy content.

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The present study was carried out for the purpose of obtaining information to help determine the adequate calorie level for a better utilization of the protein in the diet, when using typical maize:beans diets of different protein quality fed to individuals in a nitrogen balance study of multiple points.

The rural diets were of different protein quality, at least by calculation. Opaque-2 maize replaced common maize in one case, and chicken meat supplemented common maize in the second. In these trials, the calorie level was the same as that found in dietary surveys, i. e., 36 kcal/kg body weight.

Eighteen young males between 19 and 38 years old were distributed among 3 experimental groups. The diet fed was formulated on the basis of the averages from the 1965 dietary survey. The diet, besides corn and beans, contained the most common foods eaten in the rural area: rice, cassava, potatoes, vegetables such as cabbage, green pea, tomato, onion, bananas, oranges, vegetable oil and sugar.

The experimental subjects were fed a diet containing 0.6 g protein/kg body weight of good quality during 4 days as an initial stabilizing period, followed by 3 days on a non-protein diet, in which cassava replaced the protein sources of the previous period. The subjects then received diets where the protein level ranged from 0.2 to 0.7 g/kg/day. Each level of protein was fed for two days. Throughout the experimental period, daily samples of diets, feces and urine were quantitatively collected for nitrogen analysis. The data were analyzed by a linear regression analysis to estimate the amounts of protein necessary to reach nitrogen equilibrium and estimate, therefore, the protein requirements of the individuals.

As the nitrogen intake increased to the high level of 0.7 g protein/kg/day, the nitrogen balance with the rural diet improved. In the diet with maize alone or supplemented with chicken, all subjects retained nitrogen when the intake was 0.6 protein/kg/day or higher. In the case of Opaque-2 maize, retention was slightly lower than that with common maize, but there was no significant difference between them. The amount of nitrogen necessary for equilibrium was 90.7 mg for the common maize diet, 98.0 for Opaque-2 maize, and 91.6 for the diet supplemented with chicken meat.

As was the case in other studies carried out by the Division of Agricultural and Food Sciences, in this study it was found that the amount of nitrogen did not vary significantly when the diet supplied 45 or 36 kcal/kg/day, even though in the latter case the diet was more varied since it included foods consumed in the rural area. A higher calorie level as well as an increase in physical activity should have an impact on nitrogen retention. These and other variables should be considered in future studies.

#### Subproject B      MINIMUM AMOUNTS OF CHICKEN MEAT FOR INCREASING THE NUTRITIVE VALUE OF LATIN AMERICAN RURAL DIETS

*L. G. Elías and R. Bressani*

The rural diets in Latin America are usually made of cereals, tubers (cassava) or starchy fruits (plantain) mixed with common beans. Due to the low consumption of beans, the diets are of a very low quality and do not meet the nutritional requirements of the population, particularly of children and pregnant or lactating women. Although there are several ways to increase the nutritive value, including an increase in bean intake, the diets never reach optimum nutritive value and their low calorie and protein content is a very serious disadvantage. The present study was designed to demonstrate that small amounts of chicken meat or eggs consumed daily are very effective in improving the nutritive value of the diets.

Chicken meat was prepared by deboning after cooking followed by dehydration of the meat, which was fed at levels that varied between 0 and 3.8% on a dry weight basis in diets made of maize:beans; rice:beans and cassava:beans which provided 0, 10, 20 and 30% of the protein in the diet. Weanling rats were fed these diets for 28 days, and weekly weight gains and food consumption were recorded in order to calculate the protein efficiency ratio (PER) as a measure of protein quality.

Table 4 shows a summary of the results obtained. As the data reveal, the food systems studied were significantly improved by substituting 30% of the diet protein for chicken meat protein. This, in terms of weight, is equivalent to about 3.8% of the supplementing source on a dry-weight basis. It is of interest

also to point out that the improvement observed was not of equal magnitude for all diets but was inversely related to the protein quality of the particular food system studied; thus, the PER values were higher for the diets based on the cassava:beans system than for the cereal:legume system. Regarding this last system, the greatest impact of supplementation was observed with the system maize:beans, as was expected. Likewise, the fact that the addition of chicken meat had a significant effect on food consumption is very important, since it shows that chicken meat improved the palatability of the diet. The increase in the consumption of diet suggested a similar tendency to that observed with PER. On the basis of these results, it was calculated that the consumption of 67 to 100 grams of chicken meat/person/day improves significantly the protein quality of the diet at a very reasonable cost (US\$0.11-0.15/person/day). Likewise, the presence of animal protein breaks the monotony of the diet, improving its palatability, as shown by the increased intake of the supplemented diets.

TABLE 4

EFFECT OF THE ADDITION OF CHICKEN MEAT ON THE NUTRITIVE VALUE AND FOOD CONSUMPTION OF DIETS BASED ON CEREAL:LEGUMES AND TUBERS:LEGUMES

Food system	Improvement in protein quality (PER)		Food consumed, g/28 days	
	Without chicken	With chicken	Without chicken	With chicken
Maize:beans (90:10)	2.13	3.01 (41%)*	298	376 (26%)
Rice:beans (90:10)	2.57	3.11 (21%)	374	383 (2%)
Cassava:beans (60:40)	1.31	2.26 (72%)	223	328 (47%)

\* Figures in parentheses indicate the improvement and/or consumption expressed as percentage.

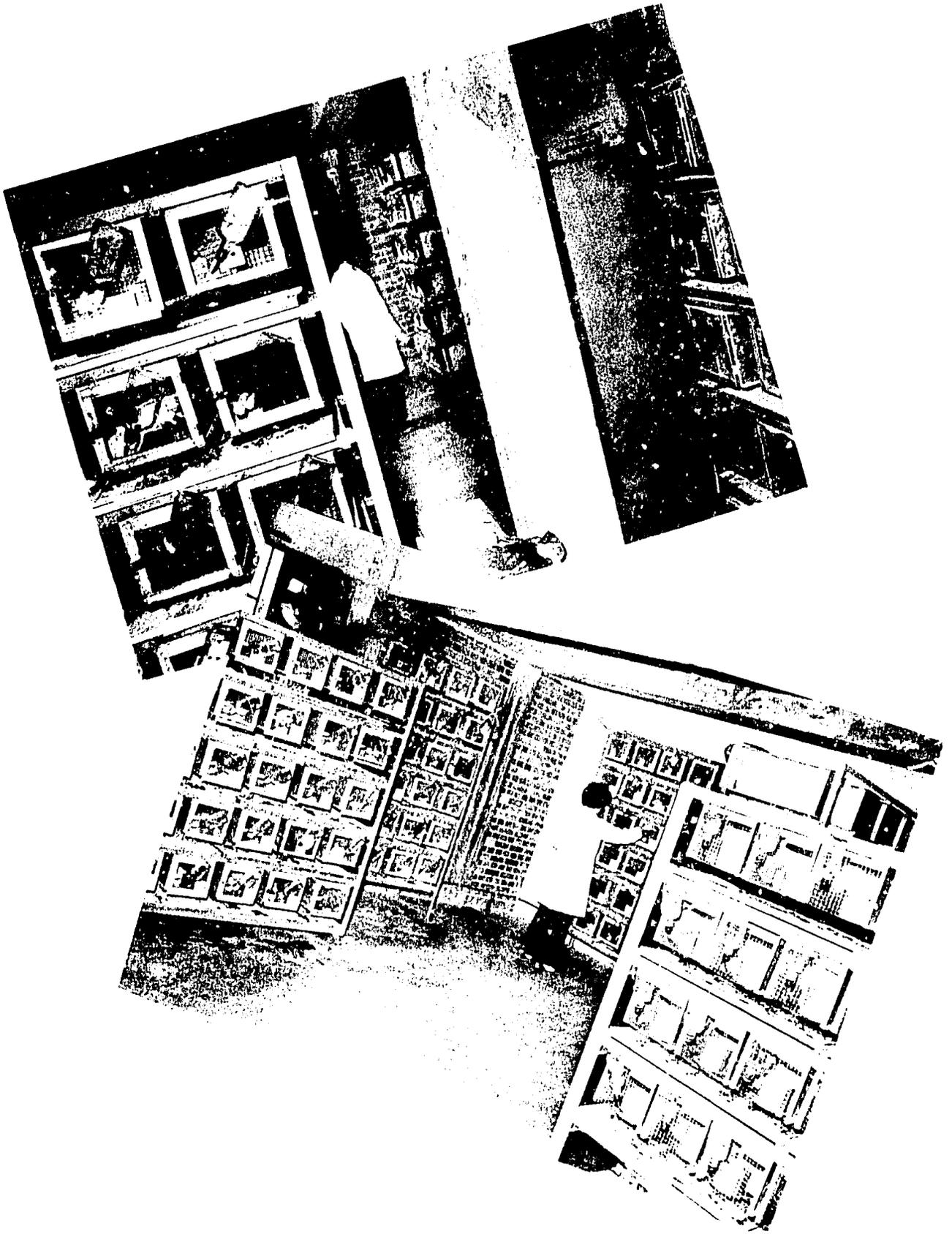
## PROJECT 4

## BIOLOGICAL METHODOLOGY. PROTEINS

Subproject A SLOPE OF ABSOLUTE GROWTH (SAG). SOME CHARACTERISTICS OF A NEW SHORT BIOASSAY TO EVALUATE PROTEIN QUALITY IN FOODS

*L. Lareo and R. Bressani*

There are several methods to evaluate the nutritive quality of a protein. All rat bioassays are essentially a measure of the content, availability and balance of essential amino acids, subjected mainly to the first limiting amino acid, which is measured by the growth of animals on a determined diet. The purpose of the present work is not to criticize the methods currently in use, but to introduce a new analysis of the information obtained through a bioassay to determine the protein quality of a food. The method is based on the growth slope of rats during one week (21-23 to 28-30 days old). This value referred to that obtained with a protein reference diet is an indicator of the quality of the protein in the food analyzed. This method showed the same screening capacity as PER and NPR for 10 proteins evaluated by the three methods.



Aspects of INCAP's animal colony, where biological studies for the evaluation of protein quality and protein digestibility are carried out

Some characteristics of the SAG method were: reproducibility, screening capacity and sensibility. It can be carried out with 4 animals for one week, being therefore inexpensive and rapid. The effect of protein and crude fiber level in the diet was also studied, and it was found that it is necessary to standardize the experimental and the reference protein diets. The method is promising for protein evaluation in quality control programs for food processing, and in agronomic programs of genetic selection of foods (cereals, legumes) of improved nutritional value.

## SUBPROGRAM B

### SOURCES OF NUTRIENTS

#### PROJECT I

##### HIGH NUTRITIVE FOODS

Subproject A      DEVELOPMENT AND NUTRITIONAL/TECHNOLOGICAL EVALUATION OF SEVERAL HIGH NUTRITIVE VALUE SUPPLEMENTS FOR CHILD FEEDING

*El-Sayed Hegazi\*, L. G. Elias, R. Gómez-Brenes and R. Bressani*

During the last years and due to the worldwide scarcity of food, there has been a renewed interest from governments and international organizations in using several foods and/or food supplements for the alleviation of the malnutrition problems prevalent in underdeveloped countries. The work reported here dealt with the development and evaluation of six formulations of high nutritive value, for human consumption. The specific objectives were the following: 1) to develop the formulations on the basis of available raw materials; 2) to study the effect of the processing techniques used on the nutritive value of the formulations; and 3) to carry out acceptability trials and to learn about the stability on storage, of the formulated foods. The raw materials used were cottonseed flour, soybean flour, rice, wheat, chickpeas, lentils and semolina. Some of the formulations were processed by drum drying and others by a Brady Crop Cooker extruder. The chemical and nutritional evaluation showed that the formulas (Table 1) contained from 17.4 to 27.6% protein and from 1.00 to 7.9% ether extract. Likewise, and except for methionine and threonine, which were the most limiting essential amino acids, all others compared favorably with the 1973 FAO protein reference pattern, as can be seen in Table 2. Regarding protein quality, the data indicated (Table 3) high PER values, which compared favorably with those for casein used as control protein. It was of interest also to observe the beneficial effect of the cooking processes on the formulations, whether the process was by drum drying or by extrusion. This improvement is attributed to the presence in the formulations of legumes (chickpeas and lentils) and oilseeds (whole soybeans), which need an adequate heat treatment for better utilization of their protein. Storage studies showed a good stability of the samples even at high (35°C) environmental temperatures, with the exception of the sample with the highest ether extract content which showed an increase in free fatty acids. Finally, the acceptability trials on flavor and color showed a good acceptability of the formulations at the laboratory level.

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TABLE 1  
COMPOSITION OF FORMULATIONS WITH A HIGH PROTEIN CONTENT  
(g/100 g)

Formulation No.	Chickpeas	Lentils	Whole wheat flour	Whole soybean	Defatted soybeans	Glandless cottonseed flour	Local cottonseed flour	Rice	Semolina
1	36	18	26	—	—	—	—	—	—
2	—	—	50	—	—	20	—	—	—
3	—	—	—	—	—	26	—	50	—
4	—	—	52	20	—	—	8	—	—
5	—	—	—	24	—	—	—	56	—
6	—	—	56	24	—	—	—	—	—
7	—	—	—	—	15	—	—	25	35

TABLE 2  
ESSENTIAL AMINO ACID CONTENT OF THE FORMULATIONS

Amino acid	Formulation No.							FAO reference pattern 1973
	1	2	3	4	5	6	7	
Threonine	3.76	3.74	3.82	3.66	3.70	4.11	4.38	4.00
Valine	5.28	5.67	5.70	5.15	6.34	5.26	5.44	5.00
Isoleucine	5.49	4.80	4.56	4.72	5.26	5.38	5.36	4.00
Leucine	7.55	7.60	7.20	7.28	7.65	8.21	8.00	7.00
Phenylalanine	4.67	5.12	5.17	4.91	4.96	4.90	4.51	3.00
Total aromatic	8.24	8.88	8.37	8.38	8.74	8.24	8.33	6.00
Lysine	6.22	5.36	5.12	5.20	5.47	5.64	6.33	5.40
Methionine	1.36	1.87	1.73	1.54	1.73	1.60	1.71	
Total sulfur	2.82	3.26	3.14	3.22	3.44	3.12	3.03	3.50
Tryptophan	1.10	1.25	1.22	1.31	1.31	1.33	1.25	1.00
Protein, g <sup>o</sup> /o	17.6	27.6	24.7	20.6	17.4	20.3	18.4	

TABLE 3  
PROTEIN QUALITY (PER) OF THE FORMULATIONS UNCOOKED AND HEAT TREATED BY DIFFERENT PROCESSES

Formulation No.	Heat process used	Weight gain g/28 days	Protein Efficiency Ratio (PER)
1	None	78 ± 5.7	2.97 ± 0.09
1	Drum dryer	103 ± 4.4	2.43 ± 0.05
2	None	120 ± 5.1	2.85 ± 0.09
3	None	134 ± 8.4	2.75 ± 0.09
4	None	65 ± 4.9	1.83 ± 0.08
4	Extrusion	100 ± 5.8	2.46 ± 0.06
5	None	57 ± 2.5	1.83 ± 0.07
5	Extrusion	108 ± 4.7	2.77 ± 0.06
6	None	58 ± 5.1	1.84 ± 0.08
6	Extrusion	117 ± 4.3	2.65 ± 0.10
7	None	120 ± 2.7	2.71 ± 0.04
Casein (control)	.....	118 ± 5.6	2.75 ± 0.08

Subproject B CHEMICAL AND BIOLOGICAL EVALUATION OF FOODS OF HIGH NUTRITIVE VALUE BASED ON GRAIN LEGUMES

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One of the most important phases in the production of foods of a high nutritive value is the evaluation of their nutritional characteristics. This type of evaluation allows not only to determine the final protein value of the formulations developed, but also the effect of processing on the nutritive quality of the ingredients used, and to recommend the most adequate process for their elaboration. In the present work several food mixtures were evaluated for their nutritional quality. The mixtures were initially developed by the Central Food Technological Research Institute (CFTRI), Mysore, India, and they were based on a cereal (rice), two legume foods (mungo beans, *Phaseolus mungo*, and chickpeas, *Cicer arietinum*) and two oilseeds (soybeans, *Glycine max*, and sesame seed, *Sesame indicum*). Both the cereal and the legumes were subjected in some cases to a mild toasting procedure with the purpose of improving the organoleptic characteristics of the ingredients. Some data on the chemical and nutritional evaluation of the final product are shown in Table 4, which indicate a protein content varying from 12.0 to 19.9% and an ether extract which oscillated between 1.0 and 6.3%. Regarding the total calorie content, it varied from 367 to 403 kcal/100 g.

TABLE 4  
PROTEIN QUALITY (PER) OF FORMULATIONS

Ingredients	Protein Efficiency Ratio (corrected)	True digestibility %	Protein g/o	Fat g/o
G.1 Rice* Mung bean*	2.34	82.3	12.0	1.0
G.2 Rice** Mung bean**	2.34	81.8	13.1	1.0
G.3 Rice** Chickpea**	2.33	77.9	11.9	3.0
G.4 Rice** Mung bean** Sesame seed flour**, *** Soybean flour <sup>•</sup>	2.20	83.0	18.0	6.3
G.6 Rice** Mung bean** Soybean flour***, <sup>•</sup>	2.08	—	18.3	6.3
G.8 Rice** Mung bean** Sesame seed flour**, *** Soybean flour***, <sup>•</sup>	2.22	—	19.9	5.1
Casein (control)	2.50	92		

- \* Raw.
- \*\* Toasted.
- \*\*\* Full fat flour.
- Low fat content.

As far as the biological evaluation is concerned, the data showed PER values between 2.08 and 2.34, which indicate a protein value equivalent to 80.6 and 90.4% of that of casein (PER = 2.50). They can be considered, therefore, as mixtures of a relatively high protein quality. The true digestibility values obtained in some cases were relatively low, between 77.9 and 83.0%. These values reflect to a certain extent the presence of a legume in the mixture. Of special interest in this study were the data obtained regarding the heat treatment by toasting on the availability of lysine in the different ingredients used. The determination of the availability of this amino acid is a valuable indication in the control of materials subjected to heat treatment, since a decrease reflects a damage in protein quality.

According to the results shown in Table 5, available lysine content showed a little increase with toasting time. Although this increase may not be significant, it is interesting to indicate that even though the process did not decrease lysine availability, it did improve significantly the organoleptic characteristics of the mixture, especially odor and flavor. It is therefore important to foster this type of studies, since the improvement in these two characteristics can contribute to an increased legume consumption.

TABLE 5  
EFFECT OF TOASTING ON THE AVAILABILITY OF LYSINE IN CEREALS AND  
LEGUMES

Ingredient	Toasting time * (min)	Available lysine g/16 gN
Rice	Uncooked	3.34
	45	3.23
	55	3.48
	60	3.55
Mung bean ( <i>Phaseolus mungo</i> )	Uncooked	6.09
	35	6.39
	45	6.16
	60	6.22
Chickpea ( <i>Cicer arietinum</i> )	Uncooked	6.22
	30	6.36
	40	5.87
	44	5.15
	49	2.86
Sesame ( <i>Sesame indicum</i> )	Uncooked	3.35
	15	2.88
	20	3.09
	25	2.98

\* Toasting temperature, 120-130°C.

## PROJECT 2

## NEW SOURCES OF NUTRIENTS

Subproject A      **CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF AMARANTH (*Amaranthus caudatus*) LEAVES**

*L. G. Elías, R. Gómez-Brenes and R. Bressani*

The nutrition surveys carried out in some rural populations in Central American countries have indicated that some leaves are consumed as vegetables, among them amaranth (*Amaranthus caudatus*) leaves. The present study evaluated this promisory food with the purpose of promoting its cultivation and utilization, and to compare it with other leaves consumed by the population. Amaranth leaves contain 13.60% dry matter and 4.40% protein, a value which is slightly lower than that of *macuy*, *chipilín*, *verdolaga*, spinach and *quixtán* leaves. Their content of essential amino acids is, however, relatively good. Although the amino acid pattern of amaranth leaves is deficient in sulfur-containing amino acids, its content in lysine and tryptophan is high. The sulfur amino acid deficiency was demonstrated in animal assays where protein quality increased from a PER of 1.05 to 1.88 with the addition of methionine. This characteristic is not unique to amaranth, since all vegetables assayed responded to the addition of methionine in a similar fashion. It was demonstrated that amaranth leaves can adequately supplement a diet made of 90% maize and 10% cooked beans, whether in the presence or absence of a vitamin supplement. The weight gain was 4.3 g/day with the control diet and 5.7 with the diet containing 5% amaranth leaves. These results were interpreted to mean that, besides protein, amaranth leaves provide other nutrients deficient in a maize:beans diet.

Subproject B      **NUTRITIVE VALUE AND UTILIZATION OF THE PROTEIN AND OIL OF LUPINE (*Lupinus mutabilis*) SEEDS**

In the 1980 Annual Report (p. 4) the present work was mentioned as having the following importance and specific objectives: 1) to determine the nutritive value of the protein and oil, and the safe levels of lupine alkaloid intake in experimental animals; 2) to investigate different alternatives to eliminate the alkaloids in lupine seed; and 3) to develop a technology at the rural level for drying the seed debittered by the traditional process. At that time the nutritive value of the debittered seed and the effect of adding different levels of bitter seed on the growth of young rats was informed. During 1981, the study continued and the following two subprojects were designed to meet the objectives mentioned above.

Subproject B.1      **NUTRITIVE VALUE AND DIGESTIBILITY OF LUPINE OIL**

*L. G. Elías, R. Bressani, J. E. Braham and L. Tuesta \**

The chemical composition of the lupine seed presents significant chemical differences, in accordance with the species and varieties studied. In the case of *Lupinus mutabilis*, this seed contains not only high levels of protein, but also considerable levels of oil, being therefore a source of both protein and energy for human and animal nutrition. In this respect, although there is information in the literature regarding the fatty acid composition of the lipid fraction, there is none regarding the nutritive value and digestibility of the oil. The objective of this study was to learn about both nutritional characteristics. For this purpose, rat diets containing a high casein content were prepared, and refined lupine oil was added in concentrations of 5, 10 and 20%. Two additional groups were run with 10% refined lupine oil heated (139-142°C) for 60 and 120 min, respectively. Refined cottonseed oil was used as control at the same levels, and

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\* Food Sciences tutorial student.

subjected to the same heat treatment. These diets were offered to growing rats for a period of 5 weeks, and weight gain and food consumption were recorded. During the last week of experimentation, individual feces were collected with the purpose of determining the content of excreted fat, and to calculate the apparent fat digestibility coefficient. Table shows a summary of the results obtained. As can be seen, both the weight gain and the lupine oil digestibility coefficients were very similar to those obtained with cottonseed oil. Likewise, it can be ascertained that the heat treatment had no deleterious effect on the parameters measured. On the basis of these preliminary results, it is considered that, a) refined lupine oil contains no toxic substances; b) the oil presents a digestibility coefficient similar to edible oils already consumed by the population; and c) the lupine oil has a good potential as a commercial oil to be used in the food industry.

TABLE 6

NUTRITIVE VALUE AND APPARENT DIGESTIBILITY COEFFICIENT OF LUPINE (*L. mutabilis*) OIL, REFINED AND HEATED\*, IN COMPARISON WITH COTTONSEED OIL

Addition to basal diet**	Oil treatment	Protein in diet o/o	Weight gain g/5 weeks	Apparent digestibility o/o	Mortality
5 <sup>o</sup> /o lupine oil	Refined	21.5	153	96.3	0/8
10 <sup>o</sup> /o lupine oil	Refined	22.1	165	98.1	0/8
20 <sup>o</sup> /o lupine oil	Refined	21.7	175	98.2	0/8
5 <sup>o</sup> /o cottonseed oil	Refined	22.2	164	97.2	0/8
10 <sup>o</sup> /o cottonseed oil	Refined	21.6	166	97.6	0/8
20 <sup>o</sup> /o cottonseed oil	Refined	22.4	165	98.4	0/8
10 <sup>o</sup> /o lupine oil	Refined and heated***	21.3	160	97.8	0/8
10 <sup>o</sup> /o lupine oil	Refined and heated●	21.3	149	97.9	0/8
10 <sup>o</sup> /o cottonseed oil	Refined and heated***	21.2	167	98.1	0/8

\* 139-142°C.

\*\* Casein.

\*\*\* 60 minutes.

● 120 minutes.

Subproject B.2 EFFECT OF DIFFERENT TREATMENTS ON THE TOXICITY AND NUTRITIVE VALUE OF THE LUPINE SEED (*Lupinus mutabilis*)

*L. G. Elias, R. Bressani, J. E. Braham and L. Tursta*

As reported before (Annual Report, 1980), there are several problems which limit the adequate and efficient utilization of the lupine seed, especially of bitter varieties (*L. mutabilis*). Among these problems, the presence of alkaloids in the products made of this variety is a problem deserving priority, especially at the industrial level. Up to now, two detoxifying processes have been used. The traditional, used at the rural level, consists in boiling the seeds in water for 40 min and washing them in running water for three days; this process leaves the seeds with a 0.02 g<sup>o</sup>/o alkaloid content, from an original value of 2.0 g<sup>o</sup>/o. The other process, used in industry, consists of treating the meal obtained after oil extraction with 80<sup>o</sup>/o ethyl alcohol; in this case, the alkaloid content decreases from an original value of 4.0 g<sup>o</sup>/o (bitter meal) to values of 1 to 1.2 g<sup>o</sup>/o, figures which are considered as still too high. The purpose of the present study was to learn of the effects of the detoxifying processes on the protein quality and residual toxicity of the

above-mentioned products. For this purpose, the original raw seed was studied, as well as that debittered by the rural method, the meal obtained from oil extraction and the industrial meal debittered with 80% ethyl alcohol.

Regarding protein quality (Table 7) it can be observed that when the alkaloids are extracted by the industrial method, there is an increase in the Protein Efficiency Ratio (PER) of 0.54 (bitter meal) to 1.01 (debittered meal). It should be pointed out, however, that the PER value for the seed debittered by the rural method (0.51) was similar to that of the bitter meal (0.54), although the alkaloid content was significantly higher in the latter when compared with that obtained by alcohol extraction. Although there is no explanation at present of this finding, it is possible that other antinutritional factors, aside from alkaloids, are affecting the protein quality of the lupine seed debittered by the rural method. This interesting point requires further research. Likewise, and as was expected, the animals fed raw seed did not grow normally; furthermore, mortality was observed. Another experiment (Table 8) of a longer duration (6 weeks) and with higher levels of the materials already described, showed interesting results. In the first place, the tendency of the bitter meal to promote equal or better growth than the seed washed by the rural method was corroborated, even though with the former product (bitter meal) one animal died. The growth data from diets of a similar protein content showed the superiority of the debittered meal (by the industrial process) over the seed debittered by the rural water treatment. In the case of raw seeds, there was a direct relationship between the alkaloid content (which increased with increasing levels of seeds in the diet) and mortality of the animals, a relationship which was not observed with the bitter seed (industrial process), as was to be expected. Finally, it is interesting to point out that, in all cases, a protective effect of the protein content in the diet on animal mortality was observed. The present study will be continued with the purpose of clarifying some of the findings.

TABLE 7  
PROTEIN QUALITY OF LUPINE SEEDS SUBJECTED TO DIFFERENT TREATMENTS

Treatment of seed	Protein in raw material %	Protein in diet %	Weight gain g/28 days	PER	Mortality
Raw	36.1	8.8	- 3	-	1/8
Raw, washed and dried	43.3	9.8	7	0.51	0/8
Bitter meal (industrial process)**	61.0	9.1	7	0.54	0/8
Debittered meal (industrial process)***	23.2	9.3	14	1.01	0/8

\* Rural method (water).

\*\* Residue from oil extraction.

\*\*\* Extracted with 80% ethyl alcohol.

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**TABLE 8**  
**GROWTH OF YOUNG RATS FED DIFFERENT LEVELS OF LUPINE SEED SUBJECTED TO DIFFERENT TREATMENTS**

Treatment of seed	Protein in diet o/o	Alkaloid content (estimated)			Weight gain g/16 weeks	Mortality
		In raw material mg o/o	In diet mg o/o	Maximum consumption/day, 20 g diet		
Raw	8.8	2,000	500	100	1.2	1/8
Raw	13.1	2,000	750	150	3.2	1/8
Raw	16.6	2,000	1,000	200	4.8	3/8
Raw, washed and dried*	9.8	20	4	0.8	16	0/8
Raw, washed and dried	13.8	20	7	1.4	39	0/8
Raw, washed and dried	17.8	20	9	1.8	56	0/8
Bitter meal***	9.1	4,000	612	122	14	1/8
Bitter meal	13.3	4,000	916	183	41	0/8
Bitter meal	17.5	4,000	1,220	244	72	0/8
Debittered meal***	6.5	1,120	307	61	10	0/8
Debittered meal	9.3	1,120	460	92	24	0/8
Debittered meal	12.2	1,120	490	98	45	0/8

\* Rural method (water).

\*\* Residue from oil extraction (industrial process).

\*\*\* Industrial method.

**Subproject C**      **EFFECT OF DIFFERENT TREATMENTS ON THE BITTERNESS, HEMOLYTIC ACTIVITY AND SAPONIN CONTENT OF QUINUA GRAINS (*Chenopodium quinua*, Willd)**

*R. Gómez-Brenes, J. A. Romero\*, J. E. Braham and R. Bressani*

Quinoa is a cereal widely produced in South America; however, its consumption is limited by its high saponin content. These organic compounds impart a characteristic bitter taste to the grains, and it is necessary to wash them off with abundant running water before being used for human consumption. The washing process is relatively rustic and is responsible, at least partially, for the low level of industrialization of this cereal. For this reason, the present research was undertaken with the purpose of finding an adequate process to eliminate the bitter taste in quinoa. Quinoa seeds were subjected to the following treatments: extraction with cold water (20°C), washing with hot water (70°C), autoclaving for 30 minutes at

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16 psi and 121°C, washing with 80% ethyl alcohol, and cooking with 1% calcium hydroxide. After each treatment the samples were dried, ground and extracted with water, and both the extracts and residues were subjected to chemical (saponin fractionation by TLC), biological (red cell hemolysis) and organoleptic (taste) evaluations. For the latter, a panel of 6 individuals from the Division of Agricultural and Food Sciences was formed. The panel evaluated the samples assigning a score to each flavor, thus: 1, without bitter taste; 2, bitterness barely perceptible; 3, perceptible bitterness; 4, bitter; and 5, very bitter. The results obtained indicated for all trials that none of the treatments is enough by itself to remove completely the bitter taste of the seeds. Treatments with 80% ethyl alcohol, and with 1% Ca(OH)<sub>2</sub>, however, looked promising, since with these treatments the extracts were more bitter than the residues. On the basis of the results obtained, it is important to continue with this line of work, since ethyl alcohol can be distilled and used again and it has the additional advantage of increasing the calcium content of quinoa, making it a more nutritious food.

Subproject D      **CHARACTERIZATION OF THE PROTEIN OF *Candida utilis* WITH A LOW NUCLEIC ACID CONTENT. CHEMICAL COMPOSITION, PROTEIN VALUE AND PRELIMINARY TOXICITY TRIALS**

*M. Bautista\*, L. G. Elías, R. Gómez-Grenes and R. Bressani*

One of the most serious obstacles for a better utilization of protein concentrates obtained from yeasts in human nutrition is their relatively high nucleic acid concentration. This limitation is due to the fact during their catabolism, nucleic acids produce uric acid, which can accumulate in the blood stream forming crystals in the joints which eventually could result in arthritis or gout. Likewise, if the renal load of uric acid is high, it can result in calculi in the urinary tract. For the purpose of decreasing the nucleic acid content in single cell protein concentrates, techniques have been developed which involve the disintegration of cells, thus liberating the protein which can be used in foods for human consumption.

The purpose of the present research was to characterize chemically and biologically a protein residue from the extraction and purification of nucleic acids from a yeast, *Candida utilis*. During the extraction process, nucleic acids were removed by treatment with an NaCl 10% solution at 60°C. The residue was dried by aspersion, dialyzed to remove the high salt content and freeze-dried. Chemical characterization of the residue showed a high true protein content (55.3%) and a low nucleic acid concentration (2.0%). Regarding the essential amino acid content, it was similar to that of other single cell protein concentrates and compared favorably with the 1973 FAO amino acid pattern, with the exception of sulfur-containing amino acids, which showed a chemical score of 92%. The protein quality (Table 9) was evaluated by the protein efficiency ratio (PER), and the results were compared with casein used as control. The results obtained confirmed the deficiency in methionine, and the PER values (3.22) were very similar to those obtained with casein (3.59). The digestibility found for *C. utilis* was about 79%, while that for casein was above 90%. Toxicity trials were also carried out by feeding rats with diets containing 20 and 30% of protein (about 40 to 60% of the yeast residue) for a 6 to 7 week period. The parameters measured were weight gain, liver weight, kidney weight, blood serum uric acid and histopathological lesions in liver and kidneys. There were no symptoms of toxicity in rats fed *C. utilis*. It is concluded from this work that the protein from *C. utilis* has good possibilities to be used in human nutrition.

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TABLE 9  
 PROTEIN QUALITY (PER) AND APPARENT DIGESTIBILITY OF THE SINGLE  
 CELL PROTEIN CONCENTRATE WITH A LOW NUCLEIC ACID CONTENT

Diet	Protein %o	Weight gain g $\bar{x} \pm S. D.$	Protein Effic. Ratio $\bar{x} \pm S. D.$	Apparent digestibility $\bar{x} \pm S. D.$
<i>Candida utilis</i>	10.4	44 $\pm$ 6.5	1.58 $\pm$ 0.26	78.9 $\pm$ 1.48
<i>Candida utilis</i> + 0.3%o DL-methionine	10.6	136 $\pm$ 21.7	3.22 $\pm$ 0.41	78.6 $\pm$ 3.44
Casein	9.7	114 $\pm$ 17.7	3.03 $\pm$ 0.22	91.3 $\pm$ 1.10
Casein + 0.3%o DL-methionine	10.0	148 $\pm$ 34.9	3.59 $\pm$ 0.43	92.0 $\pm$ 0.68

## SUBPROGRAM C

### FOOD TECHNOLOGY

#### PROJECT I

##### DEVELOPMENT OF FOOD PRODUCTS

Subproject A      UTILIZATION OF OLD HENS, MAIZE FLOUR AND WHOLE SOYBEANS IN THE PRODUCTION OF SAUSAGES AND SAUSAGE-LIKE PRODUCTS

*M. de J. Muñoz \*, M. R. Molinc and R. Bressani*

The production of sausages and sausage-like products (i.e., paté, Italian sausage, etc.) could yield a practical alternative for the efficient utilization of old hens. In the present study, the production of sausages using old hens and chicken meat was evaluated, comparing their acceptability against that of commercial sausages in a rural area of Guatemala (Santiago Sacatepéquez). After being chopped and frozen, the old hen and chicken meat was extended at 0, 25 and 40% (dry basis) either with extruded cooked (160°C) whole soybeans or with a maize/whole soybean (70/30) mixture processed in a similar manner. Condiments, potassium nitrite and sodium ascorbate (the last 2 as preservatives) were then added to the extended meat dough. Each sample of dough was emulsified and filled into commercial sausage packaging film. After cooking, the sausages were stored under refrigeration (2-4°C) until their evaluation. The emulsifying capacity of the old hen or chicken meat was lowered by 10-15% when extended either with the extruded whole soybean or the extruded maize/whole soybean mixture. The protein content of the products prepared with the extended meat was always lower than that of the products prepared from 100% meat (Table 1). The nutritive value of the sausages, however, tended to improve when using the chicken or old hen meat extended at the stated levels (Table 2). The acceptability trials carried out in large scale in a rural community of Guatemala (Santiago Sacatepéquez) indicated that the products prepared from old hen meat extended with the extruded maize/soybean mixture (70/30) were better accepted than either those prepared from the extruded whole soybean extended meat or from the 100% pure meat dough, or even the commercial sausages available at the community. The product prepared from the meat extended at the 40% level with the extruded maize/whole soybean mixture had a higher organoleptic score (6.33) than that prepared with the meat extended at the lowest level (25%) with extruded

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TABLE 1  
 CHEMICAL CHARACTERISTICS OF SAUSAGES MADE FROM OLD HEN'S MEAT EXTENDED  
 WITH EXTRUDED-COOKED WHOLE SOYBEANS OR AN EXTRUDED MIXTURE OF  
 MAIZE/WHOLE SOYBEANS (0/o)

Component	Level of extender (0/o dry basis)				
	0	25 (whole soy)	40 (whole soy)	25 (corn/soy)	40 (corn/soy)
Moisture	66.5	66.5	64.1	65.3	64.6
Protein (N x 6.25)	16.5	15.0	15.5	14.6	14.4
Fat	13.9	17.6	15.5	16.7	14.6
Free fatty acids (x 10 <sup>-2</sup> )	2.0	1.6	3.0	1.6	2.5
Peroxides	0.0	0.0	0.0	0.0	0.0
Caloric density (cal/100 g)	206.0	216.6	222.2	221.9	213.5

TABLE 2  
 PROTEIN QUALITY OF SAUSAGES FROM CHICKEN AND OLD HEN'S MEAT EXTENDED  
 WITH EXTRUDED-COOKED WHOLE SOYBEANS OR WITH AN EXTENDED MIXTURE  
 OF A MAIZE/WHOLE SOYBEAN

Type of meat	Formulation (dry basis) (meat:soy:maize/soy)			Net protein ratio (NPR)*	Protein efficiency ratio (PER)*
Chicken	100:	0:	0	4.06 <sup>d,e</sup>	2.71 <sup>b</sup>
	75:	25:	0	4.11 <sup>c,d</sup>	2.65 <sup>b,c</sup>
	60:	40:	0	4.48 <sup>a,b</sup>	2.97 <sup>a,b</sup>
	75:	0:	25	4.37 <sup>b,c,d</sup>	3.07 <sup>a,b</sup>
	60:	0:	40	4.44 <sup>a,b</sup>	2.87 <sup>b</sup>
Old hen	100:	0:	0	4.36 <sup>b,c,d</sup>	3.06 <sup>a</sup>
	75:	25:	0	3.74 <sup>c</sup>	2.43 <sup>c</sup>
	60:	40:	0	4.41 <sup>b,c</sup>	2.64 <sup>b,c</sup>
	75:	0:	25	4.10 <sup>c,d</sup>	2.77 <sup>b</sup>
	60:	0:	40	4.74 <sup>a</sup>	3.15 <sup>a</sup>
Casein	---			3.70 <sup>c</sup>	2.71 <sup>b</sup>

\* Figures followed by different letters indicate significant difference (P < 0.05).

whole soybeans (5.54) and that of the commercial sausages (5.08) (Table 3). The raw material costs of the sausage prepared from old hen's meat extended at a 40% with the extruded maize/whole soybeans (70/30) mixture proved to be around 30% lower than that reported for the commercial formulation. Based on the above, it is considered that sausage production may be a viable alternative for the utilization of old hens which are presently discarded.

TABLE 3  
ORGANOLEPTIC SCORE OBTAINED IN RURAL AND URBAN AREAS FOR SAUSAGES  
PREPARED FROM FORMULATIONS BASED ON OLD HEN'S MEAT

Formulation (dry basis) (meat:soy:maize/soy)	Organoleptic score	
	Urban area	Rural area
100: 0 : 0	5.05 <sup>a</sup>	5.26 <sup>a</sup>
75: 25 : 0	4.88 <sup>a,b</sup>	5.54 <sup>a</sup>
60: 40 : 0	3.97 <sup>b</sup>	5.13 <sup>a</sup>
75: 0 : 25	6.05 <sup>a</sup>	6.13 <sup>a</sup>
60: 0 : 40	4.88 <sup>a,b</sup>	6.33 <sup>a</sup>

\* Average values from 25 panelists in each case. The values are based on a hedonic scale of 1, 3, 5, 7 and 9, according to the likeness levels. Figures followed by different letters indicate significant differences ( $P < 0.05$ ). The organoleptic score obtained for commercial sausage in the urban area was 5.31 and in the rural area 5.08.

## PROJECT 2

### CONSERVATION AND PROCESSING

#### Subproject A USE OF WOOD SMOKE TO PREVENT CORN (*Zea mays*) BIODETERIORATION

*G. Merino\* and R. Bressani*

In the rural areas of some countries, ears of corn are stored inside the house, using the smoke produced in the kitchen from wood combustion as a means to repel insects that attack corn. The purpose of the present work was to evaluate the effectiveness of the treatment with smoke on the biodeterioration of corn. A lot of 100 lb ears of corn was stored inside the house of a farmer and a similar lot of 100 lb was stored at INCAP, for a period of six months. A record was kept weekly of temperature and relative humidity of the storage environment, as well as moisture content of the grain, damaged grains and germination percentage. At the end of six months, the materials were evaluated for protein quality.

The environmental conditions varied little within the two storage sites; however, temperature and relative humidity in the rural home were 30°C and 54%, while in the control site they were 18°C and 75%, respectively. Although smoke was not an absolute preserving agent (61% of damaged grains), a higher level of damaged grains (98%) and a total germination loss were found in the grain stored without exposure to smoke. The nutritive value tests showed that protein quality was not affected by the storage system.

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**Subproject B      EFFECT OF THE MOISTURE LEVEL IN RECENTLY HARVESTED BLACK BEANS (*Phaseolus vulgaris*) ON THE EFFICACY OF THE ALTERNATIVES TO IMPROVE COOKING TIME OF STORED BEANS**

*M. R. Molina, G. Merino, M. A. Baten and R. Bressani*

Previous reports have informed on the efficacy of a short-term heat treatment or a treatment with sodium chloride (common salt) on recently harvested beans to improve their cooking time and resistance to biodeterioration during storage. Nothing has been informed, however, on the possible effect that the initial moisture content of the grain may have on the efficiency of these treatments, nor on the possibility of reusing the sodium chloride solution, which would facilitate the implementation of this last alternative. In order to find answers to both questions, two lots of recently harvested black beans (*Phaseolus vulgaris*) were adjusted to 12 and 18% moisture, respectively. A sample of each lot was subjected to steam treatment at atmospheric pressure (95°C) for two min, and then the moisture content adjusted to 12% previous to storage in polyethylene bags at room temperature. Likewise, five samples at each moisture level were treated sequentially with a 15% sodium chloride solution and then stored in a similar fashion as that described for the heat treated samples. The results showed that the level of moisture in the grain significantly ( $P < 0.05$ ) affects the effectiveness of the heat treatment to minimize the cooking time of the beans stored for five months. The level of 18% moisture proved the most adequate. The reutilization of the sodium chloride solution implies an exponential reduction in its concentration, which suggests a better absorption in the case of concentrations nearing 15%. Regarding the grain with 18% moisture, the 14% salt solution was more effective in minimizing its cooking time during storage. All samples stored during five months had a similar protein quality when cooked for the determined time.

**Subproject C      CHEMICAL AND FUNCTIONAL CHARACTERISTICS OF 39 LINES OF TOMATO (*Solanum esculentum*) CULTIVATED IN FOUR LOCALITIES IN GUATEMALA**

*M. R. Molina, O. Orozco\*, A. A. García\* and R. Bressani*

One of the alternatives for the use of tomatoes is their industrialization for the manufacture of processed products. Among these, catsup and juice are the ones with the highest demand. In order to insure the success of a tomato processing plant, it is necessary to establish an association between cultivation and quality of the processed product. With this in mind, 39 lines of tomato were sown in four localities in Guatemala. After harvesting, the fruit was analyzed regarding yield and chemical and functional characteristics of the juice. The characteristics evaluated were pH, viscosity, total solids and soluble solids. Results indicated that variety and environment exert a significant ( $P < 0.01$ ) effect on viscosity and solids (soluble and total) content of the juice. No relation was found between solids content and viscosity of the juice. With the most viscous juice, a catsup of better consistency was obtained. These findings will permit the initiation of selection as a function of processing quality, which is very important, especially to agricultural cooperativists who are starting a tomato processing agroindustry. The quality of the byproducts as a feed is still to be determined.

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\* ICTA professional.

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## **SUBPROGRAM D**

### **ANIMAL NUTRITION**

#### **PROJECT 1**

##### **FEEDS**

###### **Subproject A      NUTRIENT CONTENT OF MATERIALS USED IN ANIMAL NUTRITION**

*R. Gómez-Brenes, L. G. Elías, J. E. Braham and R. Bressani*

For the purpose of providing information on the chemical composition of the materials most commonly used in Central America for poultry feeding, INCAP has continued to evaluate materials to complement the Feed and Forage Composition Table, and offer poultry farmers detailed information on the nutrient content of local raw materials, as well as on the existing variability among the different samples analyzed. In the present study, 10 samples were evaluated: cottonseed flour, fish meal, wheat middlings, corn gluten meal, meat meal, soybean meal, red and white sorghum, feather meal, yellow corn and poultry offal meal. The following analyses were carried out: proximate chemical composition, sodium chloride, calcium, phosphorus, total and available lysine, cystine, methionine and tryptophan. In the cottonseed sample, the content of free and total gossypol was also determined. These nutrients were selected for analysis because they are the ones that influence most the quality of poultry feeds.

###### **Subproject B      AMINO ACID CONTENT OF CENTRAL AMERICAN RAW MATERIALS USED IN ANIMAL FEEDS**

*R. Gómez-Brenes and R. Bressani*

Animal industry is an important component in the development of a country, not only because it utilizes existing raw materials, but because it increases the availability of good quality foods which are good sources of energy, protein, vitamins and minerals, all very important for the maintenance of body health and work capacity in both humans and animals. The animal nutrition field is very dynamic and has advanced a great deal during the last few years. For this reason, if industrial concerns dedicated to animal production want to obtain maximum benefits, they must apply modern techniques in the elaboration of rations and concentrates, with special emphasis on the balance of necessary nutrients for the different stages of growth and production. With the purpose of collaborating in increasing food production in the Central American area, INCAP has continued with its program of study and evaluation of the available

natural resources; on this occasion, special attention has been given to amino acid composition, since this kind of data is very scarce as far as native materials are concerned. The information obtained could be used by feed producers to balance better those essential nutrients in each type of ration, and to know the chemical composition of the existing raw materials which can replace other raw materials when the latter are scarce. The materials evaluated in this study were about 40, among them cottonseed flour, fish meal, shrimp meal, soybean meal, coffee pulp, milk whey, sesame, rubber seed, brewer's yeast, water hyacinth whole plant and leaves, and other byproducts with a potential for animal feeding.

Subproject C      **CHEMICAL CHARACTERIZATION OF ANIMAL FATS OF LOCAL MANUFACTURE USED IN THE NATIONAL POULTRY INDUSTRY**

*R. Gómez-Brenes, R. Bressani and E. Estrada\**

It is a well-known fact that energy sources for poultry feeding are getting more and more scarce. Therefore, it is necessary to use those local materials that can provide the necessary nutrients for the adequate growth of the animals. An example of these materials are animal fats which can be incorporated into poultry feeds as energy sources, as long as these materials are adequately prepared and stored to avoid deleterious effects in the animals consuming them. For the purpose of having a uniform quality in animal fats, and in order to offer poultry farmers information on the quality of the different products that are being marketed, INCAP is at present collecting and analyzing samples of animal fats so as to develop quality standards that can be helpful to the feed manufacturers. There was a large variability among the samples analyzed regarding color, odor and chemical and physical characteristics. Color varied from mother-of-pearl white to dark brown, the odor from sui generis to nauseating. In nine samples thus far analyzed, levels of moisture and volatile matter varying from 0.05 to 4.57% were found; insoluble impurities oscillated between 0.122 and 1.046 and melting points from 49.0 to 53.3°C, all of which indicates the importance of uniforming quality before placing the product in the market. Other aspects are being studied at present, such as chemical and microbiological characteristics, to identify those products which offer a better guarantee to the poultry farmer.

## PROJECT 2

### PROCESSING OF AGROINDUSTRIAL PRODUCTS AND BYPRODUCTS

Subproject A      **IMPROVEMENT IN THE NUTRITIVE QUALITY OF COFFEE PULP FOR MONOGASTRIC ANIMALS THROUGH SOLID FERMENTATION**

*M. R. Molina, W. Peñalosa\*\* and R. Bressani*

The use of coffee pulp as an ingredient in rations for monogastric animals has been limited by the anti-physiological factors (caffeine, tannins and fiber) contained in the pulp. In order to minimize the content of these compounds in the byproduct, an appropriate technological alternative such as solid fermentation was evaluated with three molds (*Penicillium crustosum*, *Trichoderma harzianum* and *Aspergillus niger*). Bioassays with this type of open fermentation, at a pH of 3.5, temperatures of 30° and 35°C, air flow of 8 lt/min/kg and an initial moisture content in the substrate of 60, 70 and 80% showed that the true protein concentration obtained after 24 and 67 hours of fermentation was significantly ( $P < 0.01$ ) higher when *A. niger* and 80% moisture in the substrate were used; fermentation temperature has a much lesser effect. When the kinetics of the process were determined for *A. niger* at pH 3.5, 35°C and an initial moisture content in the substrate of 80%, the optimum harvest time was 43 to 48 hours of fermentation. The

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increase in true protein content was significantly ( $P < 0.01$ ) associated with a decrease in dry matter and an increase in pH during the process. The final product had a true protein content twice as high as that present in the original raw material, and a decreased content in cellulose, hemicellulose, crude fiber and acid detergent fiber. Although the caffeine and tannins content in the final product was similar to that of the original material, chickens fed rations containing 10% of the fermented material gained significantly ( $P < 0.01$ ) more weight than those fed rations containing 10% of the original coffee pulp. It is concluded that solid fermentation offers a viable alternative to improve the nutritive quality of coffee pulp and constitutes an adequate technology for the Central American area.

Subproject B      EFFECT OF TWO ALKALINE TREATMENTS FOR THE INACTIVATION OF AFLATOXINS IN MAIZE AND THEIR IMPACT ON BIOLOGICAL ASSAYS

*G. Alanis\*, L. G. Elías and R. Bressani*

Maize has been, for many years, the main component in human diets in Latin America. In different parts of the world, other cereals and grains, such as oats, barley, wheat, rice and beans, or their combination, are vital ingredients of the diet. It has been estimated, however, that 30% of the annual harvest is lost and in spite of the measures undertaken —within the Latin American economic possibilities— to curb them, losses continue to be large. It is therefore necessary to study further treatments and techniques to improve the damaged grain and be able to utilize it for animal nutrition. This will prevent its total loss, and this is the purpose of the present study.

Maize contaminated with molds was analyzed for its aflatoxin content by the AOAC method, and was divided into two lots. One lot was treated with  $\text{NH}_4\text{OH}$  at a concentration of 1.5% the weight of maize (Treatment I), and the moisture content was taken to 20%; the second lot was treated with 1%  $\text{Ca}(\text{OH})_2$  and then taken to 20% moisture content (Treatment II). Both lots were placed in convection ovens at 40°C, and samples were taken at 3, 6 and 10 days and analyzed for aflatoxins. The results shown in Table 1 indicate that Treatment I was very efficient and that even after 6 days of reaction, satisfactory results were obtained.

Biological assays with rats and chicks were run with maize treated with either  $\text{NH}_4\text{OH}$  or  $\text{Ca}(\text{OH})_2$ . Table 2 shows that, in the case of rats, a decrease in PER and food efficiency was observed when rats were fed the untreated contaminated maize as compared to uncontaminated control maize, and the effectiveness of the treatments is once again shown by the increase in PER and food efficiency in the samples treated. In spite of the fact that the chemical analysis showed that treatment with  $\text{Ca}(\text{OH})_2$  was less effective, the biological trials showed that maize treated with this chemical had a higher PER than maize treated with  $\text{NH}_4\text{OH}$  and similar to the untreated control maize. Besides, the food efficiency of the  $\text{Ca}(\text{OH})_2$  treated maize was higher than that for the control maize. This could be due to the fact that lime, besides its beneficial action in destroying aflatoxins, could improve maize utilization through a partial hydrolysis of its protein. Another reason for the more effective results obtained with  $\text{Ca}(\text{OH})_2$  could be the palatability of the diet containing maize treated with ammonia, since food intake decreased considerably in this case, resulting in a decrease in PER and food efficiency.

In another series of biological trials, diets containing maize contaminated with aflatoxins were fed at two protein levels (8 and 16%), and in this case a protective effect of the protein on the symptoms of acute aflatoxin toxicity was observed, but this effect was not apparent on the symptoms of chronic toxicity.

In the biological trials with chicks, a ration containing 60% maize was used; the other main source of protein in the ration (22%) was soybean meal. Chicks were fed rations with uncontaminated maize

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\* Graduate student in the Course in Food Science and Technology.

TABLE 1  
EFFECT OF ALKALINE TREATMENTS ON THE AFLATOXIN CONTENT  
OF CONTAMINATED MAIZE

Treatments	Total aflatoxins		
	Initial level ppb*	Final level ppb*	Decrease o/o
I. $\text{NH}_4\text{OH}$ , 1.5% by weight and taken to 20% moisture			
3 days of reaction	3,900	2,600	25.0
6 days of reaction	3,900	260	93.0
10 days of reaction	3,900	245	93.7
II. $\text{Ca}(\text{OH})_2$ , 1% by weight and taken to 20% moisture			
3 days of reaction	3,900	3,070	21.0
6 days of reaction	3,900	1,300	66.6
10 days of reaction	3,900	1,040	73.0

\* Parts per billion ( $\mu\text{g}/\text{kg}$ ).

as control, with contaminated maize, with contaminated maize treated by I ( $\text{NH}_4\text{OH}$ ) and by II ( $\text{Ca}(\text{OH})_2$ ) for four weeks. No weight differences or changes in the tissues were observed with any treatment; feed efficiency was not affected. On this basis, a level of 234 ppb of aflatoxins can be tolerated by chicks for four weeks without any deleterious effect.

### PROJECT 3

#### BIOLOGICAL NUTRITIONAL EVALUATION

##### Subproject A      NUTRITIONAL EVALUATION OF THE RUBBER (*Hevea brasiliensis*) SEED KERNEL IN GROWING CHICKS

*E. Estrada, M. González, L. G. Elías and R. Bressani*

The purpose of the present study was to evaluate the nutritive potential of the kernel of the rubber tree seed, as an energy and protein source for broilers. The seed was collected in the Retalhuleu area in Guatemala, and was dehydrated by hot air at 45-50°C for 24 hours. The seed was dehulled through a hammer mill, adjusting the screens to allow the separation of husks and kernels. The kernel contained 93.4% dry matter, which included 18.6% protein, 46.1% ether extract, 3.0% crude fiber and 3.7% ash. The high protein and ether extract levels suggest that the kernel could be used as a source of these nutrients in broiler rations, as a substitute for energy sources such as animal fat, and part of the protein in the ration. For this purpose, rations containing 0, 5, 10, 15 and 20% rubber seed kernel meal processed by extrusion were mixed; the levels of energy, amino acids and minerals were adjusted through a computer program. A total of 200 day-old chicks were distributed among 5 treatments of 40 chicks each divided into two replicates of 20 chicks each for each treatment. The experimental time was 8 weeks. It was found that chicks performed satisfactorily to rubber seed kernel feeding and there was no mortality in any of the experimental groups. The level of rubber seed meal giving the best results, measured as weight gain and feed consumption, was 15%. These data demonstrate that rubber seed kernel has a very good potential for animal feeding. Further studies are needed, however, to guarantee its safe utilization.

TABLE 2  
RESULTS OF BIOLOGICAL TRIALS WITH RATS FED MAIZE, MAIZE CONTAMINATED  
WITH AFLATOXINS AND CONTAMINATED AND TREATED MAIZE

Ration	Protein o/o	Weight gain*, g $\bar{x} \pm S.D.**$	Average food consumption, g $\bar{x} \pm S. D.$	PER $\bar{x} \pm S.D.$	Food efficiency $\bar{x} \pm S. D.$
Control maize diet	8.0	38.5 $\pm$ 7.76	332.7 $\pm$ 26.96	1.43 $\pm$ 0.20	8.82 $\pm$ 1.34
Diet with aflatoxin-infected maize	8.0	13.0 $\pm$ 2.16	226.0 $\pm$ 61.87	0.743 $\pm$ 0.14	17.44 $\pm$ 4.30
Diet with aflatoxin-infected maize, treated with Ca(OH) <sub>2</sub>	8.8	26.0 $\pm$ 5.29	207.66 $\pm$ 21.03	1.41 $\pm$ 0.20	8.14 $\pm$ 1.17
Diet with aflatoxin-infected maize, treated with NH <sub>4</sub> OH	8.0	15.0 $\pm$ 1.0	169.66 $\pm$ 9.60	1.18 $\pm$ 0.06	11.33 $\pm$ 0.64
Control maize diet	7.1	17.0 $\pm$ 7.78	219 $\pm$ 28.40	1.07 $\pm$ 0.38	14.67 $\pm$ 5.51
Diet with control maize treated with Ca(OH) <sub>2</sub>	7.3	15.0 $\pm$ 2.94	193.75 $\pm$ 9.22	1.07 $\pm$ 0.24	13.36 $\pm$ 3.12
Diet with control maize treated with NH <sub>4</sub> OH	7.4	13.5 $\pm$ 1.73	186.75 $\pm$ 3.68	0.975 $\pm$ 0.12	13.98 $\pm$ 1.56

\* Initial weight,  $\bar{x} = 44.28 \pm 4.8$  g.

\*\* Standard deviation.

**PROGRAM IX**

**HUMAN NUTRITION AND BIOLOGY**

**SUBPROGRAM A**

**NUTRITIONAL STATUS AND ITS FUNCTIONAL  
CONSEQUENCES**

**PROJECT 1**

**SUPPORTING RESEARCH OF THE PROGRAM OF FORTIFICATION OF  
SUGAR WITH VITAMIN A**

Subproject A      **INTERRELATION BETWEEN VITAMIN A AND IRON: RELATIONSHIP  
BETWEEN VITAMIN A DEFICIENCY AND IRON TRANSPORT AND STORAGE  
PROTEINS**

*L. A. Mejía and G. Arroyave*

The background, experimental design and objectives of this Subproject have been reported previously. It is based on previous investigations by Mejía and Arroyave\* about the effect of vitamin A fortification of sugar on the iron nutrition and metabolism of Guatemalan preschool children. It was found that such intervention had a positive impact on iron nutrition, resulting in an increase in the serum levels of iron accompanied by an increase of total serum iron binding capacity (TIBC). These latter observations suggested that the deficiency of vitamin A may alter the serum levels of transferrin, the iron-carrier glycoprotein.

In order to investigate this hypothesis, the present study was planned to evaluate the effect of vitamin A deficiency on serum transferrin levels and its relationship to iron transport and storage proteins. For this purpose, 300 serum samples from INCAP's serum bank have been used. They belong to rural preschool children from El Salvador and were obtained in 1976 in order to evaluate the vitamin A nutritional status of that country. Based on their retinol levels, the samples have been classified in three groups, as follows: 1) low (< 20 µg/dl); 2) medium (20-30 µg/dl); and 3) high levels (> 30 µg/dl). In addition to retinol, the following biochemical levels were determined: a) retinol binding protein (RBP); b) transferrin; c) ferritin; d) iron; e) TIBC and percent saturation of transferrin; and f) total protein, albumin and globulins.

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\* Mejía, L. A. and G. Arroyave. The effect of vitamin A fortification of sugar on iron metabolism in preschool children in Guatemala. *Am. J. Clin. Nutr.*, 35, 1982. (In press).

TABLE 1  
AVERAGE LEVELS OF RETINOL, RBP, IRON AND TRANSFERRIN IN THE  
BLOOD SERUM OF CHILDREN

	Group I n = 94	Group II n = 105	Group III n = 96
Retinol ( $\mu\text{g}/\text{dl}$ )	14.3 $\pm$ 3.7 <sup>•</sup>	24.8 $\pm$ 3.0	36.5 $\pm$ 7.8*
RBP ( $\mu\text{g}/\text{ml}$ )	20.5 $\pm$ 5.1	26.8 $\pm$ 3.5	34.4 $\pm$ 6.4*
Serum iron ( $\mu\text{g}/\text{dl}$ )	54.0 $\pm$ 18.3	57.7 $\pm$ 20.8	67.1 $\pm$ 23.7*
Transferrin (mg/dl)	272.7 $\pm$ 57.3	291.8 $\pm$ 43.6	295.7 $\pm$ 48.2*

•  $\bar{x} \pm \text{S.D.}$

\*  $P < 0.05$  or better (ANOVA).

The laboratory determinations have been completed and a preliminary analysis of the data has been carried out. Table 1 shows the average values of retinol, RBP, iron and transferrin of the three groups of children. There are significant differences in iron and transferrin levels among the three groups indicating that those children with a better vitamin A nutritional status (higher retinol and RBP levels) also have higher levels of serum iron and transferrin. These observations are supported by the correlations shown in Table 2. Using all the cases ( $n = 295$ ) it was found that transferrin correlated positively with both the levels of retinol and RBP. The correlation with ferritin was negative, indicating that higher levels of transferrin correspond to a lesser amount of stored iron. This negative association suggests that vitamin A improved the mobilization of iron stores. It is interesting to see in the same Table 2 the significant correlation between serum retinol and serum iron. It confirms once again this epidemiologic association reported by us for Central American children since our early studies in this field\*.

TABLE 2  
CORRELATIONS OF TRANSFERRIN AND SERUM IRON WITH BIOCHEMICAL  
INDICATORS OF VITAMIN A NUTRITURE

Correlations	r
Transferrin vs. retinol	0.22*
Transferrin vs. RBP	0.31*
Transferrin vs. ferritin	-0.28*
Serum iron vs. retinol	0.21*

\*  $P < 0.05$  or better.

These preliminary analyses indicate that in the children studied, there is a positive and significant association between their vitamin A nutritional status and their transferrin serum levels. A more complete statistical analysis now in progress will permit the validation of these preliminary findings.

\* Mejía, L. A., R. E. Hodges, G. Arroyave, F. Viteri and B. Torún. Vitamin A deficiency and anemia in Central American children. *Am. J. Clin. Nutr.*, 30: 1175-1184, 1977.

Subproject B      **BIOCHEMICAL METHODOLOGY FOR THE DETERMINATION OF VITAMIN A. TIME OF COLLECTION AND STABILITY OF THE VITAMIN IN BLOOD SAMPLES**

*L. A. Mejía and G. Arroyave*

In nutrition surveys aimed at evaluating the vitamin A nutritional status of populations, it is usually necessary to obtain blood samples in rural areas located far away from the central laboratory where they will ultimately be sent for analysis. During this process, several hours may elapse from the time of collection to the moment in which they will be analyzed, and there is some concern about the stability of the vitamin during this period. Another point to consider is the most appropriate time of blood collection, especially when the subject is no longer under fasting conditions. Based on these considerations, the objectives of the present study were: a) to investigate the stability of retinol and RBP in blood serum separated from the clot at different times after blood extraction; and b) to evaluate the effect of ingesting a vitamin-A rich breakfast on postprandial serum levels of retinol, RBP and carotenoids. In the stability trials, venous blood was drawn from 12 adult subjects and the samples were maintained either at 4°C or at room temperature (26-28°C). The serum was then separated from the clot by centrifugation respectively as follows: immediately after clotting, and at 2, 4, 6, 12 and 24 hours after the extraction of blood. It was found that retinol\* and RBP were stable either at 4°C or at room temperature even if the serum was separated 24 hours after blood extraction. The results obtained when the samples were maintained at room temperature are shown in Table 3.

TABLE 3  
STABILITY AT ROOM TEMPERATURE (26-28°C) OF RETINOL AND RBP AT DIFFERENT TIMES OF SEPARATION OF SERUM

	Hours after blood extraction						
	Basal*	2	4	6	12	24	
Retinol ( $\mu\text{g}/\text{dl}$ )	55.6 $\pm$ 10.3 <sup>●</sup>	55.3 $\pm$ 10.8	55.7 $\pm$ 10.5	55.3 $\pm$ 10.0	55.0 $\pm$ 11.5	55.3 $\pm$ 10.5	NS
RBP ( $\mu\text{g}/\text{ml}$ )	52.1 $\pm$ 7.3	52.1 $\pm$ 7.8	55.5 $\pm$ 7.6	52.7 $\pm$ 7.5	52.8 $\pm$ 7.6	52.6 $\pm$ 7.5	NS

\* Immediately after clotting.

●  $\bar{x} \pm$  S.D.

In the breakfast experiment seven adult subjects ingested a standardized breakfast containing 257  $\mu\text{g}$  of retinol equivalents (about 61% retinol and 39% carotenes). The serum levels of retinol, carotenoids and RBP were measured before this meal and each hour postprandially, up to a period of four hours. As shown in Table 4, the ingestion of breakfast did not alter significantly the levels of the biochemical indicators studied.

These results are of practical importance in nutrition surveys involving field work when, as is common, blood samples cannot be obtained under fasting and, in addition, they have to be transported from far away localities to a central laboratory.

\* All the determinations of retinol and carotenoids in this study were performed according to the method of Bessey et al. (*J. Biol. Chem.*, 166: 177-188, 1946).

TABLE 4  
EFFECT OF BREAKFAST ON POSTPRANDIAL SERUM LEVELS OF RETINOL,  
RBP AND TOTAL CAROTENOIDS

	Hours after ingestion of breakfast					
	Basal*	1	2	3	4	
Retinol ( $\mu\text{g}/\text{dl}$ )	$66.9 \pm 12.1$ ●	$65.7 \pm 12.0$	$65.9 \pm 11.8$	$65.6 \pm 11.0$	$67.3 \pm 11.0$	NS
RBP $\mu\text{g}/\text{ml}$	$59.2 \pm 9.8$	$59.0 \pm 10.2$	$59.3 \pm 9.7$	$59.0 \pm 9.9$	$59.3 \pm 10.5$	NS
Total carotenoids ( $\mu\text{g}/\text{dl}$ )	$138.2 \pm 36.0$	$138.5 \pm 36.3$	$136.8 \pm 35.6$	$137.0 \pm 35.9$	$139.7 \pm 36.8$	NS

\* After overnight fast.

●  $\bar{x} \pm \text{S.D.}$

## PROJECT 2

### DEVELOPMENT OF PSYCHOPHYSIOLOGICAL TESTS OF VISUAL PERCEPTION AS FUNCTIONAL INDICES OF NUTRITIONAL ASSESSMENT

*N. W. Solomons, L. A. Mejía, O. Pineda and B. Torún*

As noted in the 1980 Annual Report, we became interested in the study of psychophysiological tests of visual perception as functional indices of nutritional status, since the changes in certain biochemical levels do not always accurately reflect nutritional status with respect to a given nutrient. The basis for our focus on retinal function relates to the alteration in dark adaptation produced by deficiencies of such nutrients as vitamin A and zinc.

#### *Rapid dark adaptation test*

A rapid dark adaptation test (RDAT) was developed by S. P. Thornton\*. It is based on the Purkinje shift, the phenomenon by which, during adaptation of the retina to night vision, blue objects appear brighter and more visible than red ones. The time necessary to correctly separate different colored poker chips (white, blue and red) under standardized dim illumination provides a quantitative evaluation of the ability to dark adapt.

Last year, we reported the results of the RDAT in 100 adults and 24 children\*\*. It was found that repetition of the test after a 28-day interval produced no significant change in the results. Since then, we have investigated whether or not more frequent repetitions at shorter intervals would affect the results. Twenty adults underwent the RDAT and two subsequent repetitions were made at 14 and 28 days. The geometric means of the results of the 3 tests were 167, 140 and 136 seconds, respectively. The second and third test scores were better than the first ( $P < 0.05$ ), which indicates a learning effect with the repetition of the initial test at a 14-day interval.

In another study, 8 subjects performed the RDAT on 4 consecutive days. As shown in Figure 1, there was progressive improvement in the results, and the time required to identify all of the chips was significantly less on the fourth day than on the first ( $P < 0.05$  by paired "t" test).

\* *Ann. Ophthalmol.*, 9: 731, 1977.

\*\* INCAP, *Annual Report*, 1980, p. 88.

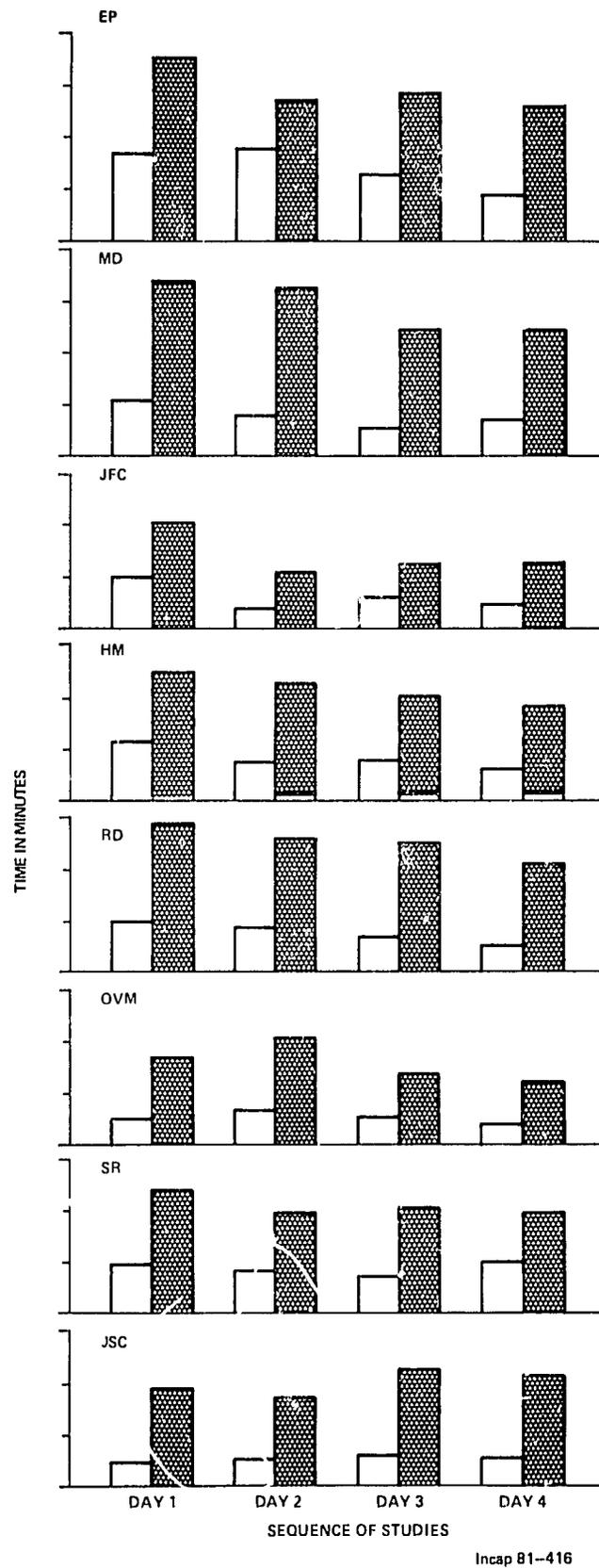


FIGURE 1. *Progressive improvement in the results of the rapid dark adaptation test repeated on 4 consecutive days.*

*Twenty-eight-day supplementation with zinc gluconate*

Investigators in Baltimore, Maryland, U. S. A. (N. E. Vinton and R. M. Russell, unpublished observations) demonstrated an inverse correlation between the ingestion of retinol and carotene and the time to perform the RDAT in children; that is, the greater the intake of these nutrients, the better the performance on the RDAT. As zinc deficiency is also associated with alterations in dark adaptation, we considered it pertinent to explore whether zinc supplementation would improve the RDAT results, even in individuals with apparently good zinc nutrition, insofar as circulating levels of the mineral are not necessarily a reliable index of nutriture with respect to this element. In this study, 7 healthy subjects—5 women and 2 men—received 100 mg of zinc in the form of zinc gluconate in two divided doses daily during 28 days (for more details on the supplementation, see the Project “Studies on the regulation of intestinal zinc absorption”, in this same Subprogram). The RDAT was performed before and at the conclusion of the supplementation period. The 28-day interval was chosen in view of the aforementioned experience, which demonstrated the absence of any spontaneous improvement when the RDAT was repeated once over this time interval. Three of our subjects had an initial plasma zinc concentration below 70  $\mu\text{g}/\text{dl}$ . All of the participants showed an increase in plasma zinc concentration as a result of supplementation. As shown in Table 5, zinc supplementation did not produce consistent changes in the time required to identify and separate the blue chips.

TABLE 5

THE EFFECT OF ZINC SUPPLEMENTATION FOR 28 DAYS ON THE RESULTS OF THE  
RAPID DARK ADAPTATION TEST (RDAT)

Subject	Time to perform the RDAT in seconds		Difference
	Day 0	Day 29	
L.W.	185	172	-13
M.P.	128	143	+15
D.S.	131	107	-24
C.G.	99	101	+ 2
S.A.	206	176	-30
A.A.	136	102	-34
J.R.G.	171	192	+21
Mean	151	142	- 9
SEM	38	39	22

## PROJECT 3

CHANGES IN TOTAL BODY IRON DURING THE RECUPERATION OF MALNOURISHED  
CHILDREN

*B. Caballero\*, R. Batres, N. W. Solomons and B. Torún*

Various studies have indicated that some children with severe protein-energy malnutrition (PEM) show a poor hematological response to treatment with oral iron. It has been proposed that this phenomenon is the result of intestinal malabsorption of iron as a consequence of anatomical and functional lesions

\* INCAP/UNU fellow.

of the digestive tract that are frequently observed in PEM. On the other hand, iron reserves are often normal in malnourished children due to the marked inhibition of erythropoiesis that accompanies the growth arrest and loss of lean body mass. Given that iron reserves play a fundamental role in the regulation of the intestinal absorption of this mineral, the present study was conducted to evaluate the status of this regulatory mechanism in malnourished children. Eleven children with severe PEM, 18 to 40 months of age, participated in the study during the 60 to 90 days following their admission to the INCAP Clinical Center. Their iron reserves were estimated in terms of plasma ferritin concentrations, assuming that each ng/ml was equivalent to 10 mg of storage iron. Circulating iron was estimated from the concentration of circulating hemoglobin, assuming a blood volume of 75 ml/kg of body weight to calculate total hemoglobin. The iron content of a gram of hemoglobin was considered to be 3.4 mg.

According to their initial iron reserves, the 11 children were divided into 2 groups: Group A, with "low" reserves ( $< 300$  mg Fe); and Group B, with "normal" or "high" storage iron level ( $> 350$  mg Fe). Both groups had edematous PEM of a similar severity, and equivalent hematological characteristics on admission (Table 6). Given that iron demand is a function of hemoglobin production, which in turn is regulated by the oxygen demand of metabolically active tissue (lean body mass), the values of total body iron and of circulating iron were calculated as a function of the lean body mass of each child, expressed as square meter of body surface times creatinine-height index ( $m^2 \cdot CHI$ )\*. Expressing it thus, we confirmed that Group A had a deficit of total body iron on admission, even considering their low lean body mass, with values of  $110 \pm 58$  mg Fe/ $m^2 \cdot CHI$  (normal = 205-260 mg Fe/ $m^2 \cdot CHI$ ), while Group B had adequate quantities for their lean body mass ( $262 \pm 63$  mg Fe/ $m^2 \cdot CHI$ ) (Figure 2). The quantities of circulating iron were similar in both groups.

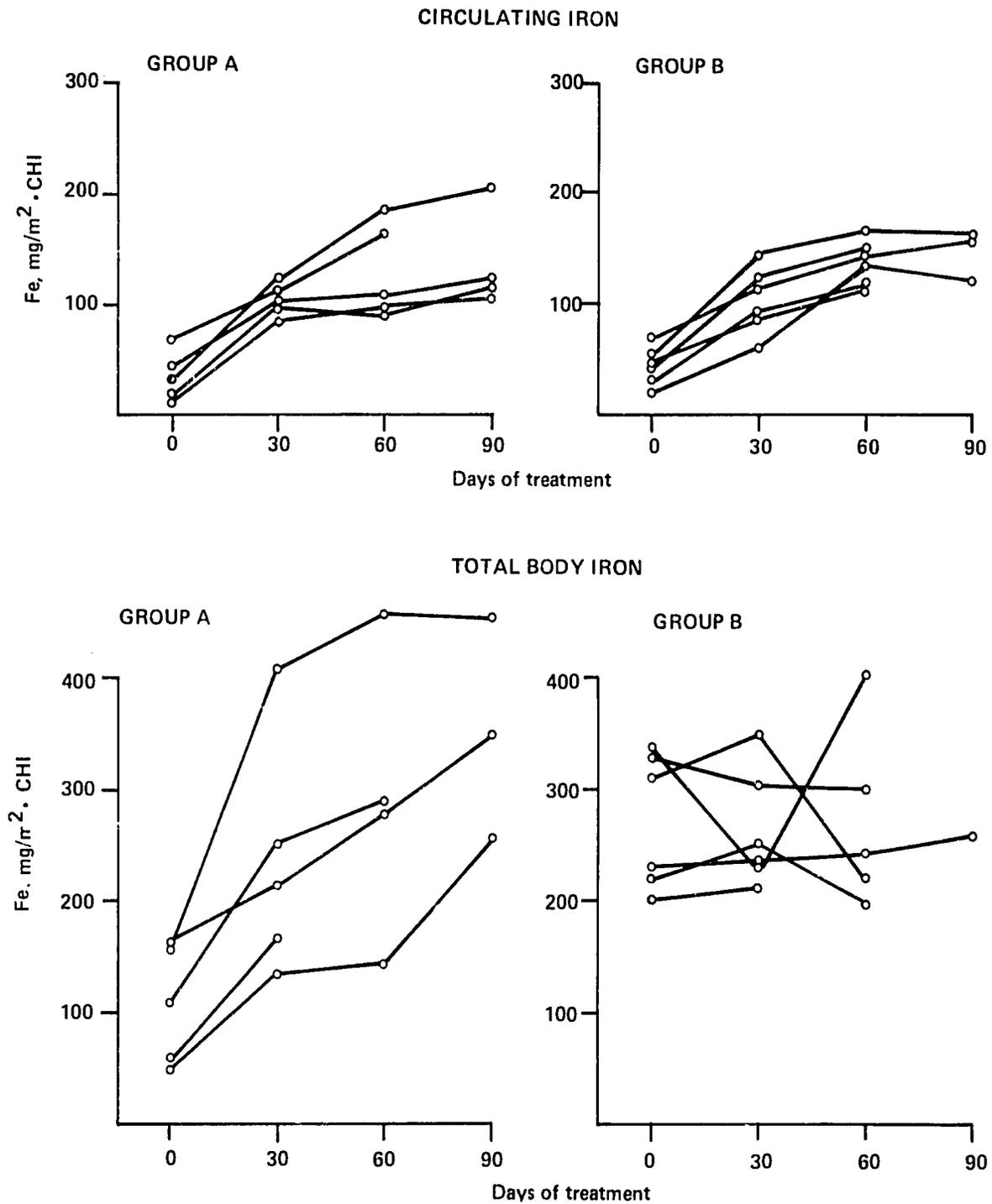
TABLE 6  
HEMATOLOGICAL DATA ON ELEVEN MALNOURISHED CHILDREN ON  
ADMISSION TO INCAP'S CLINICAL CENTER (MEAN  $\pm$  SEM)

	Group A (Reserves $< 300$ mg Fe) (n = 5)	Group B (Reserves $> 350$ mg Fe) (n = 6)
Weight-for-height, % of standar	74 $\pm$ 2	74 $\pm$ 9
Hemoglobin, g/dl	9.5 $\pm$ 0.8	9.5 $\pm$ 1.0
serum iron, ug/dl	63 $\pm$ 18	61 $\pm$ 14
TIBC, ug/dl	132 $\pm$ 35	123 $\pm$ 41
Transferrin saturation, %	51 $\pm$ 18	53 $\pm$ 12

\* Standard = 50th percentile of the Boston standards. Weight corrected for edema.

All children received adequate nutritional treatment, including 60 mg of elemental iron (300 mg  $FeSO_4$ ) per day. Changes in hemoglobin concentration, serum iron and total iron-binding capacity were similar in both groups. By contrast, changes in total body iron were different (Figure 2): the children in Group A, with initially low deposits, increased their levels from the beginning of the treatment, while those in Group B, with initially normal or high reserves, did not increase. After 60 days, total body iron was similar in both groups ( $281 \pm 120$  and  $259 \pm 74$  mg Fe/ $m^2 \cdot CHI$  in A and B, respectively). Insofar as circulating iron increased in a parallel form in both groups, the difference in the change in total body

\* Viteri, F. E., J. Alvarado, D. G. Luthringer and R. P. Wood II. *Vitamins & Hormones*, 26: 573-615, 1968.



**FIGURE 2** *Changes in circulating and total body iron during nutritional recovery. Values are calculated corrected for lean body mass ( $m^2$  of body surface  $\times$  creatinine-height index).*

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iron could have been due to the incorporation of absorbed iron into hemoglobin by Group B, with little or no incorporation into storage iron; or to a redistribution of total body iron, with an increase in circulating iron (hemoglobin), partially at the expense of iron reserves. In any event, these data suggest that the quantity and adequacy of the stores of iron at the beginning of the nutritional treatment, in relation to lean body mass, play an important role in the regulation of intestinal absorption of iron in malnourished children.

#### PROJECT 4

##### VALIDATION OF A SIMPLE ANALYTICAL INSTRUMENT WITH A RAPID RESPONSE TIME FOR THE CLINICAL EVALUATION OF CARBOHYDRATE ABSORPTION USING THE HYDROGEN BREATH-ANALYSIS TEST

*N. W. Solomons, T. Christman\* and L. Hamilton\**

In studies conducted in the Division of Human Biology and Nutrition since 1975, we have used hydrogen ( $H_2$ ) breath-analysis tests as an index of carbohydrate absorption. The tests are based on the principle

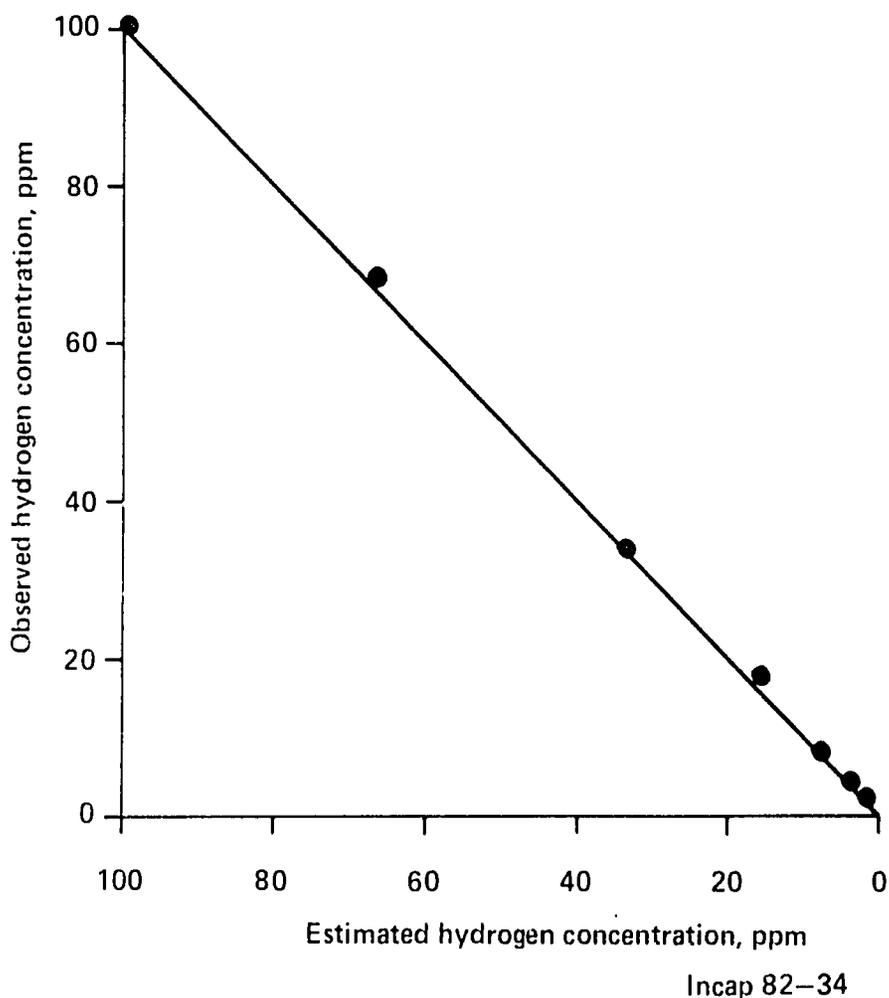


FIGURE 3 *Comparison of the instrumental measurements of hydrogen concentration with the calculated (predicted) concentrations of injected samples of gas.*

\* Scientist, Department of Physiology, Medical School of Wisconsin, Milwaukee, WI, U.S.A.

that carbohydrates not completely absorbed in the small intestine will arrive in the large intestine where bacterial enzymes will ferment them with the liberation of H<sub>2</sub>; a portion of this gas is absorbed in the colon and excreted in expired air. Thus, the increase in amount of H<sub>2</sub> expired after ingesting a carbohydrate is proportional to the quantity of substrate not absorbed. As noted in previous years, this Division has contributed to the understanding of the application of this technology in children, in field studies, and with physiological doses of food carbohydrates. It has been applied primarily to the diagnosis of lactose malabsorption.

Various analytical instruments have been utilized at INCAP, including the Varian Aerograph system with helium ionization detector and the Quintron Model S with thermal conductivity detection. Both instruments are complex, requiring analog recorders, long chromatographic columns and compressed gases for the carrier gas. In 1981, we adapted for clinical application a new instrument developed by the Quintron Instruments Co., with various new features in the chromatographic and detection systems. These features include: 1) a detector relatively insensitive to gases other than H<sub>2</sub>; 2) the use of a simple pump which converts room air into the carrier gas; and 3) a digital readout panel which displays the concentration of the H<sub>2</sub> in the sample being analyzed. Moreover, the instrument is lightweight and compact, weighing only 4.5 kg.

The response to various dilutions of H<sub>2</sub> gas was linear, as shown in Figure 3. There was a good correlation between the digital display and the peak heights on the analog recorder for various concentrations of H<sub>2</sub>. The time from the injection of the sample until the moment when the peak registered was 17 to 20 seconds, so that more than 30 samples of a volume of 20 ml could be analyzed per hour. The instrument showed a good correlation with the results obtained using a conventional chromatograph for H<sub>2</sub> detection (Carle Model 101).

The installation of this apparatus in the laboratory of the Division has permitted us to expand our capacity to develop clinical investigations on the absorption of carbohydrates using the approach of measuring the excretion of breath H<sub>2</sub>.

## PROJECT 5

### STUDIES ON THE REGULATION OF INTESTINAL ZINC ABSORPTION

*N. W. Solomons, O. Pineda and D. B. Milne \**

The regulation of iron absorption is a well-studied phenomenon: when an organism is deficient in iron, the intestine permits a greater uptake of the mineral into the body, the opposite of what occurs when the total body reserves of iron are adequate or excessive. The experiments conducted in various laboratories suggest that there exists a similar homeostatic control in diverse mammals. In one human study\*\* , it was shown that the maximum increase in plasma zinc after ingesting 50 mg of the mineral was increased by about 50% after switching 7 subjects from a conventional, mixed diet to a vegetarian regimen rich in fiber and phytic acid for 3 weeks.

We decided to examine in humans the other aspect of this homeostatic control of zinc absorption, namely, whether high intakes of zinc depress the absorption of pharmacologic doses of the mineral. For this purpose, 6 women and 2 men received 100 mg of zinc as zinc gluconate daily for 28 days. They ingested 50 mg of zinc 30 min before breakfast and the other 50 mg before bedtime. A modified zinc absorption test was performed on the day before and on the day following the supplementation period. For this, 50 mg of zinc (as 110 mg of zinc gluconate) were administered to the fasting subject in an aqueous solution. Samples of plasma were taken at zero time (basal) and at 1.5 and 3 hr thereafter. The concentration of plasma zinc was determined by atomic absorption spectrophotometry.

\* Scientist of the USDA Grand Forks Human Nutrition Research Laboratory, Grand Forks, ND.

\*\* Freeland-Graves, J. H., M. L. Ebangit and P. J. Hendrikson: *Am. J. Clin. Nutr.*, 33: 1757, 1980.

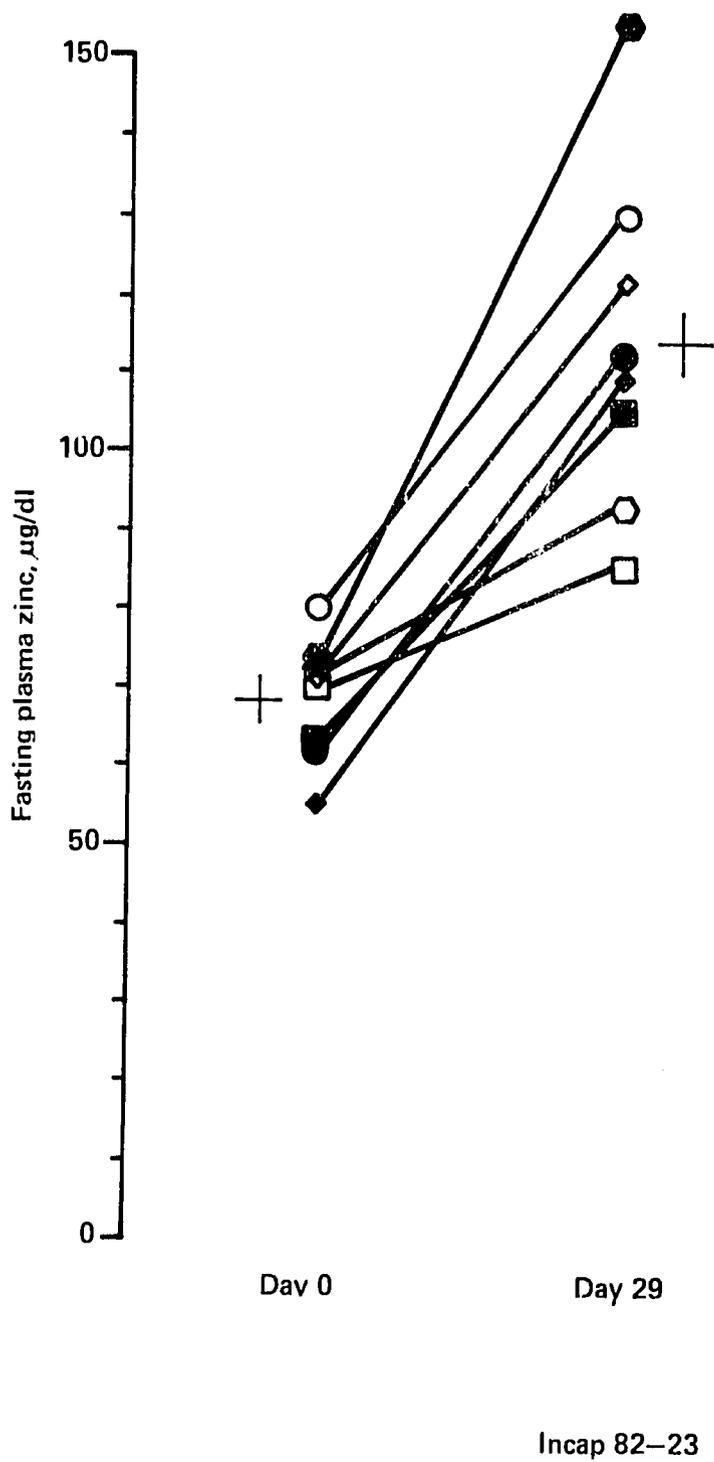


FIGURE 4 Plasma zinc concentration before and after 28 days of zinc supplementation.

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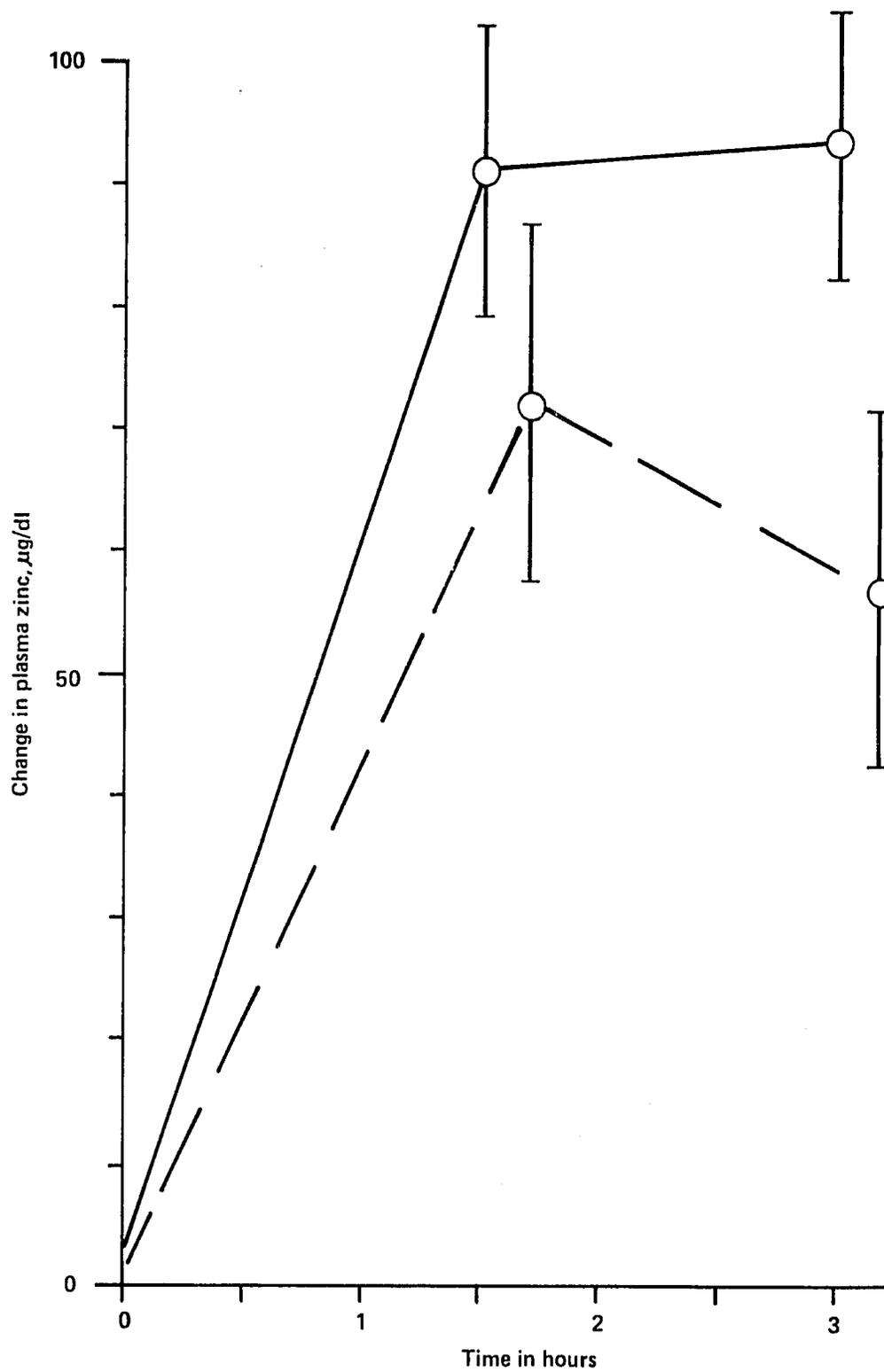
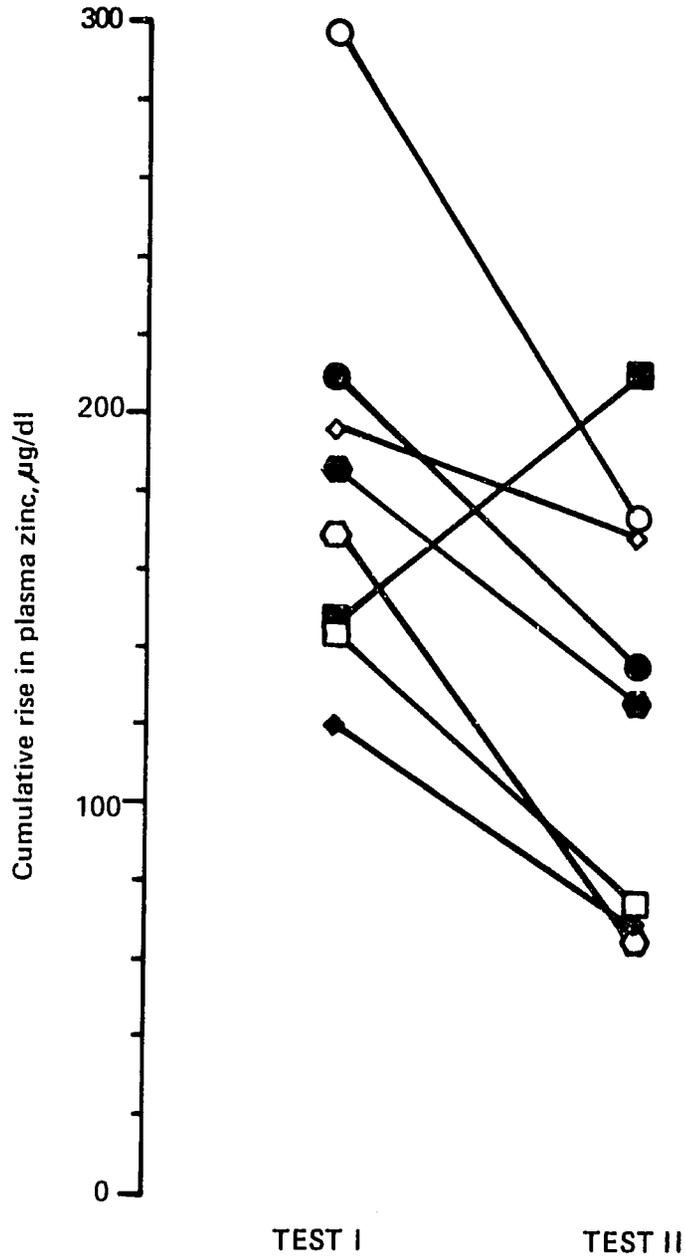


FIGURE 5 *Change in plasma zinc concentration after ingestion of 25 mg of zinc on day 0 (solid line) and day 29 (dashed line) of the study.*

Three people initially had zinc concentrations below  $70 \mu\text{g/dl}$ , which is the lower limit of the range of normal concentration. Figure 4 shows the fasting zinc concentrations before and after a period of supplementation. All of the participants showed an increase in basal plasma zinc levels, with the mean rising from  $68 \pm 8$  to  $118 \pm 23 \mu\text{g/dl}$  (mean  $\pm$  SEM), ( $P < 0.001$ , paired "t" test). Figure 5 shows the mean increment in plasma zinc after the ingestion of 25 mg of oral zinc on day 0 and day 29 of the study. The increase in plasma zinc at 1.5 hr was  $91 \pm 12 \mu\text{g/dl}$  (before) and  $72 \pm 14 \mu\text{g/dl}$  (after) supplementation. The corresponding values for the 3-hr interval were  $93 \pm 11$  and  $56 \pm 9 \mu\text{g/dl}$ , before and after supplementation, respectively. The sum of increments in plasma zinc at both post-dose sampling intervals was  $184 \pm 19 \mu\text{g/dl}$  before and  $128 \pm 19 \mu\text{g/dl}$  after. Seven of 8 individuals showed a reduction in the sum of the plasma zinc increments after 28 days of supplementation (Figure 6). The differences in the sum of the rises in plasma zinc between the initial and final test were significant ( $P < 0.05$ , paired "t" test).

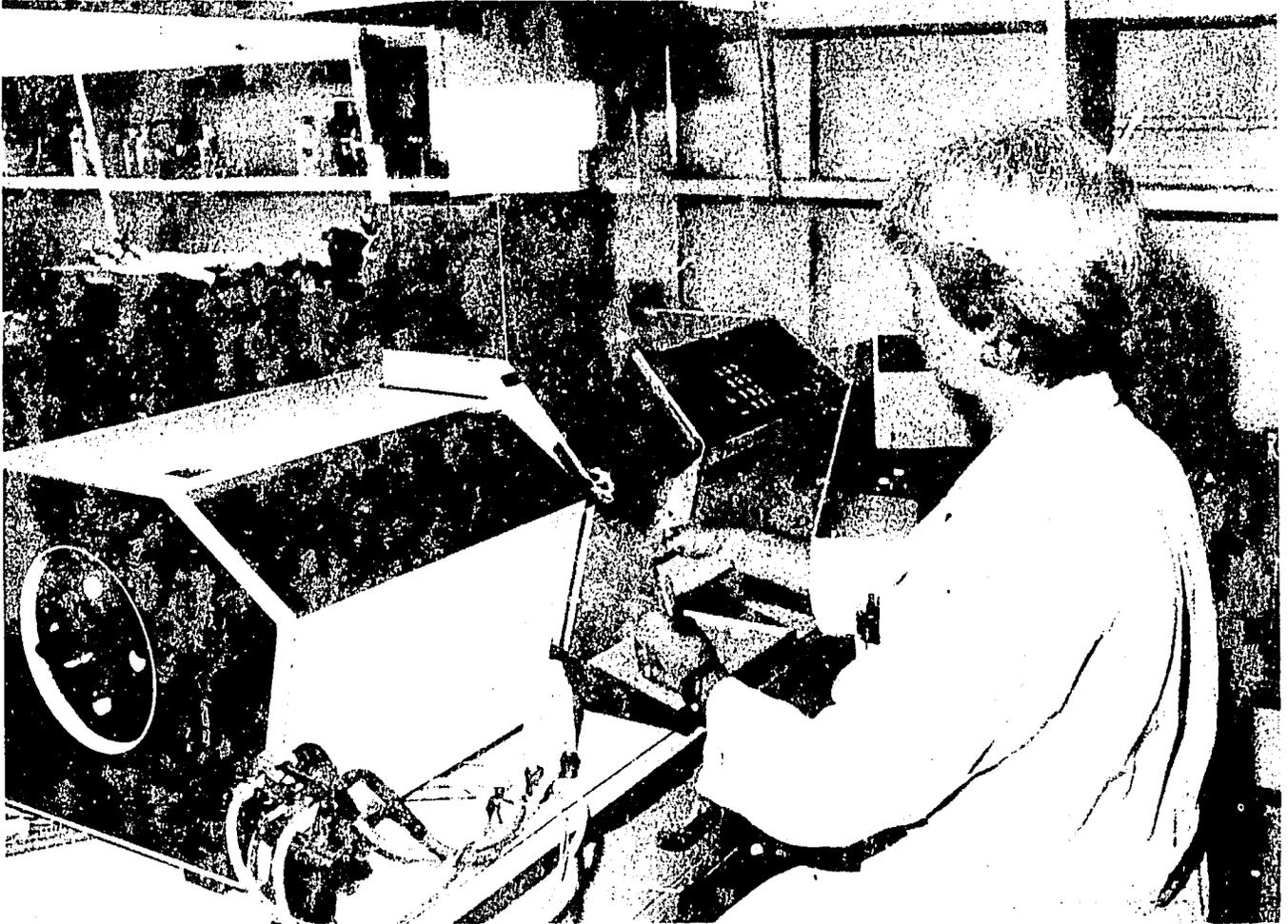
These studies suggest that increasing zinc stores through dietary zinc supplementation reduces the efficiency of zinc absorption in humans. It also suggests that the absorption of pharmacological doses of zinc is regulated physiologically by the intestine.



Incap 82-22

FIGURE 6 Sum of the increments in plasma zinc concentration at 1-1/2 and 3 hours after ingestion of 25 mg of zinc, before and after 28 days of zinc supplementation.

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**Atomic absorption spectrophotometry is used to determine the nutritional status of trace elements**

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**SUBPROGRAM B**

**BIOLOGICAL AND ENVIRONMENTAL  
FACTORS WITH IMPACT ON NUTRITION**

**PROJECT 1**

**INTESTINAL IMMUNIZATION AND IMMUNE RESPONSE IN HUMAN MILK**

*J. R. Cruz and L. A. Hanson\**

Specific antibodies which are present in human milk are produced in response to antigenic challenges at the intestinal level. Women from rural areas of Guatemala who suffer from chronic undernutrition and urban mothers produce comparable amounts of milk secretory IgA during 24-hr periods. The levels of specific antibodies against microbial and food products differ, however, between the two population groups. This could be due to either differences in exposure to microorganisms or in ability of the women to produce specific antibodies which are excreted through milk. The objective of this Project is to determine if mothers from Guatemalan rural areas can produce and secrete, through milk, adequate levels of specific antibodies in response to antigenic challenge to the intestinal mucosa with food protein isolates.

Eleven women from Santa María Cauqué received 2 g of a protein isolate from *Vigna sinensis* (cowpea) during 5 consecutive days, starting on the 5th day postpartum. Milk specimens were obtained before and during the time of immunization, and on days 7, 14, 21 and 28. Samples from six women were analyzed by ELISA. One woman had high antibody levels against cowpea at the beginning of the study; four of the five negative subjects showed an increase in specific anticowpea antibodies 1-2 weeks postimmunization.

The samples from the other subjects are currently being analyzed. In future studies, including a larger number of women, the immune response of rural women will be compared to that of well-nourished mothers from urban areas.

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\* Chief of the Department of Clinical Immunology, University of Gothenburg, Sweden.

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## PROJECT 2

EFFECT OF OPSONIN REPLACEMENT IN THE TREATMENT OF SEVERE  
PROTEIN MALNUTRITION

*B. Torún, G. T. Keusch\*, S. Flores-Huerta\*\* and J. R. Cruz*

Infections that would not be of clinical importance in well-nourished children are more severe in subjects with protein-energy malnutrition (PEM); complications arising from infections are the main contributing factor to death shortly after hospitalization of malnourished patients. This is due to the alterations in immune mechanisms that accompany PEM; some of the immune deficiencies disappear with nutritional rehabilitation. Accelerating the recovery of immune mechanisms would be advantageous for malnourished patients, reducing mortality among them.

As stated in previous Annual Reports (1979 and 1980), we studied the effect of transfusions of either gamma-globulin or fresh frozen plasma on some immune mechanisms. The indicators to be evaluated were the serum opsonic capacity, and complement levels in samples taken during the first 28 days after treatment. Opsonization facilitates phagocytosis of bacteria and complement collaborates in their lysis by specific antibodies. Additionally, the effects of either of the two treatments on circulating levels of IgA, IgM, IgG, transferrin, C-reactive protein, alpha-1-acid glycoprotein and alpha-2-macroglobulin were studied.

The results obtained last year suggested that administration of fresh frozen plasma increases complement activity in the serum of undernourished children. The effect, however, was not as dramatic as expected; it is thought that increasing the dose of transfused plasma would induce a better response. Accordingly, in 1981 a new protocol was established: each malnourished child received, during the first 3 days of hospitalization, daily transfusions of either fresh frozen plasma (10 mg/kg body weight) or plasmatic proteins without complement activity in the same dosis as for fresh frozen plasma. The analysis of clinical and laboratory data will be completed in 1982.

## PROJECT 3

CHEMOTAXIS OF POLYMORPHONUCLEAR LEUKOCYTES  
DURING PROTEIN-CALORIE MALNUTRITION AND ITS TREATMENT

*S. Flores-Huerta and J. R. Cruz*

The synergistic effect of undernutrition and infections on the health status of individuals and groups of population is well known. The relationship has been explained in the following terms: 1) undernutrition induces immunodepression, and 2) the immunodepressed individual is more susceptible to infectious diseases which, in turn, accentuate the nutritional deficiencies. Several immune parameters have been reported to be deficient in undernourished individuals. The findings on polymorphonuclear leukocytes (PMNL) function are inconsistent.

The objectives of this project were to study: 1) PMNL chemotaxis during the acute phase of protein-calorie malnutrition and its treatment, and 2) the effect on chemotaxis of serial transfusions of fresh frozen plasma (FFP) with complement (C') activity during the first week of hospitalization. Thirteen children 12-30 months old, with kwashiorkor and 15-28% deficit in weight-for-height as corrected for edema were studied. None of the subjects had overt symptoms or signs of infection on admission to INCAP's Clinical

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\* Chief of the Division of Geographic Medicine, Tufts University, Boston, Massachusetts, U.S.A. Associate Investigator of INCAP since 1974.

\*\* INCAP/UNU fellow.

Center. Starting on the second day of hospitalization, and during three consecutive days, 8 children received 3 transfusions of FFP (10 ml/kg of body weight) and 5 received an isotonic IV solution of plasma proteins (Plasmanate<sup>R</sup>, Cutter) in the same doses and with the same protein concentration as FFP. The nutritional treatment was identical for children in both groups.

Using the under-agarose method and comparing the results of the 13 patients with 2 normal adults, we found that PMNL chemotaxis in malnourished children is similar to that of healthy controls. The plasma of malnourished children, however, seems to be deficient in chemoattractants for normal PMNL (Table 1). There were no differences between the two experimental groups (Table 2). The great variability of the data did not allow us to make comparisons for determining the effect of either nutritional treatment or FFP.

All the children included in this study also participated in the project on opsonin replacement in severe malnutrition (see preceding Project). We will study if PMNL chemotaxis is in any way correlated with the immune parameters measured in the opsonin project.

TABLE 1  
CHEMOTACTIC INDEXES (CI) OF LEUKOCYTES FROM  
UNDERNOURISHED CHILDREN AND HEALTHY ADULTS (CONTROLS)

Leukocytes: Plasma:	Tests			
	$\frac{C^*}{C}$	$\frac{P}{P}$	$\frac{P}{C}$	$\frac{C}{P}$
CI (mean $\pm$ S.D.) (n = 13)	187 $\pm$ 49**	157 $\pm$ 67	153 $\pm$ 60	144 $\pm$ 41**

\* C = normal controls; P = undernourished patients.

\*\* Mean values differ,  $p < 0.05$ .

TABLE 2  
CHEMOTAXIS INDEXES (MEAN  $\pm$  S.D.) OF PMNL FROM MALNOURISHED CHILDREN  
AFTER THREE TRANSFUSIONS OF FRESH FROZEN PLASMA OR PLASMANATE

Group	Days after admission				
	0	4	7	21	35
<i>FFP</i>					
C/C*	211 $\pm$ 93	154 $\pm$ 24	184 $\pm$ 46	169 $\pm$ 47	152 $\pm$ 30
P/P	184 $\pm$ 72	168 $\pm$ 51	174 $\pm$ 48	152 $\pm$ 37	154 $\pm$ 56
P/C	171 $\pm$ 67	173 $\pm$ 87	215 $\pm$ 111	154 $\pm$ 18	161 $\pm$ 59
C/P	161 $\pm$ 35	166 $\pm$ 48	173 $\pm$ 37	174 $\pm$ 52	180 $\pm$ 118
<i>Plasmanate</i>					
C/C	149 $\pm$ 34	175 $\pm$ 55	134 $\pm$ 18	166 $\pm$ 37	149 $\pm$ 45
P/P	113 $\pm$ 19	171 $\pm$ 70	157 $\pm$ 77	161 $\pm$ 30	154 $\pm$ 34
P/C	123 $\pm$ 26	188 $\pm$ 76	119 $\pm$ 22	152 $\pm$ 15	136 $\pm$ 31
C/P	116 $\pm$ 36	145 $\pm$ 48	145 $\pm$ 45	161 $\pm$ 90	140 $\pm$ 48

\* Leukocytes/plasma; C = normal controls; P = undernourished patients.

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## PROJECT 4

### REFERENCE LABORATORY FOR THE DIAGNOSIS OF ROTAVIRUS INFECTIONS BY MEANS OF THE ELISA

*J. R. Cruz*

As stated in the 1980 Annual Report, the objectives of this project are, in addition to being a reference center for quality control of 20 Latin American laboratories, to train personnel and to distribute the reagents needed for the enzyme-linked immunosorbent assay to diagnose rotaviral infections.

During 1981 we trained five individuals on laboratory aspects and epidemiology, virology, pathology and diagnosis of rotavirus infections. Two professionals came from Colombia, one from Brazil and two from Guatemala.

Due to problems associated with the production of some of the specific reagents, and following instructions from the WHO/PAHO Program, the materials were no longer distributed to the 20 Latin American laboratories and the quality control system was stopped.

## PROJECT 5

### COLLABORATIVE STUDY ON BREASTFEEDING. CROSS-SECTIONAL STUDY ON VOLUME AND QUALITY

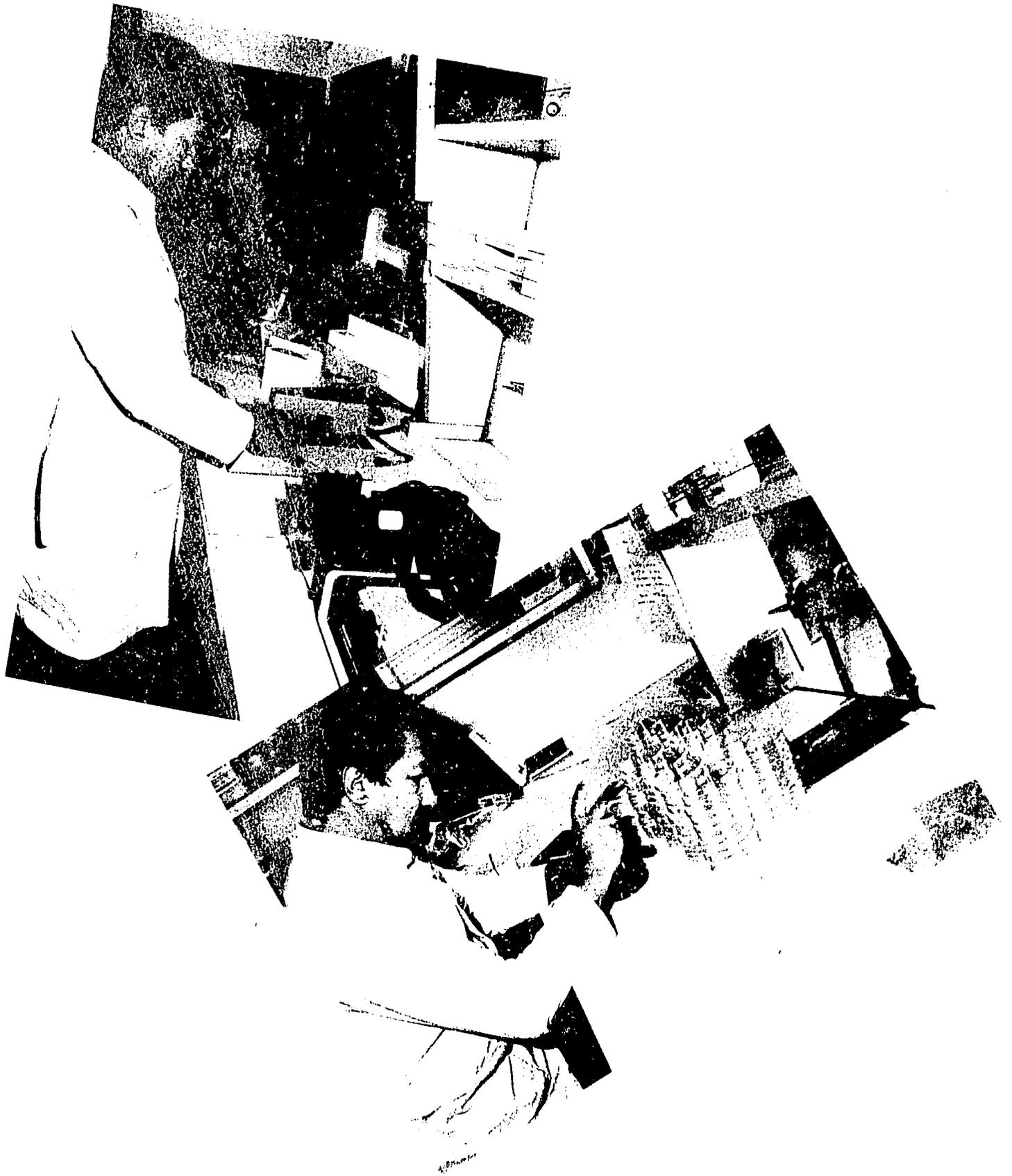
*J. J. Urrutia, O. Pineda and B. García*

The objectives of this study are to determine:

1. Breastfeeding practices and habits in several countries of the world (Hungary, Sweden, Philippines, Zaire, Nigeria and Guatemala).
2. Volume of milk produced by women (through consumption by their children) from three different socioeconomic levels and at different feeding periods. The socioeconomic levels studied were: rural, urban poor and urban privileged.
3. Proximal composition of this milk, in order to compare the results obtained in each of the above-mentioned countries, in terms of volume of milk produced, nutrient concentration and adequacy to fill the child's demands for adequate growth.
4. Levels of contamination with persistent organo-chlorinated pesticides, in order to determine pollution levels and conditions in various countries with different agricultural practices.
5. Concentrations of trace elements and heavy elements. This part of the study includes analyses of different degrees of sophistication, such as atomic absorption, X-ray fluorescence and neutrons activation.

The studies on volume, proximal composition and contamination by pesticides have been completed and will be published in a monograph by the World Health Organization, at the end of 1982.

The studies concerning trace and heavy metals are in process. It is hoped that the information on zinc, iron, copper, lead, calcium and magnesium will be complete at the end of 1982.



Methods of immunological and microbiological research facilitate the evaluation of the inter-relationship between nutrition and the immune system of children and adults

## PROJECT 6

### NUTRITIONAL STATUS, AGE AT MENARCHE AND AGE AT MARRIAGE

*H. L. Delgado, E. Hurtado, V. Valverde and R. E. Klein*

Several lines of evidence suggest that nutrition may be an important determinant of age at menarche and age at marriage :

1. It has been reported that during war famines, menarche is delayed from one to three years.
2. A downward trend has been observed in the age of menarche in European girls in the last 100 years. Recently, it has been reported that this secular trend has disappeared in developed countries, possibly because of the leveling off of nutritional improvement.
3. Observational studies have shown an earlier menarche in high socioeconomic groups than in low socioeconomic groups.
4. Earlier menarche has been reported in developed countries than in developing countries.
5. In addition to the implications in previous studies, the possibility that nutrition is related to age at menarche is given support by studies on the association of physical growth and age at menarche.
6. The potential effect of nutrition on marriage has received virtually no attention. It has been suggested that nutrition could affect age at marriage. If nutrition affects menarche and menarche affects age at first marriage (as is the case in some traditional societies), then the nutritional status of a woman would influence her age at marriage through variations in age at menarche.

The existence of an association between nutritional status of women and the age at menarche and age at marriage could have important public health implications because of the increased risks of pregnancies occurring during adolescence.

In this project, we analyze the interrelationship between nutritional status, age at menarche and age at marriage in women 10 to 20 years of age living in coffee plantations in Guatemala. Data on menarchial status is based on both cross-sectional reporting of whether the woman had begun menstruating by the time of the interview and retrospective information on when menses first began in those who had reached menarche. The mean age at menarche is 15 years, and anthropometric measurements of the woman are the most important factors associated with age of onset of menarche. In addition, interactions between age at menarche and age at marriage have been found. More analyses of these data are being performed.

**SUBPROGRAM C**

**DIETARY PRACTICES AND CONDITIONING  
FACTORS**

**PROJECT 1**

**USE OF TRADITIONAL CENTRAL AMERICAN FOODS TO SATISFY  
THE PROTEIN-ENERGY NEEDS AND RECOVERY OF CHILDREN  
WITH MILD-TO-MODERATE MALNUTRITION**

*B. Torún, B. Caballero\* and S. Flores-Huerta\**

In October, 1977 a Meeting of Experts on Energy Intake and Protein Requirements was organized by FAO/WHO to determine if the present recommendations of protein and energy intakes were valid for developing countries, and if the customary diets in these countries were adequate to satisfy the physiologic need for those nutrients. It was considered that the low energy density and the large volume of the diets might be limiting factors, especially for the fulfillment of the energy needs of preschool children. These limitations, in turn, might affect the satisfaction of protein needs, in view of the metabolic interaction between dietary energy and proteins. Therefore, it was considered important to study if the customary protein intake would be sufficient for preschool children who eat the traditional foods of their country and whose dietary energy intake satisfies their energy requirements.

Studies carried out in previous years\*\* demonstrated that a diet based on the traditional foods consumed in homes of low socioeconomic status in Central America can satisfy the protein-energy needs of well-nourished preschool children, provided: 1) there are sufficient staple foods (beans, corn, bread) to satisfy the children's appetite; b) the energy density of the diets is increased by adding oil to the bean preparations and sugar to beverages; c) diets are prepared and administered to the children in the same way as it is done for adults in the family; d) an adult or an older child stimulates and, if necessary, helps the preschool child to eat three times a day; e) other nutrients, such as vitamins and minerals, are not a limiting factor in the diet; and f) the child lives in a sanitary environment with relatively low infectious morbidity.

In view that a high proportion of children of low socioeconomic status are mildly or moderately malnourished, as shown by their weight-for-height, it was decided to prove the hypothesis that the diets under

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\* INCAP/UNU fellow.

\*\* INCAP, *Annual Report*, 1980, p. 77-84.

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investigation would allow their nutritional recovery, even without supplementing them with pharmacological preparations of vitamins and minerals, but complying with the other conditions outlined in the preceding paragraph. Thus, a study was carried out following an experimental design similar to the one described in the First Phase of these investigations with well-nourished children (*Annual Report*, 1980), this time with the participation of children apparently healthy but with a deficit of 5 to 15% in the weight expected for their height.

Each child was studied at INCAP's Clinical Center for a period of 11-16 weeks. The first two weeks were considered as "adaptation" to the new environment and to the experimental diet, and the 9-14 following weeks were considered as the period of research. The experimental design followed in the First Phase of these investigations (*Annual Report*, 1980) was modified as follows:

1. *Children's nutritional status.* Chronically "adapted" to dietary intakes that kept them with a deficit of 5-18% in weight expected for height. The participants were 9 boys and 4 girls 15 to 40 months of age, who had been fed in public nurseries (*guarderías infantiles*) of Guatemala City for at least 4 months and whose weight-for-height had not been modified at least in the 3 months previous to their admission to INCAP. Their characteristics are shown in Table 1. Since 9 children had a deficit in weight-for-height greater than 10%, while 4 had a deficit of 8% or less, and in view of the possibility that nutritional recovery might vary in accordance with the initial deficit, the results were evaluated dividing the children in 2 subgroups, as shown in Table 1.

TABLE 1  
CHILDREN'S CHARACTERISTICS AT THE BEGINNING OF THE STUDY

Age (months)	Age-height (months)	Height (cm)	Weight* (kg)	Weight-for-height** (% of standard)	Hemoglobin (g/dl)	Plasma protein (g/dl)
<i>Subgroup I*** (n = 9)</i>						
25 ± 5	16 ± 3	80.5 ± 3.5	9.51 ± 0.58	86 ± 2	11.9 ± 1.3	7.2 ± 0.4
<i>Subgroup II● (n = 4)</i>						
31 ± 8	17 ± 1	82.0 ± 1.2	10.77 ± 0.64	95 ± 4	11.4 ± 1.9	7.0 ± 0.3
<i>All (n = 13)</i>						
27 ± 7	17 ± 3	80.9 ± 3.0	9.88 ± 0.84	89 ± 5	11.7 ± 1.4	7.1 ± 0.4

\* Average weight of each child during the first 7 days.

\*\* 100% of standard = 50th percentile of Boston standards.

\*\*\* Initial weight-for-height < 90% of standard.

● Initial weight-for-height ≥ 92% of standard.

2. *Diets.* These were based on the proportions of foods frequently ingested by children from poor Guatemalan homes, as in the previous year but with the following modifications: a) energy density was modified in the same manner for all the children, adding 27.4 g vegetable oil to each 100 g black bean flour to prepare 500 g cooked beans, ready for eating (that is, 5.5% fat), 10 g sugar were added to each 100 ml milk and 20 g sugar to each 100 ml corn *atole* (gruel) or lemonade; b) foods of animal origin were reduced by offering one instead of two eggs per week.

Table 2 shows the menus offered to the children each day of the week. They could eat as much as they wished of all foods, except for bread and those foods of animal origin (milk, meat, egg), which were limited to the amounts described in Table 2.

3. *Vitamin and mineral supplements:* Instead of administering pharmacological preparations, sugar fortified with vitamin A and NaFeEDTA (1.5 mg retinol and 13 mg Fe/100 g sugar) and iodized salt (1:20,000) were used in the food preparations.

TABLE 2  
MENUS OFFERED TO THE CHILDREN\*

	Breakfast	Lunch	Dinner
	Corn, beans** and	Corn, beans, 15 g sweet bread and	Corn, beans, 15 g sweet bread and
Monday	1 egg	banana	<i>güisquil</i> ***
Tuesday	potatoes	banana	potatoes
Wednesday	<i>güisquil</i>	40 g meat	banana
Thursday	squash	potatoes	potatoes
Friday	rice	squash	squash
Saturday	rice	banana	rice
Sunday	squash	<i>güisquil</i>	rice

Snack (3 p.m.)

15 g sweet bread and 200 ml lemonade (Tuesday, Thursday, Friday, Sunday)  
or 100 ml milk (Monday, Wednesday, Saturday)

\* All foods offered in quantities *ad libitum*, except bread, egg, meat, milk and lemonade.

\*\* Corn gruel (*atole*), small corn tamales and black bean (*Phaseolus vulgaris*) puree.

\*\*\* *Güisquil* = *chayote* = *Sechium edule*.

4. *Metabolic studies:* Total urinary and fecal excreta were collected each day, except in the case of the youngest child, from whom urinary and fecal excretion was obtained every fourth day, due to technical difficulties for daily collections.

## Results

The children were healthy most of the time, but 10 of them had a total of 17 infectious episodes, which varied in importance and severity from impetigo without systemic manifestations, to shigellosis with profuse diarrhea and high fever. These episodes lasted from 2 to 16 days, with an average of 8 days. Metabolic results and growth of children were analyzed separately for the days (or weeks) when they were healthy or ill.

*Dietary intake:* Intake of solid foods is a better reflection of appetite than liquid intake, since the latter is influenced by appetite as well as thirst. Intakes were calculated weekly and expressed as g of solid or liquid foods/kg body weight/day. Total intakes were  $41.7 \pm 7.5$  g solids/kg/day, and  $83.7 \pm 13.2$  g liquids/kg/day. Table 3 shows that during the periods of illness there was a tendency to diminish the intake of solid foods and dietary energy. The reduction of solid food intake when children reached 92% of weight-for-height suggests a decrease in appetite as they were approaching a normal weight-for-height.

Net energy intake was calculated by bomb calorimetry, subtracting fecal energy from dietary energy. The mean was  $98.3 \pm 4.3$  kcal/kg/day. Carbohydrates provided 76.5% of dietary energy, proteins 7.8%, and fat 15.7%. The sugar used in the preparation of foods and beverages provided around 40% of the dietary energy, which is approximately twice the dietary energy derived from sugar in the habitual diets of children in the Guatemalan rural area.

Energy intake was higher during the initial stages of recovery, while the children's weight-for-height was below 92%. Energy intake of 5 healthy children whose weight-for-height had become normal and stable during the last two weeks of the study, and whose growth continued at the rate expected for normal

TABLE 3  
DAILY FOOD INTAKE CALCULATED ON A WEEKLY BASIS  
(Mean  $\pm$  standard deviation)

	While weight-for-height was $< 92\%$ of standard		After reaching $92\%$ of weight-for-height	
	Healthy	Ill	Healthy	Ill
	(n = 49 child-weeks)	(n = 8 child-weeks)	(n = 92 child-weeks)	(n = 8 child-weeks)
Solids (g/kg/day)	44.4 $\pm$ 8.7*	39.7 $\pm$ 8.7	41.3 $\pm$ 6.1*	37.2 $\pm$ 6.0
Liquids (g/kg/day)	84.1 $\pm$ 11.1	79.9 $\pm$ 14.0	85.5 $\pm$ 13.5	85.7 $\pm$ 19.5
Protein (g/kg/day)	2.1 $\pm$ 0.3**	1.9 $\pm$ 0.4	1.9 $\pm$ 0.3**	1.8 $\pm$ 0.2
Energy (kcal/kg/day)***	103.2 $\pm$ 10.4**,**	94.2 $\pm$ 11.2*	96.6 $\pm$ 8.3**	91.2 $\pm$ 6.2

\* Groups differ,  $P < 0.05$ .

\*\* Groups differ,  $P < 0.01$ .

\*\*\* Net energy = dietary energy (bomb calorimetry) — fecal energy (bomb calorimetry).

children of that age and height, was  $90.5 \pm 5.5$  kcal/kg/day. This figure is slightly higher than the net intake of  $84.6 \pm 4.7$  kcal/kg/day observed in well-nourished children who participated in the First Phase of these investigations.

Average protein intake was  $1.99 \pm 0.51$  g/kg/day, and it showed the same tendencies of change as solid food intake (Table 3). Seventy percent of the protein came from black bean and corn, 17% from other vegetable foods and 13% from animal foods. The ratio of bean protein:corn protein was  $53.47 \pm 2$ , which coincides with an optimal amino acid complementation.

*Growth and recovery:* Anthropometric changes and their rates are shown in Tables 4 and 5. Growth rates were good, with increments in both muscle mass and subcutaneous fat tissues. Weight gain was faster than expected for well-nourished children of the same height (around 0.6 g/kg/day). Consequently, 12 children improved in weight-for-height and 9 in weight-for-age. The only child who did not show changes in weight-for-height was the one who lost much weight during an episode of shigellosis that lasted 9 days, with high fever and profuse diarrhea; at the end of the study, this child's weight-for-height was  $92\%$ , the same as when he was admitted to INCAP.

Height increase was slightly less than expected for children of these sizes ( $0.30 - 0.33$  mm/day). Five children increased in height-for-age by 1 or  $2\%$ , 4 continued growing at the same rate as when the study began, and 4 did not grow in height, which resulted in a reduction of 1 or  $2\%$  in height-for-age by the end of the study. This could be due to the fact that growth in height is usually by steps and not continuous.

Recovery in weight-for-height was adequate (Table 4) and at the end of the study the subgroup of children who were admitted with a weight-for-height below  $90\%$  of the standard did not differ from the subgroup that was admitted with a weight-for-height  $\geq 92\%$ . All children reached a weight-for-height of at least  $92\%$ , except for a child who was admitted with  $82\%$  of weight-for-height; at the end of the study, he had reached  $88\%$  and was still in a phase of catch-up growth.

*Absorption of nutrients:* Apparent absorption of dietary energy was  $91.3 \pm 1.7\%$ . Apparent digestibility of dietary protein was  $66 \pm 7\%$ , and "true" digestibility (corrected for obligatory losses of fecal nitrogen) was  $74 \pm 7\%$ .

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TABLE 4

INITIAL AND FINAL ANTHROPOMETRIC MEASUREMENTS OF CHILDREN ADMITTED TO THE STUDY  
WITH MORE OR LESS THAN 92% OF WEIGHT EXPECTED FOR THEIR HEIGHTS

	Weight-for-height <92% on admission (n = 9)		Weight-for height ≥92% on admission (n = 4)		All children (n = 13)	
	Initial	Final	Initial	Final	Initial	Final
Weight (kg) <sup>b</sup>	9.49 ± 0.58 <sup>c*</sup>	10.72 ± 0.72	10.77 ± 0.64*	11.46 ± 1.11	9.88 ± 0.84	10.95 ± 0.88
Height (mm)	805 ± 35	828 ± 38	820 ± 12	835 ± 27	810 ± 30	830 ± 34
Weight-for-height (%) <sup>a</sup>	86 ± 2*	94 ± 3	95 ± 4*	98 ± 5	89 ± 5	95 ± 1
Lean arm diameter (mm) <sup>d</sup>	36.9 ± 2.6	36.9 ± 1.2	36.5 ± 1.7	37.8 ± 1.3	36.8 ± 2.3	37.2 ± 1.2
Leg circum- ference (mm)	166 ± 7	177 ± 7	174 ± 3	182 ± 9	168 ± 7	178 ± 8
Subcutaneous skinfold thicknesses (mm) <sup>e</sup>	16.4 ± 1.5	22.9 ± 2.8	20.2 ± 6	22.6 ± 5.8	17.6 ± 3.6	22.9 ± 3.7

<sup>a</sup> Weight expected for height: 100% = 50th percentile of Boston standards.

<sup>b</sup> Using average weight of each child during the first and last weeks of the study.

<sup>c</sup> Mean ± standard deviation.

<sup>d</sup> Corrected for subcutaneous skinfold thickness.

<sup>e</sup> Sum of 3 sites: tricipital, subscapular, and paraumbilical.

\* Children admitted with more or less than 92% of weight-for-height had different initial measurements,  $P < 0.01$ . All final measurements were greater than the initial ones,  $P < 0.01$ , except for lean arm diameter.

TABLE 5  
 RATES OF CHANGE (GROWTH) OF ANTHROPOMETRIC MEASUREMENTS  
 OF CHILDREN ADMITTED TO THE STUDY WITH MORE OR LESS THAN 92%  
 OF THE WEIGHT EXPECTED FOR THEIR HEIGHT<sup>a, b</sup>

	Weight-for-height < 92% (n = 9)	Weight-for-height ≥ 92% (n = 4)	All children (n = 13)
Weight (g/day)	14.8 ± 4.1 <sup>b</sup>	10.4 ± 6.5	13.4 ± 5.2
Weight (g/kg/day)	1.45 ± 0.40	0.91 ± 0.57	1.29 ± 0.50
Height (mm/day)	0.28 ± 0.11	0.19 ± 0.15	0.25 ± 0.12
Lean arm diameter (mm/day) <sup>c</sup>	0 ± 0.03	0.02 ± 0.02	0 ± 0.03
Leg circum- ference (mm/day)	0.13 ± 0.05	0.10 ± 0.09	0.12 ± 0.06
Subcutaneous skinfold thicknesses (mm/day) <sup>d</sup>	0.08 ± 0.03*	0.04 ± 0.02*	0.07 ± 0.04

<sup>a</sup> Changes in weight were calculated by regression analysis throughout the study, including the days of illness. Other changes were calculated from the difference between initial and final measurements.

<sup>b</sup> Mean ± standard deviation.

<sup>c</sup> Corrected for subcutaneous skinfold thickness.

<sup>d</sup> Sum of 3 sites: tricipital, subscapular, and paraumbilical.

\* Groups differ,  $P < 0.05$ .

*Nitrogen balance:* All children had a positive cumulative nitrogen balance. Some had a negative balance during some days, particularly when they were ill, due to a decrease in protein intake which sometimes was accompanied by an increase in urinary nitrogen excretion. Nitrogen balances were evaluated in weekly periods, due to the variability of fecal habits (some children did not defecate at all one day and defecated 3 or 4 times on other days). During the 146 child-weeks that were analyzed, "true" nitrogen retention (assuming integumentary nitrogen losses of 8 mg nitrogen/kg/day) was  $94 \pm 37$  mg nitrogen/kg/day. These retentions were lower on the weeks when the children were ill ( $62 \pm 30$  mg nitrogen/kg/day,  $n = 15$ ) than on the weeks when they were healthy ( $98 \pm 36$  mg nitrogen/kg/day,  $n = 131$ ). The proportion of ingested nitrogen excreted through the urine was higher during the days of illness than when the children were healthy ( $40 \pm 17\%$ ,  $n = 112$ ; and  $35 \pm 11\%$ ,  $n = 910$ , respectively — Student's paired "t" test in 8 children = 3.647,  $P < 0.01$ ).

*Energy expenditure:* Total energy expenditure was calculated in 11 children based on measurements of the individual relationship between heart rate and oxygen consumption, and on the child's heart rate during the waking hours, and using estimates of basal metabolism for the periods of rest and sleep. As an average, total energy expenditure was  $66 \pm 7$  kcal/kg/day. These values are very low, which is probably due to an underestimation of the basal energy expenditure and/or to technical problems in measuring the heart rate\*.

\* A revision of the raw data showed that energy expenditure was underestimated by approximately 20% due to calibration errors of the equipment to measure energy expenditure by indirect calorimetry.

*Hematological and biochemical analyses:* Table 6 shows that by the 45th day of the study, hematological and iron nutrition indicators had improved. When the children were admitted to INCAP's Clinical Center, 7 had subnormal blood hemoglobin concentrations, 7 had low serum iron, 10 had low transferrin saturation and 7 had low plasma ferritin. Forty-five days later, only 2 children had subnormal values in any of those indicators, and by the 90th day of the study, only one child had moderately low values of serum iron and transferrin saturation. This improvement was probably due to the intake of sugar fortified with NaFeEDTA (for more details, see INCAP, *Annual Report*, 1980, p. 85-87).

TABLE 6  
HEMATOLOGICAL AND BLOOD CHEMISTRY VALUES DURING THE STUDY  
(Mean  $\pm$  S.D., n = 13)

		Days in the study		
		0	45	90
Packed cell volume	(%)	35.9 $\pm$ 3.0	38.1 $\pm$ 2.0*	38.8 $\pm$ 2.3
Hemoglobin	(g/dl)	11.7 $\pm$ 1.4	12.7 $\pm$ 0.9*	13.1 $\pm$ 0.9*
Plasma proteins	(g/dl)	7.1 $\pm$ 0.3	6.8 $\pm$ 0.6	6.8 $\pm$ 0.2
Vitamin A	( $\mu$ g/dl)	30.5 $\pm$ 8.2	30.6 $\pm$ 8.2	29.6 $\pm$ 6.9
Serum iron	( $\mu$ g/dl)	48.7 $\pm$ 22.6	76.2 $\pm$ 31.7 <sup>a*</sup>	73.5 $\pm$ 25.8 <sup>a</sup>
Iron binding capacity	( $\mu$ g/dl)	365.3 $\pm$ 46.3	279.1 $\pm$ 41.2 <sup>a*</sup>	310.2 $\pm$ 17.8 <sup>a</sup>
Transferrin saturation	(%)	13.3 $\pm$ 6.1	27.2 $\pm$ 10.5*	23.4 $\pm$ 7.3
Serum ferritin	(ng/ml)	11.1 $\pm$ 6.9	18.6 $\pm$ 7.4*	16.3 $\pm$ 4.2

<sup>a</sup> n = 11.

\* Values differ from the previous measurement. Student's paired "t" test,  $p < 0.01$ .

### Conclusions

1. Adequate nutritional recovery and weight increases were achieved with the experimental diet. Only 5 children showed an adequate recovery in height. This could be due to dietary deficiencies, to an experimental period too short to allow a height increase, or to irreversible stunting due to chronic malnutrition from an early age.

2. The occurrence of acute infections did not affect recovery or growth, and the children who were sometimes ill had an overall positive cumulative nitrogen balance during the 9-14 weeks of the study.

3. The results confirm the conclusions reached on the First Phase of these investigations, which was carried out with well-nourished children. These conclusions were:

a) Diets based on the foods traditionally used in low-income homes of Central America can satisfy the energy needs of preschool children, on condition that: i) the energy density of some foods is increased; ii) there are sufficient staple foods available; iii) foods are prepared and offered to the children in the same way as they are prepared and offered to adults in the family; iv) an adult or an older child stimulates or helps the preschool child during mealtimes; and v) the child lives in a sanitary environment.

b) It is not essential to provide foods of animal origin every day of the week.

c) It is not necessary to modify the diet's composition during or after short, acute episodes of infectious diseases, provided foods are available in adequate amounts to satisfy the child's appetite during convalescence.

d) The energy needs of physically active children between 2 and 4 years of age can be satisfied with a net intake of 85-90 kcal/kg/day. An intake of 95-105 kcal/kg/day allows catch-up weight gain and nutritional recovery of children with mild or moderate malnutrition.

4. It is still necessary to demonstrate if these conclusions are valid when children live under poor conditions of sanitation and are prone to a high rate of infectious morbidity.

## PROJECT 2

### EFFECT OF IRON INTAKE ON ZINC ABSORPTION

*N. W. Solomons, B. Torún and R. Batres*

Interest in the fortification of sugar with NaFeEDTA originally led to the exploration of possible interactions between iron and zinc in the human intestine. The result of studies based on changes in plasma zinc as an index of the absorption of this nutrient, using diverse forms of organic and inorganic zinc and iron, have been previously discussed\*. In 1981, we undertook additional investigations regarding: 1) the regulation of the interaction iron/zinc in relation to iron nutriture; and 2) the interaction of iron and zinc in preschool children.

#### *Effects of the nutritional status of iron on the iron/zinc interaction in the human intestine*

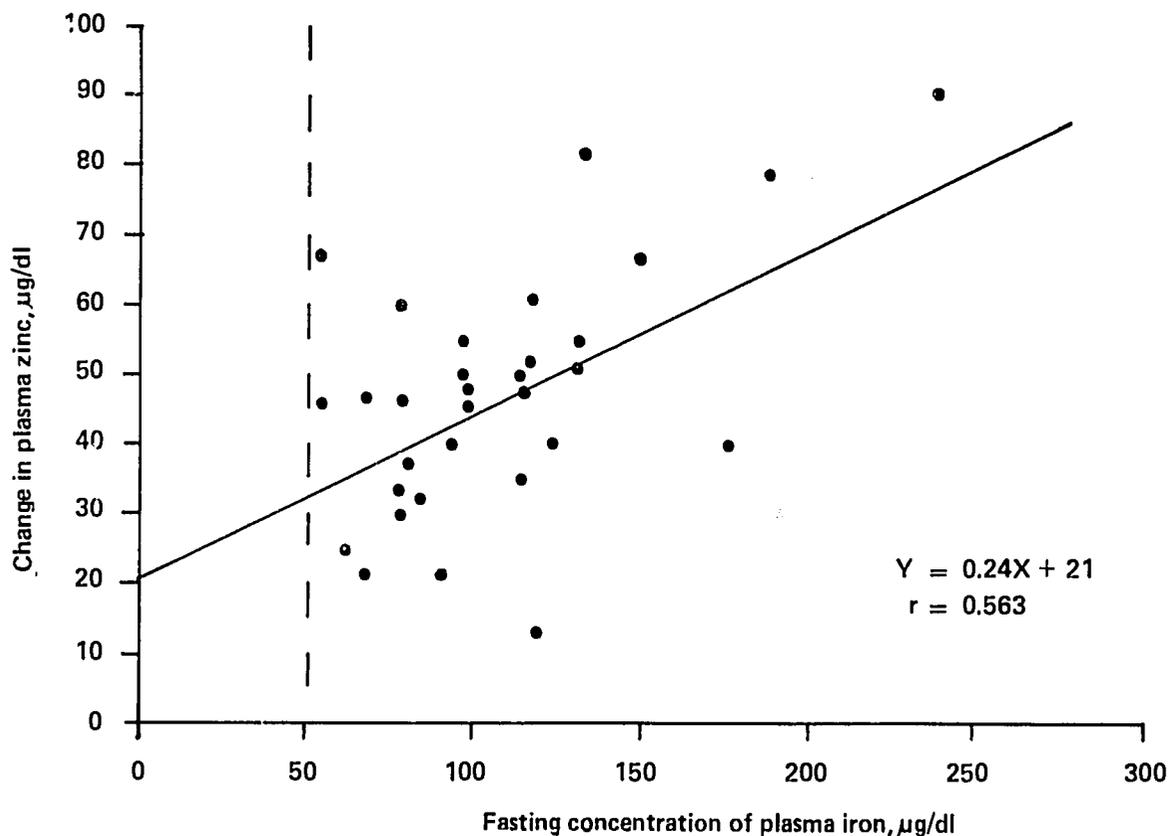
Studies of zinc absorption were conducted in 34 adult women to determine whether iron nutriture could influence iron/zinc interaction, and determine whether the anatomical site of the interaction of iron with zinc in the mucosal cell was proximal or distal to the site at which the homeostatic regulation of iron takes place. The participants were in both the childbearing and postmenopausal ages, so that we expected a group with a wide range of iron nutriture. Zinc absorption was measured by using the rise in plasma concentration of this mineral after an oral dose of 25 mg of zinc in 100 ml of Coca-Cola. We also added 50 mg of iron as ferrous sulfate to form a ratio of 2 parts iron to one part zinc. Previous studies in our laboratory have shown that this quantity of iron inhibits the uptake of plasma zinc.

The information up to the moment, corresponding to 31 women, indicates a lack of correlation between the absorption of zinc and the concentration of hemoglobin or the hematocrit. A significant correla-

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\* INCAP, *Annual Report*, 1978, 1979.

tion, however, was found between the absorption of zinc and the fasting plasma iron level (Figure 1). Assuming that a greater concentration of plasma iron represents a better iron nutrition, and hence a lesser tendency to absorb iron, then the results suggest a diminished interaction of iron with zinc in those persons with low iron absorption, and a greater inhibition of zinc absorption in those persons with a high tendency to absorb iron. These observations suggest that the location of the site of iron/zinc interaction is interior to the site at which iron absorption is regulated.



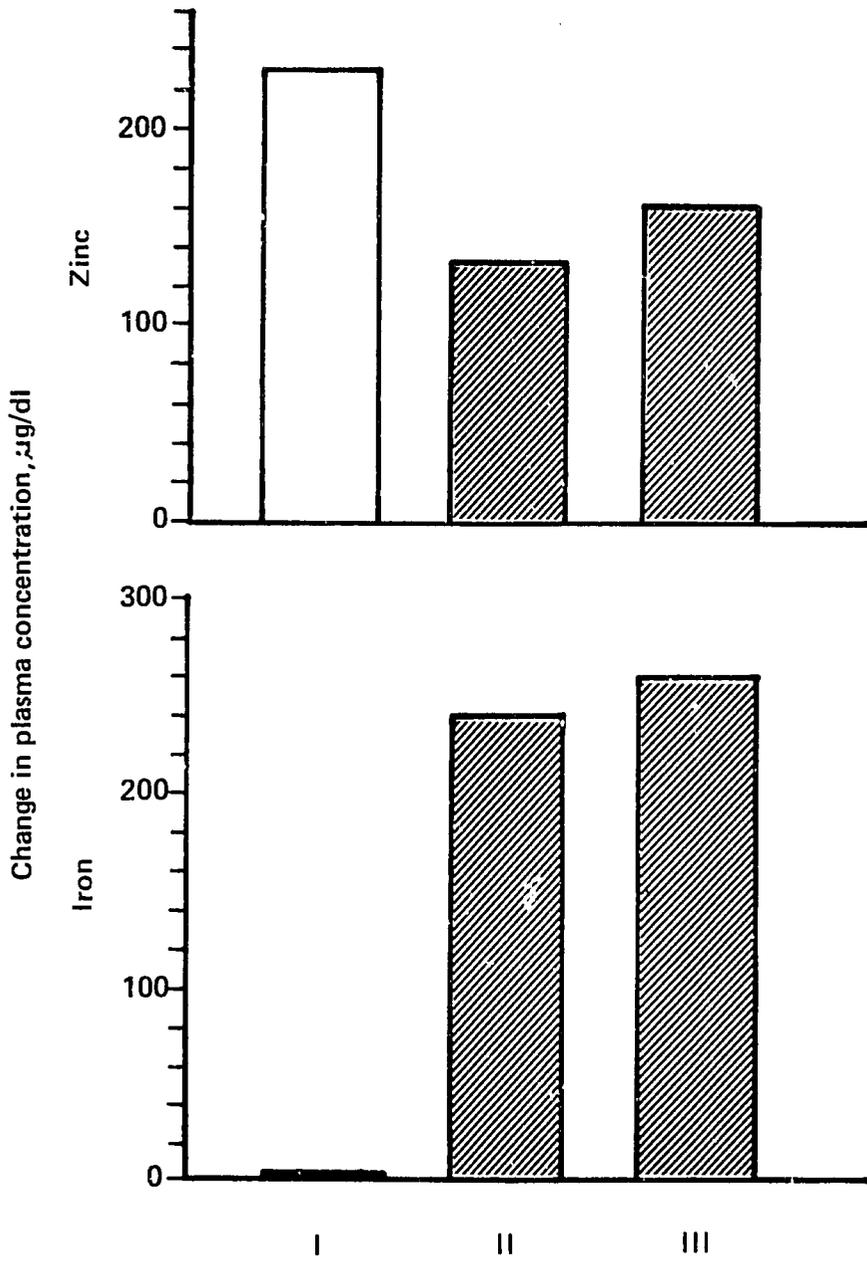
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FIGURE 1 Correlation between zinc absorption and fasting concentrations of plasma iron, after ingestion of 25 mg of zinc and 50 mg of iron.

#### *Studies in the preschool child*

All of the studies previously undertaken in the Division of Human Nutrition and Biology have involved the interaction of iron and zinc in adults. We studied this interaction in a single preschool-aged child, who had been treated for severe protein-energy malnutrition, and who had a persistent anemia despite having received daily supplementation with therapeutic doses of iron (60 mg/day). The child was studied on three separate occasions. The rise in plasma zinc concentration two hours after the administration of a dose of this mineral was used as the index of zinc absorption. The increase in plasma iron concentration was measured simultaneously. In the first test, the child received 22.4 mg of zinc (100 mg of  $\text{ZnSO}_4 \cdot 6\text{H}_2\text{O}$ ) in 100 ml of Coca-Cola. On the second and third occasions, the dose of zinc was accompanied by 44.8 mg of iron (222 mg of ferrous sulfate). The third test had the same dosages, but was undertaken 7 days after the injection of 50 mg of parenteral iron (Imferon<sup>®</sup>). Figure 2 shows that the increment in plasma zinc concentration was reduced by the simultaneous presence of iron by 43% in the second test, and by 26% in the third test. These responses coincide with the iron/zinc interaction in adults, although in the latter, the

PATIENT, J. M. C.



Incap 82-27

FIGURE 2 Changes in plasma concentrations of zinc (above) and iron (below), 2 hours after ingesting 22.4 mg of zinc and 44.8 mg of iron (in test I, only zinc was administered).

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reduction was on the order of approximately 60%\*. Figure 2 also shows that the rise in plasma iron was similar on the two occasions, with only a 7% difference.

In conclusion, the above observations suggest that the iron/zinc interaction observed in adults also occurs in a similar manner in preschool children.

### PROJECT 3

#### REASONS THAT DETERMINE DIETARY PRACTICES DURING WEANING

*B. García, B. Torún, F. E. Viteri and M. A. Guzmán*

As informed in 1980\*\*, a questionnaire for home visits was designed in such a way as to allow collection of information on the sociocultural factors that determine dietary practices during weaning. For the purpose of determining the degree of reliability and reproducibility of the information collected through this questionnaire, six surveyors interviewed 42 women of each of three socioeconomic groups of Guatemala (urban privileged, urban poor and rural). The women in each group were interviewed on two different occasions, some of them by the same investigator and others by different investigators.

The questionnaire contains a number of questions which can be divided in 7 areas:

1. Environmental characteristics (mother's work inside and outside the home, persons that take care of the child and feed him).
2. Diet of the family and child (type of diet of the child, age at which supplementary feeding was started, age of weaning, special preparation of the child's food and reasons for it, values regarding food for children, feeding utensils, concepts about the quantity to give him, age of integration to the family diet, reasons for it).
3. Mother's perception of her children's health status.
4. Maternal background (migration, relationship with relatives and with better-off families).
5. Mother's health and well-being (expectations as to having more children, more help, an easier life; ability to prepare special foods for the children, to make them eat more and to buy them other foods).
6. Sociodemographic characteristics (home ownership and physical characteristics of the house, source of water, fuel, possession of household goods, crops).
7. Census of the population investigated.

*Evaluation of questionnaire.* All the socioeconomic groups easily understood most of the questions included in the questionnaire.

Reliability of the information obtained was evaluated using statistical methods based on the degree of agreement contained in the replies given by those interviewed. The rate of agreement was obtained by comparing the replies received for each question in the first interview with those received in the second interview. It was arbitrarily decided to consider as "good" the agreement of 80% or more, and as "bad" the agreement of less than 80%.

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\* INCAP, *Informe Anual*, 1978, p. 144.

\*\* INCAP, *Annual Report*, 1980, p. 109-112.

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The results obtained showed concurrence in the replies connected with environmental characteristics, mothers' awareness of children's health status, maternal background, sociodemographic characteristics and census of the population investigated. Agreement as to questions on diet of the family and child was also good, except when the questions required an answer on events that had occurred several months ago, such as first food consumed by the children and age of the child when the food was consumed. By contrast, concurrence in replies connected with mother's health and well-being was bad. This was probably due to an error in the way in which the questions were formulated in the questionnaire, since they were posed in the context of the moment or day of the interview; therefore, the lack of concurrence may have been due, in many cases, to the different conditions prevailing at the time the interviews were carried out.

The reproducibility of the information obtained by the different investigators when interviewing the same person was satisfactory. On the other hand, analysis of the replies obtained by the same investigator in the two interviews of the same person showed more discrepancies among the women of the rural area than among those in the other two socioeconomic groups. A possible explanation may be that many of the dietary practices during weaning are carried out in the rural area in a routine manner, "because it is done so", without analyzing the reason for such practices. Therefore, many women in this group were disconcerted with some of the questions during the first interview and they apparently answered the first thing that came to their minds, while in the second interview they were more conscious of their reply.

One of the main limitations of the questionnaire was its length, as the interviews lasted around 60-75 min. This could have been corrected by eliminating those questions that were unimportant, lacked clarity, or were not subject to reproducibility during the two interviews. On the other hand, it was noted that some of the questions could have more than one answer, all of them with the same implications; therefore, a common code must be assigned when evaluating questions with this characteristic.

The above-mentioned errors were taken into account for the modification of this questionnaire.

*Factors leading to erroneous practices during weaning:* Even though the 126 women involved in this survey are not a representative sample of the three socioeconomic groups investigated—the main purpose of this Project was the development of the questionnaire and not the information itself—, there were a number of reasons frequently given by those interviewed that may be considered as limiting factors as far as good dietary practices are concerned. These factors are:

1. Lack of help for the care of children in the urban poor and rural groups, as the mothers have to mind other activities in and out of the home.
2. Lack of family support by other members of the family as regards diet and care of the child, especially in the urban poor and rural groups.
3. Insufficient information on adequate feeding of the newborn and the small child, in the three socioeconomic groups surveyed.
4. Lack of knowledge concerning the practices that favor abundant production of breast milk among women of the urban poor and urban privileged groups.
5. Lack of knowledge on the nutritional requirements of the infant in the three groups investigated.
6. Medical and other health personnel had an influence on the dietary practices of the urban privileged group only, notwithstanding the fact that the other two groups were also aware of the relationship existing between diet and health.

Even though the lack of economic resources is often adduced as the main limitation for the adequate feeding of children by their mothers, the information obtained showed that, at least in the population studied, practically all the families in the three socioeconomic groups had most of the required foods at least once a week; nevertheless, children in the urban poor and rural groups did not receive that food as often as available. On the other hand, the evaluation that the mothers made of the food was not a determining factor in the consumption of such food by their children. For example, eggs were considered as very

good for children, and almost all the families in the three groups had them, at least once a week; however, they gave eggs to the children only on rare occasions.

*Conclusions:* The results and considerations mentioned above lead us to think that, in many homes, the factors that prevent proper feeding of children during weaning are not the availability of food, the mother's concept of the nutritional value of such food, or the incorrect advice of neighbors and other people. The reason that prevents adequate feeding is a lack of stimulation and support on the part of the family regarding improvement of dietary practices as far as the child is concerned. For example, in the urban poor group, where homes are unstable and the population is highly subject to migration, mothers rarely have the support of relatives and friends; in addition, relations with their neighbors are poor and so are community activities such as social and religious meetings, or any other type of gatherings where they might communicate and exchange ideas on the care and feeding practices of children. This also applies to the rural group studied because, in spite of the fact that most of the families have lived in the same place for several generations, they have lost the sense of community which has been observed in other Indian groups.

This lack of family support is closely related to a deficient food and nutrition education. An intensive program on practical education, which could be carried out at the Health Center level with local groups of mothers, might improve customary feeding practices during weaning. These programs might induce mothers to take measures such as preparation of *papillas* (soft foods or purees) and other semisolid foods that would supplement breast milk without interfering with the continuity of breastfeeding. These *papillas* can be prepared by combining the best foods—as far as nutritive value is concerned—available in the home, in accordance with culinary practices prevailing in the area and using the simple utensils available in almost all the homes. This would help satisfy the protein-energy needs of children during weaning. Such programs should stimulate mothers that feed their children in an adequate manner to prepare foods and feed their children in the presence of other women, so that they may share their experiences and help other mothers to find solutions to the nutritional problems of their own children.

The original questionnaire, as well as detailed results of its evaluation, suggestions on how to improve it and conclusions reached after its limited use during the evaluation of its reliability and reproducibility, were forwarded to the Nutrition Unit of the World Health Organization, which originally proposed and financed this Project.

## PROJECT 4

### STUDIES ON PROCEDURES TO IMPROVE MILK TOLERANCE IN ADULTS WITH PRIMARY LACTASE DEFICIENCY

*N. W. Solomons and B. Torún*

Cow's milk contains around 5% lactose. The intestinal enzyme, lactase, is required for the digestion of this disaccharide. The majority of mankind, with the exception of those of Caucasian origin, suffer a progressive reduction in intestinal lactase activity beginning at about age 3 to 5. This reduces their efficiency to absorb milk carbohydrate. Thus, adults of Asian, African, Middle-Eastern, native American and Latin American ancestry frequently malabsorb a part of the lactose content of milk and other dairy products, at times accompanied by such symptoms as abdominal distension and pain, flatulence, meteorism and diarrheal stools. Using the hydrogen ( $H_2$ ) breath-analysis test, we have investigated a series of dietetic manipulations that can improve tolerance to milk in adults with primary lactase deficiency.

*Diagnosis of lactose malabsorption:* To evaluate absorption of lactose, it is important to use a "physiological" dose and a food vehicle of lactose. Thus, we initially studied a group of adults during the 6 hours following the ingestion of 360 ml of intact whole milk containing 18 g of lactose. Samples of expired air were collected at 30 to 60 min intervals. The concentration of  $H_2$  in this air was analyzed using the instrument described in another part of this Annual Report (see the Project "Validation of a simple, rapid, analytic instrument for the clinical evaluation of carbohydrates using the  $H_2$  breath-analysis test", in this same

Program). Malabsorption of lactose was diagnosed when the concentration of breath  $H_2$  increased by  $\geq 25$  ppm. Only lactose-malabsorbing subjects participated in the subsequent phases of the study. Figure 3 shows some examples of positive tests for lactose malabsorption.

*Treatment of milk with beta-galactosidase:* A commercial food-grade beta-galactosidase has been produced from cultures of the yeast *Kluyveromyces lactis* (LactAid<sup>®</sup>, SugarLo Company). Its pH and temperature optima for lactose hydrolysis are 6.8 and 37°C, respectively. When 12 drops of LactAid are added to a liter of milk and the milk is refrigerated for 24 hr, more than 90% of the lactose is hydrolyzed to its constituent monosaccharides. It was considered important to explore the possibility that the addition of the enzyme *immediately prior to consumption* of milk would also produce a reduction of lactose content as a consequence of *in vivo* hydrolysis in the lumen of the stomach or intestine. Body temperature is ideal for the enzymatic activity, and although the gastric milieu is acidic, the milk might contain sufficient buffer capacity to neutralize the acidity and improve the intragastric pH conditions. To test this possibility, we compared the quantity of expired  $H_2$  over 6 hr in 15 adult lactose-malabsorbers after the administration of: 1) 360 ml of intact whole milk (IM); 2) the same quantity of milk treated with the standard dose of LactAid 24 hr prior to use (HM); and 3) the same quantity of milk with double the standard dose of enzyme added 5 min prior to ingestion (EM).

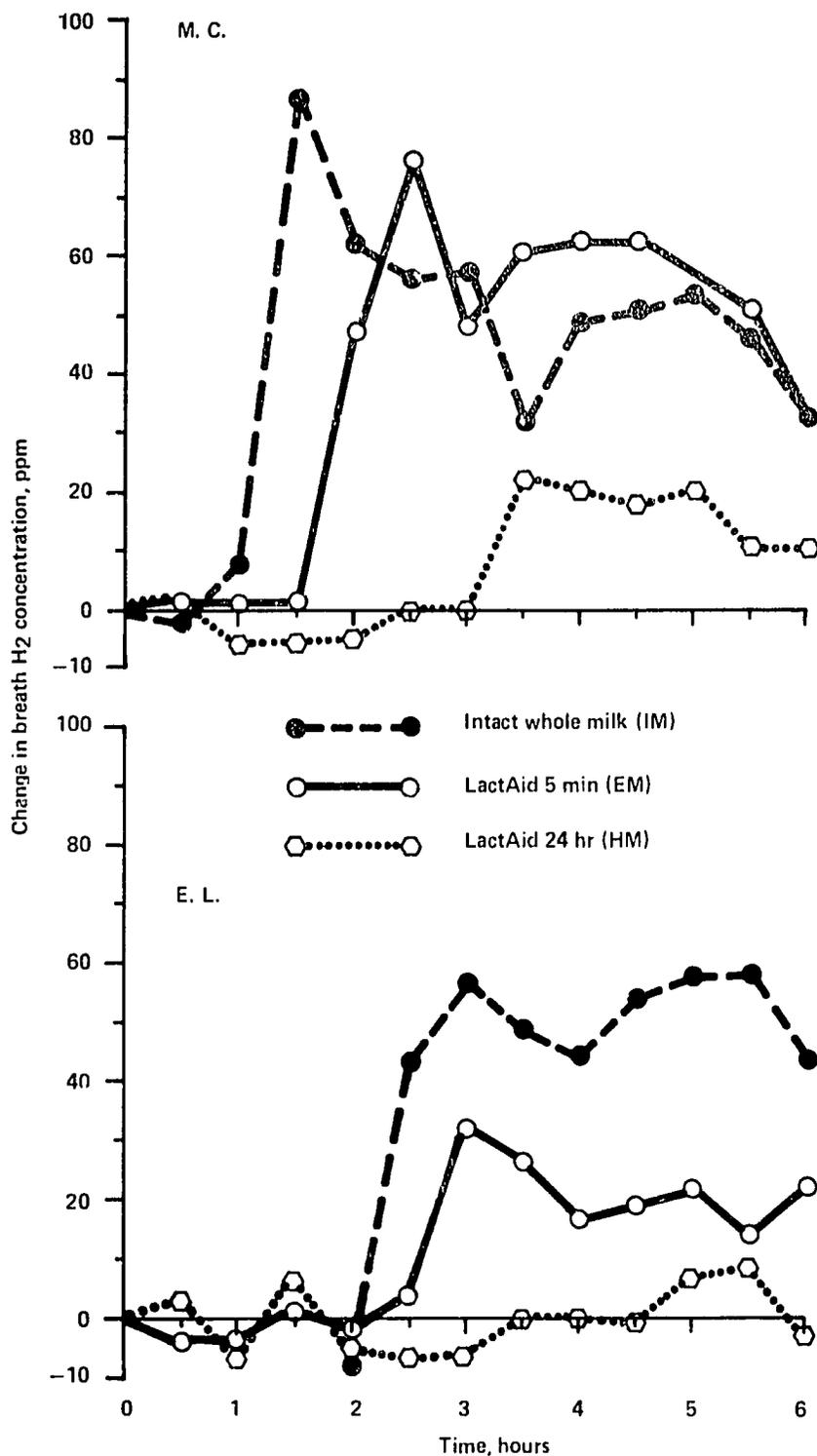
The elimination of hydrogen in expired air was reduced markedly in the 15 individuals who ingested HM. Twelve subjects also showed a reduction in the elimination of breath  $H_2$  after ingestion of EM, as compared to the ingestion of IM. This reduction ranged from 7 to 86%, with a mean of 51%. Table 7 shows the elimination of  $H_2$  excess over 6 hr calculated by integrating the area under the discontinuous curve of breath  $H_2$  concentration. The respective excretions (mean  $\pm$  S.D.) were: 118  $\pm$  56 ppm/hr (IM), 11  $\pm$  27 ppm/hr (HM), and 76  $\pm$  55 ppm/hr (EM). Figure 3 shows examples of the response to the three forms of milk. In addition to the differences in the elimination of  $H_2$ , there were differences in the experience of symptoms of intolerance: 13 persons had symptoms with IM, 3 with HM and 9 with EM.

TABLE 7

EXCESS BREATH HYDROGEN EXCRETION, IN PPM-HOURS, AFTER INGESTION OF  
INTACT MILK OR MILK SUBJECTED TO VARIOUS HYDROLYTIC TREATMENTS

	Intact Milk (IM)	Milk prehydrolyzed for 24 hr with LactAid (HM)	Milk treated for 5 min with LactAid (EM)	Milk treated for 5 min with lactase N
001	255	49	238	
002	172	2	66	
003	152	-5	72	
004	148	51	57	
005	145	-11	36	
006	140	-19	43	55
007	125	48	103	104
008	120	-36	87	
009	102	50	108	
010	98	-2	34	73
011	89	5	30	54
012	35	2	12	
013	70	-2	40	10
014	34	31	112	
015	31	-4	89	
Mean	118	11	76	59
SEM	56	27	55	34

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**FIGURE 3** Total elimination of expired hydrogen after ingesting 360 ml of intact milk, milk hydrolyzed for 24 hr with lactase or hydrolyzed 5 min with lactase.

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Given the possibility that the differences in the results among HM and EM could have been due, at least in part, to intragastric pH in relation to the pH optimum of the enzyme, the same test was repeated in 5 of the 15 subjects, but using another type of beta-galactosidase (Lactase N, GB Fermentation Industries), which has a pH optimum of 4.4. This pH is close to that of the intragastric contents after a meal. One hundred and thirty-three mg of Lactase N were added 5 min prior to ingestion. Table 7 shows that the respiratory elimination was lower in the 5 persons than when ingesting IM, but the reduction was no better than with the EM with LactAid in these same 5 individuals. In this final case, the elimination of H<sub>2</sub> in these 5 subjects was  $54 \pm 29$  ppm/hr.

*Effects of solid foods on the fermentation of lactose:* In view of the fact that the velocity of gastric emptying is regulated by the chemical composition and physical form of the foods, we explored the hypothesis that consuming liquid milk together with solid foods would produce a reduction in breath H<sub>2</sub> excretion. In 13 adult lactose-malabsorbers, the pulmonary elimination of H<sub>2</sub> was determined at 60 min intervals after ingestion: 1) 360 ml of intact milk, alone; 2) the same quantity of milk with 40 g of corn flakes, a banana and a hard-boiled egg; and 3) the same food with 360 ml of milk previously treated with LactAid for 24 hr. The curves of the mean change in H<sub>2</sub> concentration are shown in the upper portion of Figure 4. The median time from the ingestion of the milk until the appearance of the maximum peak was 3 hr after milk alone and 3 hr after drinking milk plus solid foods. In view of the fact that the solid foods themselves produce a certain increase in expired hydrogen—probably due to incomplete absorption of some carbohydrates of corn flakes or bananas—the area under the curve with the breakfast accompanied by HM was subtracted from the area under the curve with the breakfast plus IM, to determine the component of the H<sub>2</sub> production attributable to lactose. In the lower half of Figure 4, the amount of H<sub>2</sub> production that is attributed to the malabsorption of the milk lactose with milk alone and with milk plus a meal is shown.

## PROJECT 5

### COMPARISON OF THE EFFECTIVENESS OF MILK WITH AND WITHOUT LACTOSE IN THE TREATMENT OF SEVERE PROTEIN-ENERGY MALNUTRITION

*B. Torún, N. W. Solomons, B. Caballero\*, S. Flores-Huerta\*, G. Orozco and R. Batres*

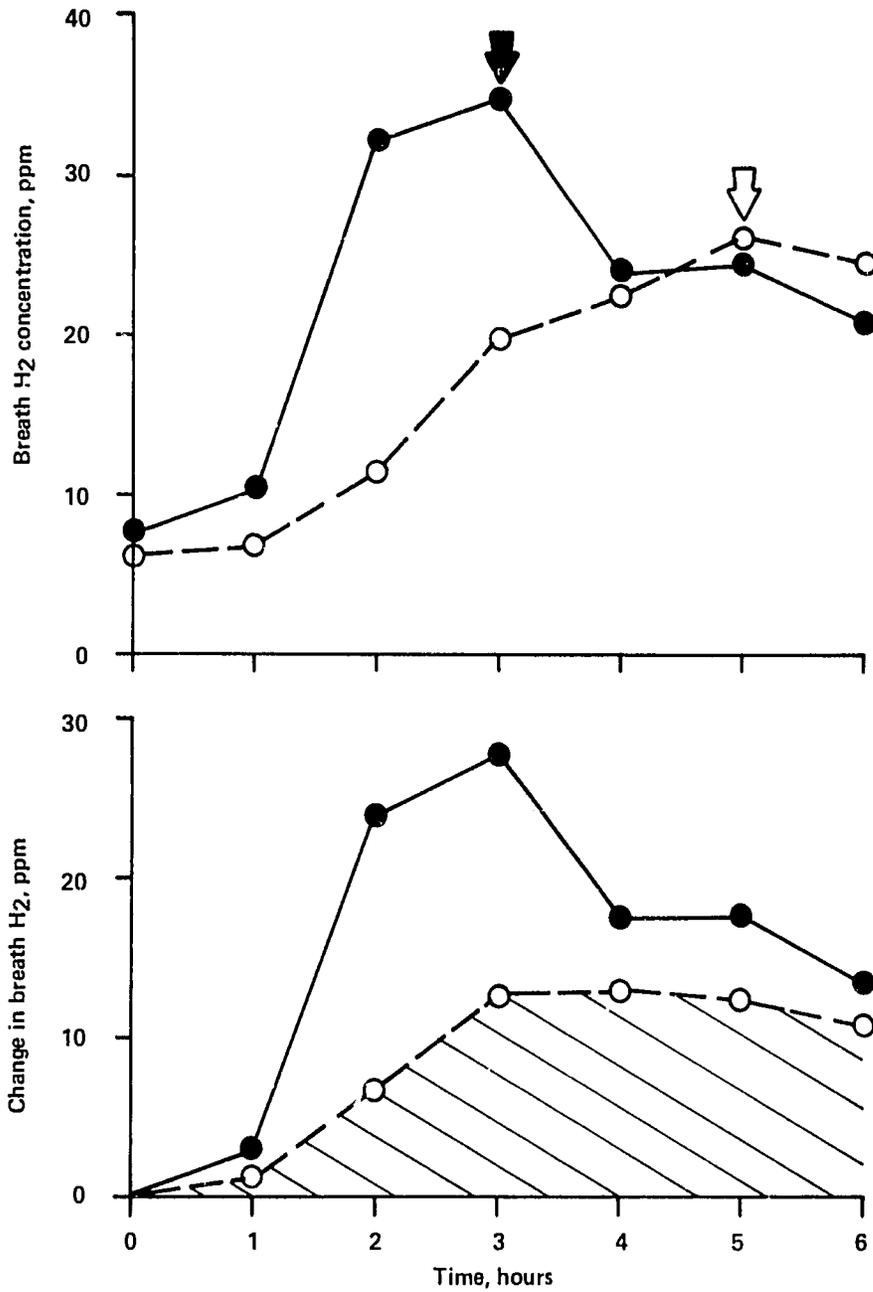
Children with severe protein-energy malnutrition (PEM) have marked deficiencies in their reserves of lean body tissue and energy (adipose deposits). Nutritional recuperation and the reestablishment of a normal body composition requires the intake of great quantities of proteins of high nutritional quality and of energy sources of easy digestibility. These quantities exceed the requirements of well-nourished children of the same age and size. Thus, the therapeutic diets used to treat children with severe PEM should provide daily, per kg of body weight, at least 3 to 4 g of high quality protein and a minimum of 120 to 150 kcal derived from easily absorbed energy sources.

Cow's milk is a source of proteins of high nutritional value. Its energy density can be increased by the addition of vegetable oil and sugar. This allows the provision of a liquid formula to small children which, in our experience in the Clinical Center of INCAP, has achieved good nutritional recovery of the patients. For example, the retrospective analysis of 24 patients treated for severe PEM with milk formulas demonstrated satisfactory rates of recuperation both in terms of clinical recovery and growth\*\*. Nonetheless, doubts still persist as to the appropriateness of using milk in the treatment of patients with PEM in view of its 5% content of lactose and the low activity of intestinal lactase which is usually observed in patients with severe malnutrition; some pediatricians believe that this will produce or aggravate the diarrhea. Given the importance to the pediatric community of resolving these issues, we undertook a comparative study using reconstituted powdered intact cow's milk, or milk from the same lot, prehydrolyzed with a beta-galactosidase (LactAid, SugarLo Co., New Jersey, U. S. A.) for at least 24 hr prior to consumption, to reduce the lactose content by over 90%, as the base of our recovery diets.

\* INCAP/UNU fellow.

\*\* Torún, B., N. W. Solomons, F. E. Viteri. *Arch. Latinoamer. Nutr.* 29: 445-494, 1979.

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**FIGURE 4** Excretion of breath hydrogen after ingestion of 360 ml of milk alone (●) or accompanied by solid foods (○). The arrows indicate the maximum rise in hydrogen excretion. The shaded area in the lower figure represents the excretion of hydrogen attributable to the lactose in the milk accompanied by solid foods.

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TABLE 8

CHARACTERISTICS OF TWO GROUPS OF SEVERELY MALNOURISHED PATIENTS  
TREATED DURING 45 DAYS WITH MILK DIETS WITH DIFFERENT LACTOSE CONTENTS  
(MEAN  $\pm$  STANDARD DEVIATION; 10 CHILDREN IN EACH GROUP)

	Admission to INCAP		End of study	
	Intact milk	Hydrolyzed milk	Intact milk	Hydrolyzed milk
Age, months	23 $\pm$ 6	21 $\pm$ 6	24 $\pm$ 6	23 $\pm$ 6
Height, cm	74.6 $\pm$ 3.2	75.6 $\pm$ 3.5	76.3 $\pm$ 3.1	77.4 $\pm$ 3.6
Height-age, months	12 $\pm$ 2	12 $\pm$ 3	13 $\pm$ 2	14 $\pm$ 3
Weight, kg	6.87 $\pm$ 0.91 <sup>a</sup>	7.13 $\pm$ 1.02 <sup>a</sup>	9.14 $\pm$ 1.20	9.62 $\pm$ 1.34
Weight-for-height, o/ob	70 $\pm$ 8 <sup>a</sup>	72 $\pm$ 7 <sup>a</sup>	89 $\pm$ 8	92 $\pm$ 8
Lean arm diameter, mm <sup>c</sup>	28 $\pm$ 3	29 $\pm$ 3	32 $\pm$ 2	35 $\pm$ 3
Leg circumference, cm	13.7 $\pm$ 1.3	13.9 $\pm$ 1.5	15.6 $\pm$ 1.4	16.1 $\pm$ 1.6
Skinfold thicknesses, mm <sup>d</sup>	3.4 $\pm$ 1.6	3.1 $\pm$ 1.1	6.4 $\pm$ 2.1	6.0 $\pm$ 1.6
Creatinine-height index <sup>e</sup>	0.63 $\pm$ 0.16	0.65 $\pm$ 0.12	1.07 $\pm$ 0.08	1.06 $\pm$ 0.10
Severity of edema <sup>f</sup>	2.0 $\pm$ 0.9	2.1 $\pm$ 0.9	—	—
Plasma proteins, g/dl	4.2 $\pm$ 0.6	4.4 $\pm$ 0.6	7.1 $\pm$ 0.3	7.1 $\pm$ 0.5
Serum albumin, g/dl	2.3 $\pm$ 0.8	2.2 $\pm$ 0.5	5.4 $\pm$ 0.4	5.2 $\pm$ 0.3
Hemoglobin, g/dl	9.9 $\pm$ 0.7	9.5 $\pm$ 2.0	10.6 $\pm$ 1.4	10.6 $\pm$ 0.8
serum iron, $\mu$ g/dl	55 $\pm$ 19	58 $\pm$ 19	54 $\pm$ 33	57 $\pm$ 28
Total iron-binding capacity, $\mu$ g/dl	128 $\pm$ 42	125 $\pm$ 30	347 $\pm$ 21	349 $\pm$ 44

<sup>a</sup> Corrected for weight of edema.

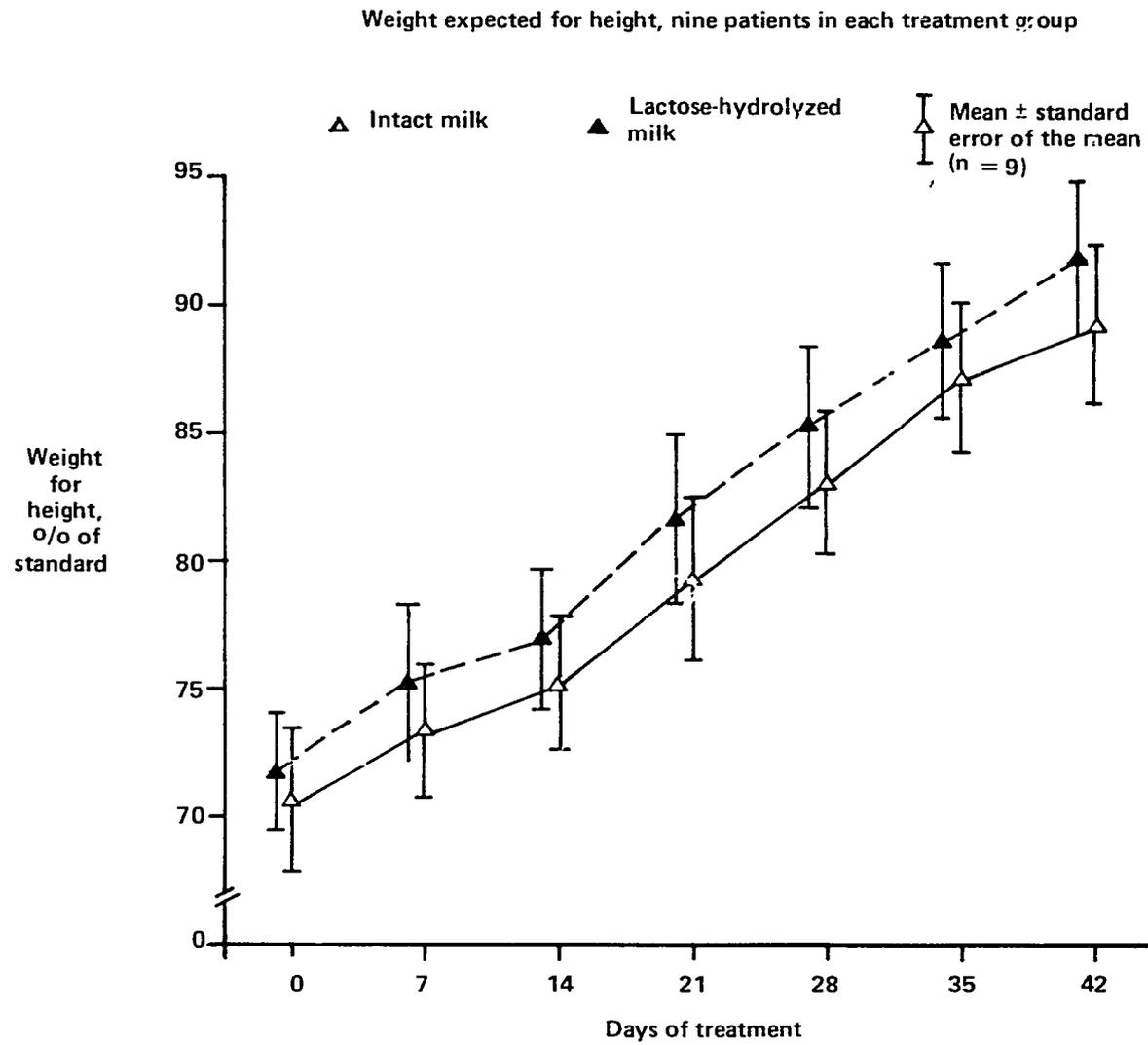
<sup>b</sup> 100<sup>o</sup>/o = 50 percentile of Boston standards.

<sup>c</sup> Corrected for subcutaneous fat.

<sup>d</sup> Mean of the tricipital, subscapular and periumbilical skinfold thicknesses.

<sup>e</sup> Normal  $\geq$  0.90 (Viteri, F. and J. Alvarado, *Pediatrics*, 46: 696-706, 1970.

<sup>f</sup> 1 = edema below the knees; 2 = edema of upper limbs; 3 = anasarca.



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FIGURE 5. Gain in weight-for-height during the treatment of malnourished children with intact or hydrolyzed milk.

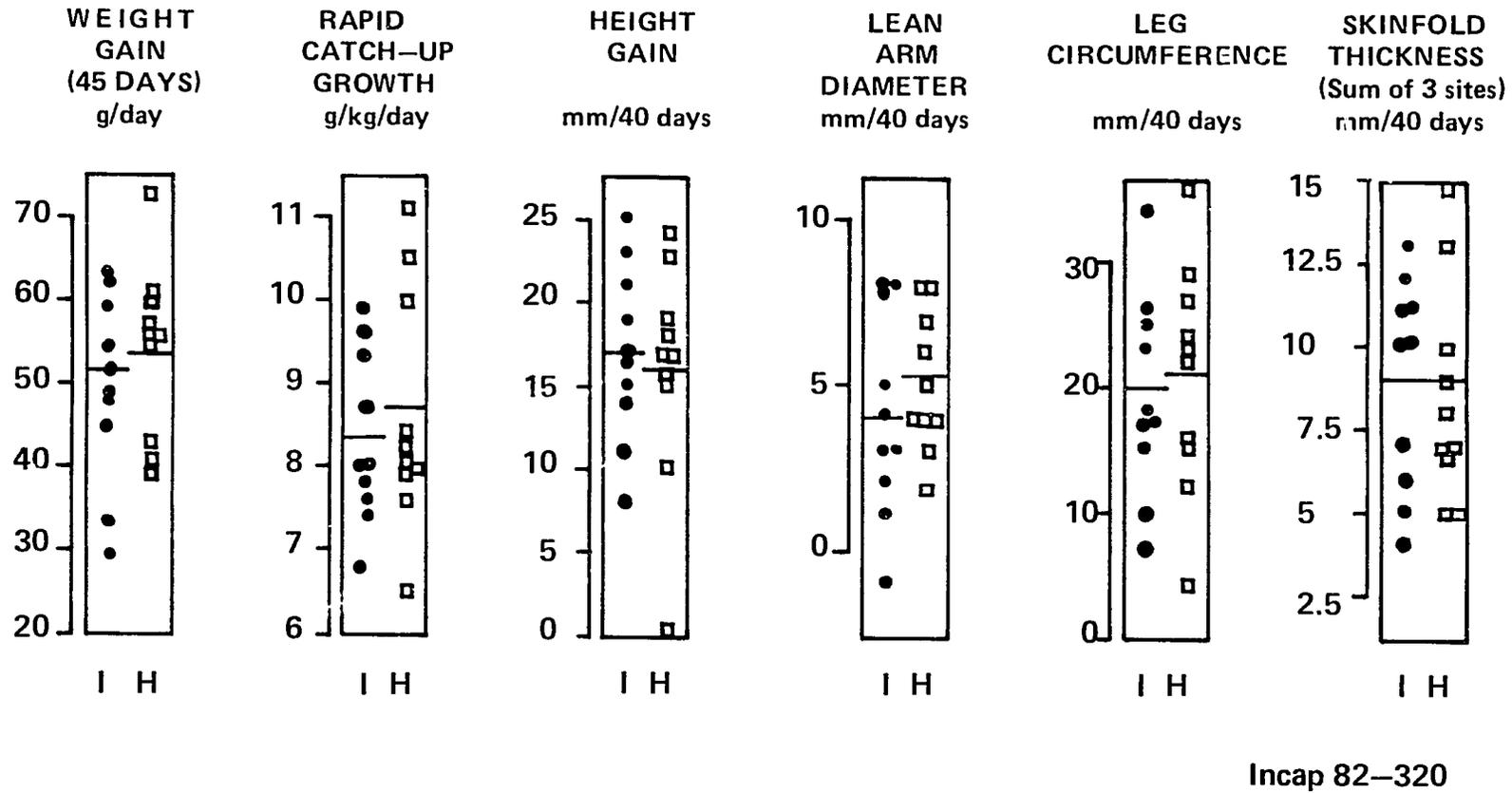


FIGURE 6 Growth and anthropometric changes during dietary treatment with intact milk (I) or hydrolyzed milk (H)

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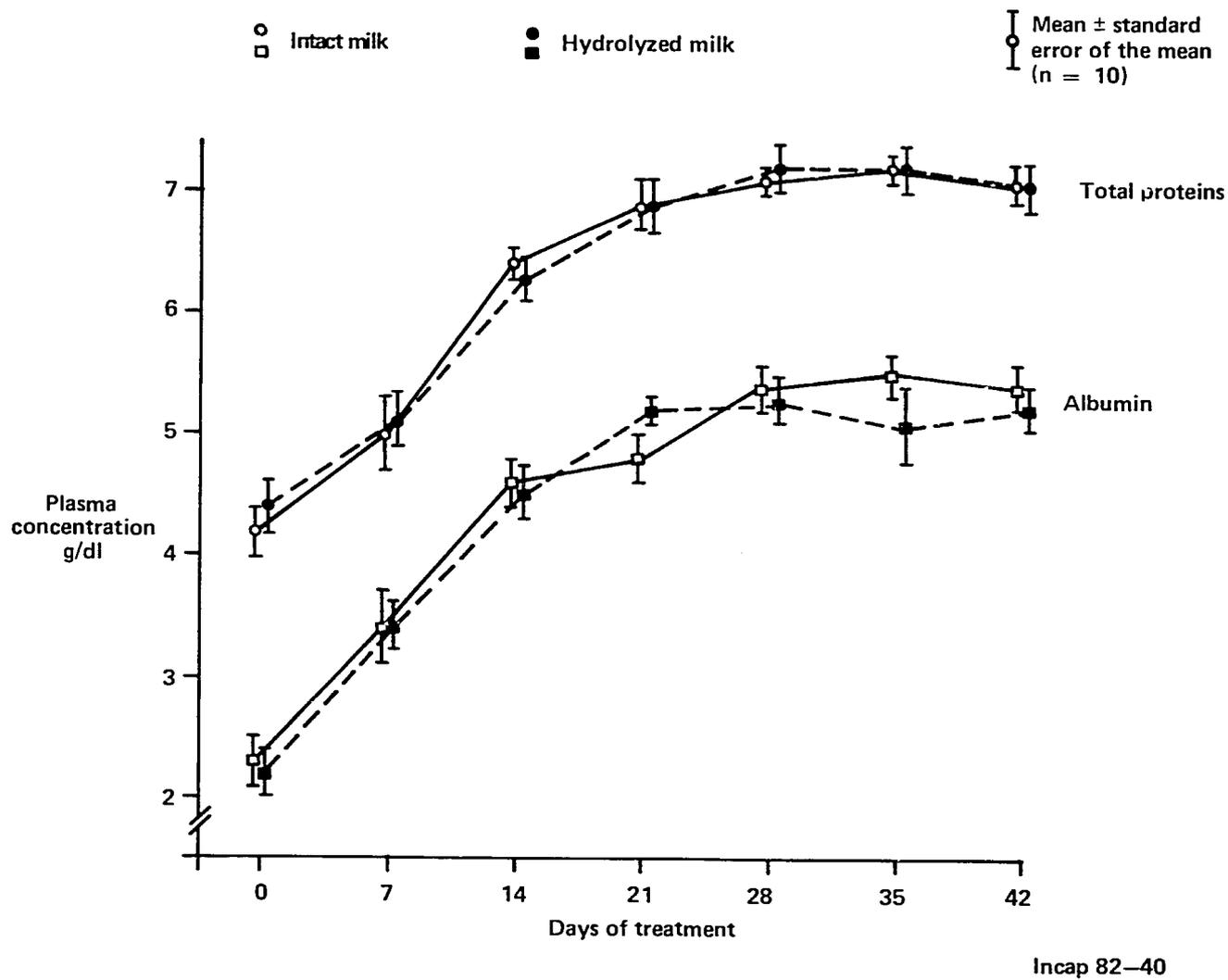


FIGURE 7 Total plasma protein and albumin concentrations, during treatment of severe PEM with intact or hydrolyzed milk.

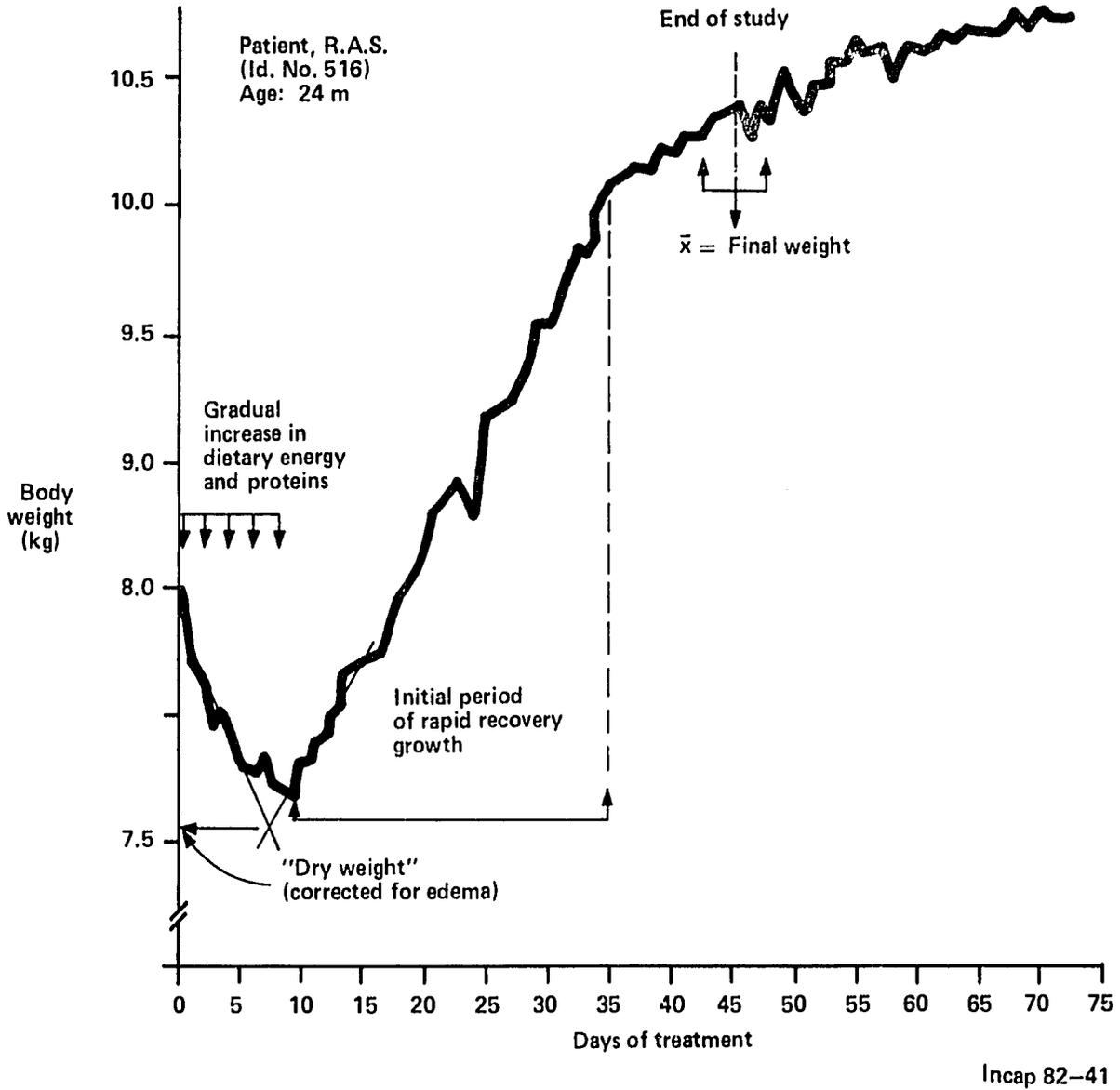


FIGURE 8 *Body weight of a child treated for protein-energy malnutrition of the edematous type.*

Twenty children aged 15 to 36 months, of Maya or *ladino*\* origin, were admitted to the Clinical Center of INCAP with severe PEM of the edematous type. They were divided randomly into two groups of 10 patients, similar in age, severity of malnutrition, antecedent diarrhea, weight-for-height corrected for edema, stunting, clinical characteristics and concentrations of plasma proteins. They were treated with identical milk-based diets, except that one group received intact milk (IM) as the protein source, while the other group received hydrolyzed milk (HM). The diets initially provided 0.7 g of protein and 70 kcal/kg/day; these were increased gradually so that from the eighth day onward the children ingested 4 g of protein and 150 kcal/kg/day. The energy density of the diet was increased through the addition of vegetable oil and sucrose to the powdered milk. The sources of energy in the formula that provided 4 g of protein and 150 kcal/100 g of diet were: milk protein, 11%; lactose, 16%; sucrose, 33%; vegetable oil and milk fats, 40%.

The clinical and metabolic evolution of the patients was evaluated during 45 days in terms of growth and nutritional recovery (clinical characteristics, anthropometric indicators, creatinine-height index, plasma total protein concentration, serum albumin concentration, transferrin saturation), gastrointestinal function (fecal volume and characteristics, excretion of breath hydrogen, measurement of reducing substances and pH in stools) and absorption and retention of nutrients.

Table 8 shows the principal clinical, anthropometric and biochemical characteristics of the patients on admission and at the end of the study. There was no difference between groups. The velocity of nutritional recovery was highly satisfactory and similar with both dietetic treatments, as shown in Figures 5-7. The period of most rapid growth velocity in early recovery (Figure 8) lasted  $25 \pm 7$  and  $26 \pm 8$  days in groups treated with IM and HM, respectively, with a velocity of weight gain  $13 \pm 2$  times more rapid than in normal children of the same height ( $8.3 \pm 0.9$  and  $8.7 \pm 1.5$  g/kg/day with IM and HM, respectively). Total weight gain during the 45 days ( $52 \pm 10$  g/day with IM vs.  $54 \pm 11$  with HM) was 7.5 times faster than would be expected in well-nourished children. The increase in weight-for-height was similar with both treatments and 6 children in each group had reached 90% or more of the standard by 45 days; the remainder continued growing at an accelerated rate at the close of the protocol. All children had reached a creatinine-height index of 0.9 or more by 45 days of hospitalization.

As shown in Table 9, there were no substantial differences in the incidence of diarrhea with either type of milk, or in other indices of gastrointestinal function. The intestinal absorption of proteins and overall nitrogen balance were high and similar with both treatments (Table 9 and Figure 9). Similarly, there were no differences in the absorption of dietary energy which, over the whole study, averaged  $92 \pm 4\%$  for IM and  $93 \pm 3\%$  for HM. Neither were differences in the absorption and retention of calcium seen with different intakes of lactose; throughout the study, absorption oscillated between 31 and 47% of the calcium consumed, and net retentions varied between 36 and 66 mg/kg/day.

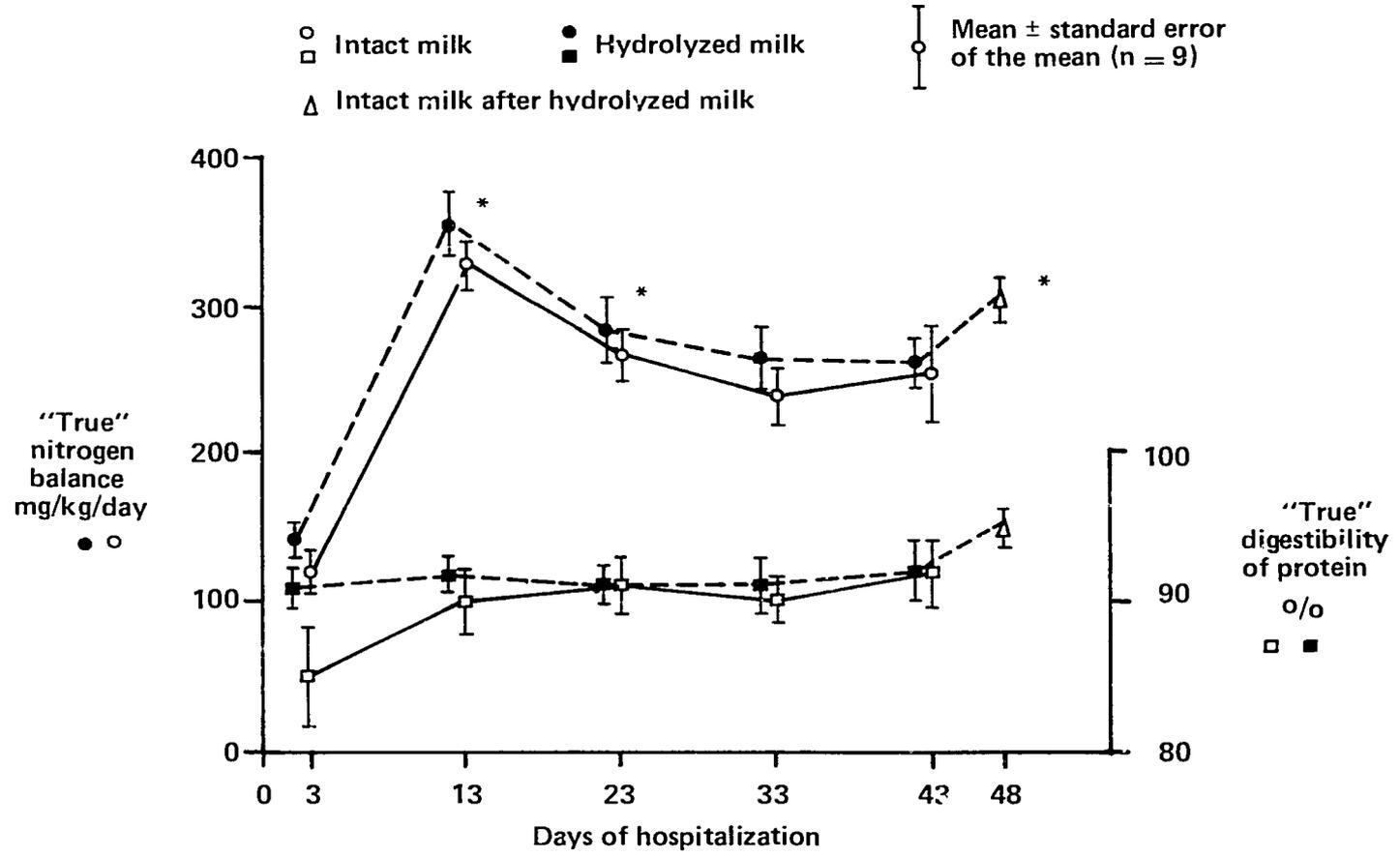
After 45 days of treatment, the children who had been on the HM diet were switched to the IM diet for 5 additional days. None showed diarrhea or any deviation from their usual pattern of defecation, although one child had a postprandial rise in hydrogen. There was a slight increase in the absorption of nitrogen and of calcium, with a corresponding slight reduction in the urinary excretion of these two elements, which resulted in the highest net balances ( $P < 0.05$ ) for any balance period during the crossover to IM. The mean absorption of dietary energy did not change.

These results confirmed our previous therapeutic experiences in the Clinical Center of INCAP, in the sense that cow's milk is an excellent food for the treatment of children with severe malnutrition, even from the very beginning of dietary therapy, and despite the fact that the Guatemalan population, and particularly malnourished children, have a low intestinal lactase activity. Intact milk did not produce diarrhea that interfered with the process of nutritional rehabilitation, nor did it provoke water and electrolyte imbalances. Therefore, it is not necessary to modify the lactose content. However, hydrolyzed milk showed itself to be a good alternative treatment for any malnourished patients that might manifest frank intolerance to lactose or who do not grow adequately due to malabsorption of this carbohydrate.

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\* *Ladino*: non-indigenous Spanish-speaking person.

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\* Differs from former level of protein ingestion, paired "t" test, P < 0.05.

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FIGURE 9 Intact or hydrolyzed milk in the treatment of PEM. "True" nitrogen balance and "true" digestibility of protein (corrected for insensible integumentary losses and assuming obligatory fecal losses of 20 mg N/kg/day). Protein ingestion = 1.5 g/kg/day during days 2 to 5 and 4 g/kg/day from day 7 on.

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TABLE 9

INTESTINAL FUNCTION AND METABOLIC BALANCES IN MALNOURISHED PATIENTS TREATED WITH INTACT OR HYDROLYZED COW'S MILK

	Beginning of hospitalization (days 1-3)		First week of treatment (days 8-14)		Final week of treatment (days 39-45)		Complete therapeutic period (days 6-45)	
	Intact milk	Hydrolyzed milk	Intact milk	Hydrolyzed milk	Intact milk	Hydrolyzed milk	Intact milk	Hydrolyzed milk
Children with diarrhea	8 of 9*	4 of 9*	7 of 9	4 of 9	2 of 9	1 of 9	2 of 9 <sup>a</sup>	2 of 9 <sup>a</sup>
Stools:								
— defecations/day	4.1 ± 0.8 <sup>b,c</sup>	2.8 ± 1.2 <sup>b</sup>	3.8 ± 0.6 <sup>b</sup>	3.1 ± 0.7 <sup>b</sup>	1.8 ± 0.6	2.2 ± 0.8	2.5 ± 0.4	2.3 ± 0.5
— % abnormal stools	85 ± 20*	68 ± 32*	51 ± 20	40 ± 27	26 ± 22	24 ± 28	37 ± 8*	30 ± 18*
— g of feces/day	263 ± 173	172 ± 108	168 ± 92	177 ± 226	105 ± 71	102 ± 92	127 ± 74	113 ± 52
Children with acid stools (pH ≤ 5) <sup>d</sup>	5 of 9	4 of 9	4 of 9*	9 of 9*	4 of 9	4 of 9	0 <sup>a</sup>	0 <sup>a</sup>
Children with fecal reducing substances <sup>e</sup> :								
— only trace	1 of 9	4 of 9	4 of 9	3 of 9	3 of 9	3 of 9	0 <sup>e</sup>	0 <sup>a</sup>
— positive (+ to ++++)	7 of 9*	4 of 9*	4 of 9	5 of 9	1 of 9	1 of 9	0 <sup>a</sup>	0 <sup>a</sup>
Children with substantial breath H <sub>2</sub> excretion <sup>e</sup> :								
— after lactulose ingestion	4 of 7	3 of 8	4 of 7	3 of 8	5 of 8	5 of 8	8 of 8 <sup>f</sup>	5 of 8 <sup>f</sup>
— postprandial	0	0	1 of 8	0	0	0	3 of 9 <sup>g</sup>	1 of 8 <sup>h</sup>
"True" N absorption, % <sup>i</sup>	85 ± 10	91 ± 5	90 ± 7	92 ± 4	92 ± 7	9 ± 8	91 ± 6	91 ± 5
"True" N balance, mg/kg/day <sup>j</sup>	120 ± 41	141 ± 37	328 ± 45	353 ± 59	255 ± 99	263 ± 52	273 ± 72	290 ± 69

\* A difference between IM and HM groups by X<sup>2</sup>, P < 0.05.<sup>a</sup> The number of children who frequently had diarrhea or abnormal stools<sup>b</sup> The means of the groups treated with IM and HM differed, Student's "t" test, P < 0.05.<sup>c</sup> Mean ± standard deviation.<sup>d</sup> Positive result in one or more defecations during the time indicated.<sup>e</sup> Rise of ≥ 20 ppm after ingestion of carbohydrates. All children could not be measured due to equipment failure.<sup>f</sup> Children with at least one positive response (increase in expired hydrogen) after ingestion of lactulose.<sup>g</sup> One child with 1 positive response in 4 tests; one with two positive responses in 6 tests; one with a positive response in the only test that could be administered.<sup>h</sup> One child with 1 positive response in 7 tests.<sup>i</sup> "True" N absorption = [(ingested N - (fecal N - 20 mg N/kg/day of obligatory fecal nitrogen losses)) ÷ fecal N] x 100.<sup>j</sup> "True" N balance = ingested N - fecal N - urinary N - 14 mg N/kg/day in integumentary and insensible losses.

This study underscores the notion that more attention should be given to the magnitude and sufficiency of those nutrients which are absorbed and utilized from a food than to the quantities not absorbed completely. Similarly, the impact of the consumption of a food on the nutritional status of the consumer should be more important than the possible occurrence of slight signs and symptoms which do not interfere with health nor cause intense discomfort.



The treatment of children with nutritional disorders benefits the patients, allows training of doctors in areas of metabolism and clinical nutrition, and facilitates the development of better systems to combat these disorders

**SUBPROGRAM D**

**BIOLOGICAL EFFECTS OF NUTRITIONAL  
INTERVENTIONS**

**PROJECT 1**

**SUGAR FORTIFICATION WITH IRON. EVALUATION OF ITS EFFECTIVENESS AT A  
POPULATION LEVEL**

*F. E. Viteri, B. Torún and O. Pineda*

The present study was initiated in 1976 with the aim to evaluate the effectiveness, at population level, of the consumption of sugar fortified with NaFeEDTA for the prevention of iron deficiency. The fortification level used was 13 mg Fe/100 g sugar.

This sugar was distributed for a 20-month period to all inhabitants of three Guatemalan towns, two in the Pacific lowlands (Masagua and El Milagro) and one in the lower highlands (Pueblo Nuevo Viñas). To evaluate the effects of fortified sugar consumption, comparative studies were carried out between these three towns and another one acting as control (not consuming fortified sugar) in the lower highlands (Santa Cruz Naranjo).

Several hematological and biochemical indicators were measured in 6,000 individuals (see Annual Reports of previous years) to establish the efficacy of NaFeEDTA as a public health measure for the correction of iron deficiency, as well as its innocuousness in relation to other nutritional parameters. For this latter purpose, an evaluation of zinc, copper and magnesium nutritional status was carried out.

Preliminary results have shown a beneficial effect of fortified sugar consumption. However, the final interpretation of this study is pending, based on statistical analyses that Dr. Fernando E. Viteri is carrying out at PAHO headquarters.

It is expected that when the statistical analysis of the generated data is finished, the implementation of a system to utilize iron-fortified sugar for the prevention and treatment of iron deficiency will be carried out in the Central American countries.

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## PROJECT 2

### EARLY DETECTION AND PREVENTION OF MALNUTRITION IN MARGINAL URBAN AREAS OF GUATEMALA

*B. Torún, L. de León de von Ahn\*, B. García, J. M. Belizán and L. Gallardo*

As reported before (1980 Annual Report) this project is a joint effort of INCAP's Division of Human Nutrition and Biology and the Child Nutrition Foundation of Guatemala (Patronato Pro-Nutrición Infantil). The purpose of the project is to improve the nutritional status of the inhabitants of marginal urban areas of Guatemala and other developing countries. Its immediate objectives are: 1) to detect malnutrition from its onset in children under five years of age and in pregnant and lactating women, in order to improve their nutritional and general health status; and 2) to develop a system which will prevent the recurrence of the rehabilitated cases and the apparition of new cases of malnutrition through educational programs and the periodic assessment of the weight and height of children under five years of age.

Work was carried out in 1981 in *Colonia Maya*, located in zone 18 of Guatemala City, with a population of 7,535 inhabitants, forming 1,672 families. Seventeen percent of the population (1,270 children) is under five years of age and 13% (818 women) of the population is represented by women with children under five years of age, pregnant or with a spouse. Due to demographic changes in November, 1981, the number of families increased to 2,000 and the total population to 8,898 inhabitants, in spite of the fact that 260 families (14%) that lived in the area at the beginning of the year were no longer there.

Ninety preschool children with 10% or more deficit in weight expected for their height received a high protein and energy density supplement. The supplement consisted of cookies made of wheat, corn, whole dried milk, sugar and vegetable shortening, and a beverage (*atole*) made of milk, corn and sugar. It provided between 30 and 45 kcal and between 0.6 and 0.9 g of protein per kg of body weight per day. Forty-three of these children reached an adequate weight for their height in 14 to 18 weeks; 20 had improved significantly but left the project before complete rehabilitation due to emigration of their families; and 27 were still receiving the supplement after 4-12 weeks. The acceptance of the supplement by the children and their mothers has been satisfactory. However, there have been few isolated cases of maternal refusal to continue with the program mainly due to erroneous beliefs related to diarrhea and other health alterations that appeared coincidentally during the supplementary feeding period.

In November, 1981, 7.8% of the preschool children had a deficit of 10% or more in weight-for-height; 53.6% had a deficit of 5% or more in height-for-age (20.9% with a deficit of 10% or more); and 43.6% had a deficit of 10% or more in weight-for-age (8.2% with a deficit greater than 25%).

The educational program on health and nutrition had several components:

1. An intensive course on health and nutrition, which lasted 32 hr, was given to 82 women of the community, divided into four groups. This course was followed by a first-aid course which lasted 16 hr.
2. Weekly cooking demonstrations using traditional staples to prepare low cost dishes were given to the women who attended the other courses.
3. An audiovisual program was designed with graphic slides accompanied by recorded dramatizations that refer to certain aspects of health and nutrition. The main contents of this program were:
  - a) breastfeeding and infant feeding practices during the first year of life;
  - b) identification of growth alterations and prevention of malnutrition; and
  - c) prevention, diagnosis and early oral rehydration in diarrheal diseases.

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\* Technical Director of the Child Nutrition Foundation of Guatemala.



Inhabitants of *Colonia Maya*, Guatemala City, take anthropometric measurements of children and pregnant women to evaluate their nutritional status. This is a volunteer service

In the last trimester of 1981 this course was given weekly to groups of approximately 15 women. By the end of the year, 157 women had received the course. The acquisition of new knowledge and the correction of misconceptions was satisfactory: the average score of an evaluation done at the beginning of the course was 57<sup>o</sup>/o, and the evaluation at the end gave an average score of 82<sup>o</sup>/o. The evaluation of the impact of these courses on changes in behavior and attitudes will be carried out in 1982.

Programs on hygiene and home sanitation were designed and will be implemented in 1982. These programs include discussions about prevailing problems and their solutions; their aim is to stimulate all members of each family to acquire commitments in trying to solve the problems.

In 1982, the educational program will also be directed to school teachers and school children.

The efforts to convince women of the community to do volunteer work as urban health promoters for two hours each day have had variable results. At any given moment between 10 and 29 women have participated in the program. The causes for the limited participation have been migration, working demands, family relations that interfere with the project's activities, and fear of long-term commitments. Due to this, the system for volunteer participation will be changed, requiring shorter term commitments, rotating the volunteers in the various activities of the program, and involving other community volunteers, such as adolescents.

In 1982, work will be continued in *Colonia Maya* and the project will be extended to other communities in zone 18 of Guatemala City, in order to extend coverage to a population of about 25,000 people.

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# PROGRAM X

## DESIGN AND EVALUATION OF INTERVENTIONS WITH NUTRITIONAL IMPACT

### SUBPROGRAM A

### EVALUATION OF THE PROCESS AND IMPACT OF FOOD/NUTRITION INTERVENTIONS

#### PROJECT 1

#### EFFECTS OF NUTRITION ON MENTAL DEVELOPMENT FROM CONCEPTION UNTIL 84 MONTHS OF AGE

*R. E. Klein, J. Townsend, A. Lechtig and B. Newman*

Does nutritional status affect mental development? In 1969 INCAP began a longitudinal study of preschool children to answer this question.

The study included four *ladino*\* villages located in eastern Guatemala, matched for size and previously established demographic, social and economic characteristics. This was done taking into consideration that those factors associated with the size of the village (for example, social stimulation available) could contribute to the mental development of children, independent of nutritional factors.

Once selected and prior to the intervention, data were collected on family diet, anthropometry and mental tests, confirming that the villages matched for size were comparable. Then, one village was selected at random within each matched pair to receive a food supplement called *atole* (a hot drink with a high concentration of protein and energy). This drink was available for all residents two times a day at a special supplementation center. The other villages were assigned to a control condition, or *fresco*, in which a cold drink low in energy was also made available *ad libitum* for all residents.

The *atole* supplement contained 163 kcal per cup, of which 46 kcal were derived from protein sources. In contrast, the *fresco* supplement contained 59 kcal per cup and no protein. From October, 1971 on, both drinks contained sufficient vitamins and minerals to assure that these nutrients would not be limiting in the recipients' diets. Also at this time, fluoride was added to combat dental caries. In all the villages, mothers and children were encouraged to consume the supplements. The content of the two supplements is presented in Table 1.

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\* *ladino*: non-indigenous Spanish-speaking person.

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TABLE 1  
NUTRIENT CONTENT OF THE SUPPLEMENTS PER CUP (180 ml)\*

Nutrient	From October 1, 1971 to February 28, 1977	
	<i>Atole</i>	<i>Fresco</i>
Energy from all sources (kcal)	163	59
Energy from protein (kcal)	46	—
Energy from non-protein sources (kcal)	117	59
Protein (g)	11.5	—
Fats (g)	0.7	—
Carbohydrates (g)	27.8	15.3
Ascorbic acid (mg)	4.0	4.0
Calcium (g)	0.4	—
Phosphorus (g)	0.3	—
Thiamine (mg)	1.1	1.1
Riboflavin (mg)	1.5	1.5
Niacin (mg)	18.5	18.5
Vitamin A (mg)	1.2	1.2
Iron (mg)	5.4	5.0
Fluoride (mg)	0.2	0.2

\* Source: Wu Leung, Woot-Tsuen, in collaboration with M. Flores. *Tabla de Composición de Alimentos para Uso en América Latina*, Washington, D. C., U. S. Government Printing Office, 1961.

From the outset of the project, preventive and curative medical care was provided free by an auxiliary nurse who was supervised once a week by a physician. The few cases of severe or clinical malnutrition which were detected were referred immediately to the clinic for medical care and nutritional rehabilitation.

From March, 1969 until March, 1977 longitudinal data were collected on the physical growth of the children, home diets, daily consumption of supplement and cognitive development. Starting in 1970, data on the frequency and severity of symptoms of children's illnesses were collected through biweekly morbidity surveys. Similar data were also collected for pregnant and lactating women.

The style of life in the study communities can be characterized by poverty, malnutrition and illiteracy. Average family income when the study began was \$200 ± \$50 per year. Infectious diseases and chronic mild-to-moderate malnutrition were endemic; in 1968-1969 more than 80% of the children less than 7 years of age suffered from some degree of malnutrition. Although each community had a public elementary school, the functional illiteracy of adults was high, and the current generation of children of school age averaged less than two years of school attendance before giving it up completely. Additional ethnographic information about these villages can be found in Nerlove *et al.* (1974)\* and Mejía Pivaral (1972)\*\*.

In 1968, the total population of the four communities was approximately 2,634 inhabitants. Two of the villages, one in the *atole* and one in the *fresco* condition, were larger, each with a total population of

\* Nerlove, S. B., J. M. Roberts, R. E. Klein, C. Yarbrough and J-P. Habicht, *ETHOS*, 2(3): 265-295, 1974.

\*\* Mejía Pivaral, V. *Características Económicas y Socioculturales de Cuatro Aldeas Ladinias de Guatemala*. Guatemala, Instituto Indigenista Nacional, 1972. (Published in the Series *Guatemala Indígena*, Vol. 7).

about 850 residents, while the smaller villages had a total of approximately 500 residents each.

The subjects of the study were pregnant and lactating women and all children under 7 years of age in March, 1969, including those who were born or immigrated into the communities from then until March, 1973. Data collection on this sample continued until February, 1977; however, newborns were not added after March, 1973. Measurement coverage of mental tests was over 95% of the children present in the villages when the tests were scheduled.

The total number of children on whom data is available (for example, morbidity, supplement consumption, etc.) is 1,623; of these, 1,235 have preschool psychological test data.

In the completely longitudinal sample followed from birth to 5 years of age, as well as in the partial longitudinal sample which was evaluated from 7 years to school age, a statistically significant impact of malnutrition on mental performance can be identified, once socioeconomic factors are controlled for (see Table 2). Nevertheless, the percentage of variance in mental performance due to nutritional and socioeconomic factors from 5 to 7 years of age was similar and modest in size. In general, for the psychological tests which demonstrated differences associated with nutritional status, the differences were not greater than 0.3 to 0.5 of a standard deviation.

TABLE 2  
MANOVA\* OF PSYCHOLOGICAL TEST PERFORMANCE (*ATOLE* VS. *FRESCO*)

Age	Number of Variables**	Boys***/ SES●	Girls/ SES●
3	5	P < .06 (n = 176)	P < .00 (n = 163)
4	6	P < .02 (n = 181)	P < .00 (n = 156)
5	14	P < .00 (n = 139)	P < .00 (n = 129)

\* Multiple analysis of variance.

\*\* The psychological variables were: LINEA 3-5; MEMOB 3-5; INCL 3-5; DIGIT 3-5; NOMBR 3-5; VERBL 4-5; MFFIG 5; CONAR 5; INCOM 5; MEMDE 5; BLKDE 5; ELIMA 5; KNOX 5.

\*\*\* The P values correspond to the differences between *atole* and *fresco* conditions for all the variables entered in the analysis.

● Socioeconomic status of the family was statistically controlled for in these analyses.

## PROJECT 2

### EFFECT OF NUTRITIONAL AND HEALTH STATUS ON SCHOOL ACHIEVEMENT AND MENTAL DEVELOPMENT OF RURAL CHILDREN

*R. E. Klein, J. Townsend and B. Newman*

The objective of this Project was to explore the importance of nutritional and health history, family and cultural factors, and school attendance, as well as the interaction between these factors in the

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intellectual and social development of children in the rural areas of Latin America. The study took place in the four rural communities in eastern Guatemala which participated in the longitudinal study of the Human Development Division (see previous Annual Reports). In this fashion, we have taken advantage of the nine years of previous longitudinal data which existed on each child who participated in this study.

In 1978 we completed the measurement of mental development using psychometric tests of those children in the original sample. These children were between 9 and 14 years old when the study was completed.

The general results were the following: after 7 years of age, nutritional factors failed to play a direct role in most analyses. Attendance and performance in school are not related to the nutritional status of children at 7 years of age. On the other hand, intellectual ability at 7 years of age is strongly associated with schooling. Family socioeconomic status also is associated with schooling. Nevertheless, since socioeconomic factors are also strongly associated with intellectual performance, when both enter into the multiple regression equation, the effect of the socioeconomic status is not statistically significant. In general, the results indicate that children who attend school for longer periods and have better school performance come from families with higher socioeconomic levels and have greater intellectual ability in the preschool years. In reality, this should not surprise us. Nevertheless, given the general level of poverty in these communities, one would not ordinarily expect such a significant impact from socioeconomic status (see Table 3).

TABLE 3

THE RELATION BETWEEN COGNITIVE TEST PERFORMANCE IN SCHOOL YEARS, PRESCHOOL INTELLECTUAL ABILITY, PRESCHOOL NUTRITIONAL AND FAMILY SOCIOECONOMIC STATUS AND SCHOOL EXPERIENCE

School age test	Preschool intellectual ability	Preschool nutritional status	Preschool family socioeconomic status	School performance	P	R <sup>2</sup>
Syllogisms (correct responses)	*		*	*	0.0001	0.28
Syllogisms (expression of verbal reasoning)	*		*	*	0.0001	0.33
Verbal inferences	*		*	*	0.0001	0.44
Vocabulary naming	*	*	*	*	0.0001	0.50
Memory for digits	*		*	*	0.0001	0.43
Block design	*		*		0.0001	0.24
Matrix test	*				0.0001	0.29
Embedded figures	*		*	*	0.0001	0.17

\* Value of the partial correlation ( $P < 0.05$ ).

School age intellectual test performance is associated with preschool factors such as intellectual ability and socioeconomic status at 7 years of age. Preschool nutritional status, although significantly

associated with intellectual performance at 7 years of age, does not contribute directly to the prediction of school age intellectual ability in the multiple regressions. When nutritional factors do play a role, they do it through preschool intellectual ability and socioeconomic status.

The impact of schooling on mental development as measured by the school battery was strong and generalized. The school experience improves performance in various classes of psychological tests of the school battery, suggesting that the impact of school improves performance in a wide range of skills.

### PROJECT 3

#### LONGITUDINAL STUDY OF THE EFFECTS OF THE EARTHQUAKE OF FEBRUARY 4, 1976

*R. E. Klein, F. Bates\*, T. Farrell, J. Glittenberg\*\* and T. Edwards\**

This study was begun in 1977, in collaboration with a group of experts in disasters from the University of Georgia, U.S.A. The major objective of the investigation was to study the short, medium and long-term effects of the earthquake that struck Guatemala on February 4, 1976. In addition, the investigation sought to test hypotheses with respect to sociocultural and development changes in general. Finally, the study was designed to analyze the intervention methods employed to assist the population, taking into account the philosophies and goals of the national and international agencies involved. The objective here was to attempt to summarize the experiences of the various relief agencies and to make this information available to the appropriate interaction agencies and national governments.

The study included 25 communities drawn from almost all the areas of the country. The communities included are divided taking into account the following criteria: 1) indigenous - *ladino*; 2) severely damaged - slightly damaged; 3) urban - rural; 4) highland - eastern areas; 5) civil administration level. These divisions provided "controls" for the exogenous variables that could influence the quantity and quality of the aid provided following the earthquake.

The study was carried out at three main levels. First at the household level, in which the total sample consisted of  $\pm$  1,500 families, interviewed on two different occasions (1977-78 and 1979-80) and a detailed subsample of 250 household groups (1978). The interviews at a household group level included questions focused on concepts such as: social structure, dwelling before and after the earthquake, economic life, aid received and opinions regarding the aid, health and nutrition. Included also were questions on attitudes and sociocultural behavior, popular beliefs, etc.

The second level of the study centered on the communities themselves; damage and recuperation of the infrastructure of the community; collaboration with the agencies and aid received; general history of development and plans for the future. This study was carried out through interviews with formal and non-formal community leaders, review of official documents and observations.

The third level consisted of interviews with official representatives of the national and international agencies, review of documents to understand the philosophy and goals, and operational politics of the involved agencies. These data will be used to structure project profiles for use in response to disasters as well as in development programs in general. The data are currently being analyzed and a final report of the study's findings will be published during 1982.

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\*\* Nursing Department, University of Colorado, Denver, Colorado, U. S. A.

## SUBPROGRAM B

### OPERATIONAL RESEARCH ON SOCIOECONOMIC BEHAVIOR AND CHANGES IN NUTRITIONAL STATUS

#### PROJECT 1

##### THE PATULUL PROJECT: PRODUCTION, STORAGE, ACCEPTANCE AND NUTRITIONAL IMPACT OF OPAQUE-2 CORNS IN GUATEMALA

*V. Valverde, H. Delgado, J. M. Belizán, R. Martorell, V. Mejía-Pivaral, R. Bressani, L. G. Elías,  
M. R. Molina and R. E. Klein*

Previous annual reports have described the objectives, hypotheses and experimental design of the Patulul Project, reporting, at the same time, the results of pilot studies and progress achieved in data collection and analyses.

The field activities were terminated in February, 1981. Financial support was obtained from the *Centro Internacional de Mejoramiento del Maíz y del Trigo (CIMMYT)*\* for the elaboration of a monograph summarizing the different experiences the Divisions of Food and Agricultural Sciences and of Human Development have had with Opaque-2 corns (soft and hard endosperm) from 1976 to 1981. The following Subprojects describe some of the findings on Opaque-2 corns.

#### Subproject A      PRODUCTION AND STORAGE

The Patulul Project promoted the cultivation of 7,615 *quintales*\*\* of soft-endosperm Opaque-2 corn (SEO-2) in the Polochic Valley, department of Alta Verapaz, Guatemala, in 1979. As shown in Table 1, a mean weighted yield of 37.5 *quintales per manzana*\*\*\* was obtained ranging from 26.5 to 50.8 *quintales*. Although the yield of Opaque-2 was acceptable, as compared with local corn varieties, the farmers explained that excessive heavy rains and floods during the flowering stage and during the development of the ear damaged the plantation near the Polochic River, therefore reducing the production of Opaque-2.

\* International Center for Improvement of Maize and Wheat, Mexico.

\*\* *Quintal* = 100 lb.

\*\*\* *Manzana* = 0.7 hectare.

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TABLE 1  
AREA CULTIVATED AND YIELD OF SOFT ENDOSPERM OPAQUE-2  
CORN PRODUCED IN THE POLOCHIC VALLEY, GUATEMALA  
APRIL - JUNE, 1979

Farmer	Manzanas* with Opaque-2	Quintales(qq) ** of Opaque-2	Yield (qq/manzana)
A	70	3,557	50.8
B	54	1,431	26.5
C	2	70	35.0
D	42	2,162	51.5
E	--	21	--
F	--	174	--
G	5	200	40.0
Total	203	7,615	37.5

\* *Manzana* = 0.7 hectare.

\*\* *Quintal* = 100 lb.

INCAP also stimulated the cultivation of 6,000 *quintales* of hard-endosperm Opaque-2 corn (HEO-2) in Guatemala in 1979 and 1980-1981. The results of the production of HEO-2 in the Pacific Coast of Guatemala during 1980 are shown in Table 2. The HEO-2 gave a yield of 36.0, 37.5, 42.0, and 42.5 *quintales per manzana* in La máquina, and 37.5 and 40.5 in the region of Chiquimulilla. The farmers reported no agronomic problems or different yields from those usually found in the same area with local varieties. A farmer pointed out that he was keeping seed for the following agricultural year. Finally, with respect to production of HEO-2, a total of 2,400 *quintales* was harvested in different blocks of a farm in the Polochic Valley for the period 1980-1981. The results are summarized in Table 3. The differences in yield among blocks within the same farm are explained by differences in the terrain and agricultural practices. It was informed that, in a neighboring farm, a yield of 62 *quintales* was obtained during the same period of time using a local hybrid, while in a similar block cultivated with HEO-2, sixty *quintales per manzana* were obtained. These results are summarized in Table 4.

TABLE 2  
AREA CULTIVATED AND YIELD OF HARD ENDOSPERM OPAQUE-2 CORN  
PRODUCED IN THE AREA OF LA MAQUINA, SEPTEMBER, 1980, AND IN  
CHIQUIMULILLA, NOVEMBER, 1980, GUATEMALA

Farmer	Place	Yield (qq/manzana)
A	La Máquina	42.0
B	La Máquina	37.5
C	La Máquina	36.0
D	La Máquina	42.5
E	Chiquimulilla	37.5
F*	Chiquimulilla	40.5

\* Yellow variety.

TABLE 3

EXTENSIONS PLANTED AND YIELDS OF HARD ENDOSPERM OPAQUE-2 CORN OBTAINED BY A FARMER IN DIFFERENT ZONES OF *FINCA* IRUNA, THE POLOCHIC VALLEY, GUATEMALA, 1980-1981

Zone within the farm	Manzanas with HEO-2	Quintales (qq) of HEO-2	Yield (qq/manzana)
Los Silos	4.0	280	70.0
El Puente	2.0	120	60.0
La Ceiba	1.0	40	40.0
Plan Grande A*	22.0	1056	48.0
Plan Grande B	10.0	500	50.0
Shucub	7.5	510	68.0

\* Intense rain and humidity affected the development of the ear.

TABLE 4

YIELDS OBTAINED WITH HEO-2 IN *FINCA* IRUÑA AND WITH COMMON CORN IN *FINCA* PAMOXAN, IN THE POLOCHIC VALLEY, GUATEMALA, 1980-1981

Farm	Type of corn	Yield (qq/manzanas)
Iruña (El Puente)	Hard endosperm Opaque-2	60.0
Pamoxan*	Common corn (ICTA-3)	62.0

\* This area is similar to the block "El Puente", in *Finca* Iruña, which had a yield of 60 qq/manzana).

It is important to point out that in Guatemala City, at the coffee plantation and at the household level, no greater losses of SEO-2 and HEO-2 were reported from 1979 to 1981, following the usual treatments and storage procedures of common grains.

Thus, while the Patulul research team estimates that the agronomic research looking for new varieties of Opaque-2 should continue, the experiences described in Guatemala indicate that the low yield and high post-harvest losses of the first Opaque-2 strains reported in past decades have been almost eliminated with the introduction of new varieties developed by CIMMYT.

#### Subproject B NUTRITIVE VALUE

The results of chemical analyses of Opaque-2 corns cultivated in Guatemala are shown in Tables 5 and 6. The SEO-2 cultivated in 1979 had a protein content of 8.2 g/100 g of corn, which is similar to the protein concentration of local corn varieties. The HEO-2 variety has a higher protein content (from 8.8 g/100 g to 10.9 g/100 g of corn). As expected, the tryptophane and lysine content of HEO-2 is higher than in common corn, but 20% lower than the tryptophane content of normal Opaque-2 (see Table 6). Growth studies conducted in rats receiving the HEO-2 cultivated in the Polochic Valley in 1981 are presently being conducted to estimate values of Net Protein Ratio (NPR).

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TABLE 5

PROTEIN CONTENT (g/100 g) IN SAMPLES OF SEO-2 CORN HARVESTED IN THE POLOCHIC VALLEY, AND HEO-2 CULTIVATED IN LA MAQUINA AND IN CHIQUIMULILLA. GUATEMALA, 1979 AND 1980

Farmers	Place	Type of corn	Number of samples	Protein (g/100 g) $\bar{x} \pm S.D.$
A	Polochic	SEO-2	12	8.2 $\pm$ 0.3
B	Polochic	SEO-2	3	8.2 $\pm$ 0.8
C	Polochic	SEO-2	3	8.5 $\pm$ 0.9
D	Polochic	SEO-2	6	8.1 $\pm$ 0.3
E	Polochic	SEO-2	2	8.0 $\pm$ 0.1
F	Polochic	SEO-2	1	8.2 $\pm$ —
G	Polochic	SEO-2	1	8.9 $\pm$ —
A	La Máquina	HEO-2	3	9.9 $\pm$ 1.8
B	La Máquina	HEO-2	2	8.8 $\pm$ 2.4
C	La Máquina	HEO-2	3	10.5 $\pm$ 1.0
D	La Máquina	HEO-2	..	Not available
E	Chiquimulilla	HEO-2	3	10.6 $\pm$ 0.9
F*	Chiquimulilla	HEO-2	3	10.9 $\pm$ 0.6
G	Polochic	HEO-2	1	9.2 $\pm$ —

\* Yellow variety.

TABLE 6

CHARACTERISTICS OF THE HARD ENDOSPERM OPAQUE-2 CORN HARVESTED IN THE POLOCHIC VALLEY, GUATEMALA, APRIL, 1981

Characteristics	Values
Humidity	8.9 <sup>o</sup> /o
Ether extract	5.5 <sup>o</sup> /o
Protein	9.2 <sup>o</sup> /o
Tryptophane	0.078 <sup>o</sup> /o (0.85 g/100 g protein)
Lysine (estimated)	0.33 <sup>o</sup> /o (3.57 g/100 g protein)
<i>References</i>	
Common corn	0.048 <sup>o</sup> /o tryptophane
Normal opaque (100 <sup>o</sup> /o)	0.098 <sup>o</sup> /o tryptophane
<i>Kernel</i>	
Modified endosperm	74 <sup>o</sup> /o
Opaque-2 endosperm	7 <sup>o</sup> /o
Crystalline endosperm	19 <sup>o</sup> /o



**The Opaque-2 corn distributed to resident populations in coffee plantations was well accepted (Subproject "Acceptance of Opaque-2 corns", Patulul Project)**

### Subproject C ACCEPTANCE OF OPAQUE-2 CORNS

Two pilot studies were conducted in coffee plantations located near the farms included in the Patulul Project, in order to test the acceptance of these corns. In the first study, 24 families received three different types of corns (common, SEO-2, and HEO-2), and the acceptability of the corn was investigated with respect to flavor, appearance, color, cooking time and number of *tortillas* produced. No significant differences were found ( $P > 0.05$ ) with respect to acceptance of the corns under investigation.

In the second study, soft-endosperm Opaque-2 corn was distributed to 25 families residing in a small coffee plantation. Only the administrator knew of the different nutritional characteristics of the SEO-2, and he was asked not to communicate them to his laborers. Table 7 shows the data collected in a sample of 12 families, regarding acceptance of SEO-2 as compared to corn usually consumed in the plantations. The SEO-2 was generally considered similar or better than common corn. Furthermore, during the distribution of Opaque-2 corns for 16 months to a total of 420 families residing in three plantations, no complaints with respect to acceptance or storage of Opaque-2 corn were received by the owners, the farm administrators or INCAP's personnel. This is perhaps the best demonstration of the acceptance of these varieties of corn in rural Guatemala.

TABLE 7  
COMPARISON, ACCORDING TO 12 WOMEN, OF OPAQUE-2 CORN (SEO-2)  
WITH RESPECT TO COMMON CORN

SEO-2 as opposed to common corn	Characteristics					
	Cooking time	Appearance	Flavor	Texture	Color	Smell
Worse*	0	2	0	0	0	1
Better**	6	4	8	10	8	5
Equal	6	5	4	2	4	5
No response	0	1	0	0	0	1

\* Response for some organoleptic characteristics may be "more", "harder" or "darker".

\*\* Response for some organoleptic characteristics may be "less", "softer" or "lighter".

### Subproject D PRELIMINARY DATA ON NUTRITIONAL STATUS

This part of the analyses of the Patulul Project is still in its preliminary phase, as more available data for the intervention phase is in the process of being integrated. Furthermore, in order to control for the impact of other interventions—such as medical care services and improvements on family income—on children's growth, use is made of cross-sectional anthropometric data from seven coffee plantations utilized as supercontrol communities (no medical care nor Opaque-2 corn).

Table 8 presents the data on weight retardation (children 0 to 60 months of age in II and III degrees of malnutrition according to Gómez) in three control plantations and in other three farms receiving Opaque-2 corn at the initiation of the medical care program (1977). Table 8 also summarizes the nutritional status of children during 4 semesters in the same plantations (1 October 1977 to 30 September 1979); during this period, considered as "base line", the six plantations received a simplified medical care program. Furthermore, additional anthropometric information from three semesters regarded as "intervention" is also presented (1 October 1979 until 30 March 1981); during this period, in addition to the continuation of medical care services, three plantations (Opaque-2) received, as indicated by their names, Opaque-2 corns, and the other continued with only medical care. It should be noted that in both groups of planta-

TABLE 8

WEIGHT RETARDATION\* IN CHILDREN 0 TO 60 MONTHS OF AGE, STUDIED AT THE INITIATION OF A MEDICAL CARE PROGRAM AND DURING VARIOUS SEMESTERS OF THE BASE LINE AND INTERVENTION PHASES IN CONTROL OR IN COFFEE PLANTATIONS RECEIVING OPAQUE-2 CORNS. PATULUL PROJECT, 1976-1981

Semester	Phase	Plantations			
		Control		Opaque-2	
		n	%	n	%
	Before base line	322	43.1	345	41.5
First	Base line	149	29.5	422	34.4
Second	Base line	172	30.2	433	34.6
Third	Base line	198	21.7	431	32.5
Fourth	Base line	338	29.2	456	34.6
Total	Base line	853	27.9	1742	34.0
First	Intervention	80	32.5	103	31.1
Second	Intervention	409	22.2	481	26.8
Third	Intervention	355	18.3	445	23.6
Total	Intervention	844	21.6	1029	25.8

\* Children with a real weight-for-age below 75% of expected weight-for-age and sex.

tions, an increase of minimum wage of around 300% became effective as of May, 1980 (second semester of intervention).

As demonstrated by these preliminary data, the drop in the percentage of children with weight retardation from the initiation of the base line to the last semester of intervention is impressive (43.1 to 21.6% in controls; and 41.5 to 25.8% in plantations receiving Opaque-2 corns). The final analyses, which use additional cross-sectional data from super-control plantations without medical care, will attempt to separate the specific effects and the interaction of medical care, distribution of Opaque-2 and increases in minimum wages.

In spite of the preliminary nature of these findings, it is important to point out that the differences of height and weight retardation between phases (base line and intervention) for control and Opaque-2 plantations, are statistically significant ( $P < 0.001$  for weight retardation,  $P < 0.0001$  for height retardation)

(Table 9). If the present results are replicated in the final analyses, they will imply that the replacement of common corn by Opaque-2 corn had a positive nutritional impact at least in children 0 to 25 months of age. However, as pointed out before, the still preliminary nature of these findings does not allow as yet to arrive at such conclusions.

TABLE 9  
WEIGHT RETARDATION\* AND HEIGHT RETARDATION\*\* IN CHILDREN 0 TO 25 MONTHS  
OF AGE STUDIED DURING VARIOUS SEMESTERS OF THE BASE LINE AND  
INTERVENTION PHASES IN CONTROL AND IN PLANTATIONS RECEIVING OPAQUE-2  
CORNS. PATULUL PROJECT, 1976-1981

Semester	Phase	Weight retardation				Height retardation			
		Control		Opaque-2		Control		Opaque-2	
		n	%	n	%	n	%	n	%
First	Base line	71	25.4	207	34.8	71	31.0	208	58.6
Second	Base line	98	26.5	225	33.3	98	23.5	222	46.0
Third	Base line	114	17.5	231	30.7	111	18.0	224	47.8
Fourth	Base line	191	24.6	253	31.6	197	33.0	252	37.7
Total	Base line	474	23.4	916	32.5	477	27.2	906	47.0
First	Intervention	44	31.8	45	22.2	44	47.7	45	35.6
Second	Intervention	213	28.2	252	27.0	213	39.4	257	44.4
Third	Intervention	163	20.9	222	22.1	166	38.0	222	44.1
Total	Intervention	420	25.7	519	24.5	423	39.7	524	43.5

\* Weight retardation includes children with an actual weight below 75% of the expected weight-for-age.

\*\* Height retardation includes children with an actual height below 90% of the expected height-for-age.

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**SUBPROGRAM C**

**OPERATIONAL RESEARCH ON SERVICE DELIVERY  
SYSTEMS AND USE OF APPROPRIATE TECHNOLOGY  
IN NUTRITION**

**PROJECT 1**

**STUDY OF DETERMINANTS AND DIFFERENTIALS OF MORTALITY CHANGES IN  
GUATEMALAN COMMUNITIES**

*H. L. Delgado, V. Valverde and R. E. Klein*

In general terms, the study of factors associated with changes in mortality in developing nations, regions or communities is extremely useful for defining strategies which would tend to improve the health and nutrition status of a population. At the micro (family or community) level, these analyses indicate the effectiveness of simple, specific measures for modifying mortality rates. The same information also facilitates estimation of the impact which these measures would have if they were to be implemented at the macro (regional or national) level. The analyses at the macro level are useful for measuring the effectiveness of various policies of the health and other sectors.

At the national level in Guatemala, the available information indicates a long-term infant mortality decline. The causes of this decline have not been identified.

The Human Development Division has collected large quantities of information at the family and community levels in rural areas, which is extremely useful for studying the determinants of general and specific mortality. The data on health and nutrition as well as socioeconomic and demographic aspects collected in the various studies are comparable. In these rural projects, health and nutrition programs were also developed. These simplified medical care programs and nutritional interventions produced a reduction in infant and preschool age mortality rates. In the longitudinal study of growth and development, infant mortality dropped from 140-160 per 1,000 live births in the year prior to the study, to approximately 50 per 1,000 live births after four years. Calorie supplementation provided to the mother during pregnancy was responsible for a reduction in low birth weight babies ( $\leq 2.5$  kg) and short gestational age ( $\leq 37$  weeks). As shown in Table 1, the risk of infant death is considerably higher in those low birth weight and short gestational age babies than in their normal counterparts. This is one of the mechanisms by which the improvement of maternal nutritional status reduces infant mortality rates.

At present we are investigating the effect of other factors on infant and child mortality rates as well as the potential of several indicators for screening for risk of infant and child mortality.

**TABLE 1**  
**INFANT MORTALITY RATES BY CATEGORIES OF**  
**BIRTH WEIGHT AND GESTATIONAL AGE**

		Gestational Age	
		Short ≤ 37 weeks	Normal > 37 weeks
Birth weight	Low (≤ 2.5 kg)	3/17* = 176.5**	6/77 = 77.9
	Normal (> 2.5 kg)	5/58 = 86.2	21/510 = 41.2

\* (Deaths/at risk) x 1,000.

\*\* Infant mortality rate per 1,000 live births.

## PROJECT 2

### STUDIES FOR DEVELOPMENT OF APPROPRIATE TECHNOLOGIES

*H. L. Delgado, J. M. Belizán, V. Valverde and R. E. Klein*

During the last decades, the severity of the health and nutritional problems in the developing countries has received much deserved attention. In most cases, the health and nutritional problems are endemic and most serious in the poor, sparsely populated rural areas. Moreover, due to the limited resources, the coverage and quality of the health services in these areas are very limited. In order to solve this situation, many governments are bringing medical and health services to the rural areas, utilizing subprofessional personnel including promoters, traditional birth attendants and health auxiliaries. The limited resources and minimally trained personnel require that the methodologies and tools used be as simple as possible.

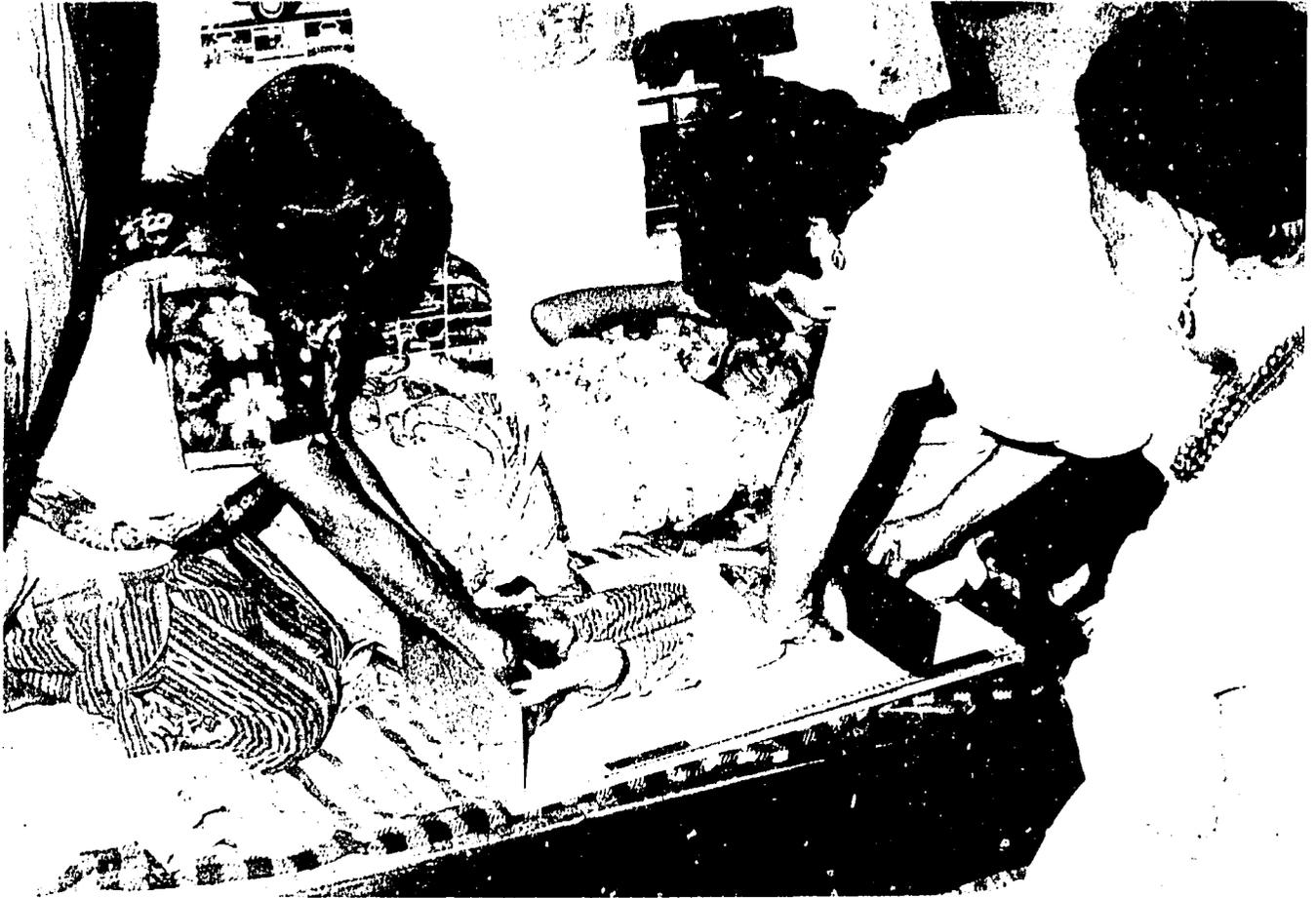
In order to identify appropriate technologies to be utilized in primary health care programs, a set of specific projects was developed.

#### Subproject A      UTILIZATION BY TRADITIONAL MIDWIVES OF EASILY TRANSPORTABLE SCALES FOR MEASURING BIRTH WEIGHT

In the context of a pilot project on Health and Rural Development implemented in four rural villages in the department of Sololá, Guatemala, a study on knowledge, attitudes and practices of traditional midwives was performed. The potential capability of the midwives to receive further training was also explored. A study was also carried out in the Patulul Project, in the department of Suchitepéquez. Similar results in terms of knowledge, attitudes and practices were found in both studies. In addition, these investigations pointed out the interest of traditional midwives in learning new techniques and procedures of benefit to the mother and the newborn. One of these techniques is the weighing of the newborn, utilizing appropriate equipment. The close contact kept with colleagues in the U.S.A. allowed us to identify an easily portable scale with a range from 0 to 5.0 kg, which could be utilized for weighing newborns. Incidentally, these scales were obtained in the San Francisco Bay Area, California, where they are utilized for weighing fish.

The specific objectives of this Subproject were to evaluate: 1) the feasibility of the use by traditional midwives of these easily transportable scales; and 2) the utilization of criteria of high risk in neonatal weight, using retrained empirical midwives.

The scales were utilized in the context of the Sololá and the Patulul Projects by auxiliary nurses and traditional midwives, under direct supervision, for a period of three years.



Traditional birth attendants are trained in the use of techniques to obtain newborn weight and length (Patilul Project)

The feasibility of the use by traditional midwives of this equipment was also explored in San Juan Sacatepéquez, with a group of traditional midwives with no previous experience in the measuring of birth weight. In total, 12 traditional midwives were trained in the utilization of the scale and in the identification of high risk cases to be referred to another level of care. After 100 measurements, it is obvious that the midwives are properly utilizing the equipment and are referring the high risk cases. In order to facilitate the identification of high risk cases, a strip with three colors identifying different levels of risk was added to the scale.

**Subproject B            EVALUATION OF THE TAPE FOR MEASURING UTERINE HEIGHT, TO BE USED BY HEALTH PROMOTERS IN THE ESTIMATION OF RISK OF INADEQUATE FETAL GROWTH**

Uterine height is frequently utilized in the estimation of the duration of pregnancy and, therefore, the gestational age. However, given the gestational age, the uterine height can be utilized to evaluate fetal growth. Based on this information, a measuring tape of three colors has been proposed by INCAP researchers as a mean to evaluate fetal growth and to select high risk pregnancies. This technique was preliminary tested in the Patulul and the Sololá projects, and was implemented in San Juan Sacatepéquez in 1981. At present, it is being tested in the field with traditional midwives and health promoters. After more than 100 measurements, it is clear that it is perfectly feasible to train paramedical personnel in the utilization of the colored tape.

**Subproject C            EVALUATION OF ARM CIRCUMFERENCE AS AN INDICATOR OF PROTEIN-ENERGY MALNUTRITION IN PRESCHOOL CHILDREN**

Arm circumference has been recommended as a useful indicator for malnutrition screening, particularly in rural areas. The great advantages of arm circumference over other anthropometric indicators are that the measure is easily obtained in rural areas and that the method for assessing arm circumference is simple, inexpensive and rapid. In this project, we analyzed the validity (specificity and sensitivity) of arm circumference as compared to more valid indicators of nutritional status in preschool children. The study was carried out in 3,699 preschool children living in coffee plantations in rural Guatemala. We conclude that arm circumference is relatively valid for detecting global malnutrition (as indicated by weight-for-age), but it is of limited validity when it is used for detecting acute or chronic protein-calorie malnutrition. Furthermore, when it was compared to weight-for-age in detecting populations or individuals at high risk of acute or chronic protein-calorie malnutrition, it was found that weight-for-age has a higher level of specificity and sensitivity than arm circumference. Finally, it was found that sensitivity and specificity of arm circumference vary with age, suggesting that arm circumference cannot be considered an age-independent indicator of nutritional status. It is recommended to have in mind these possible limitations of arm circumference when it is used in public health programs.

**Subproject D            EVALUATION OF A SIMPLIFIED SURVEY FOR SELECTION OF FAMILIES WITH HIGH MATERNAL-CHILD RISK**

Since 1969, the Division of Human Development has been investigating the effects of mild-to-moderate malnutrition on physical growth and intellectual development of children from conception to seven years of age. In the course of these investigations, a number of indicators of socioeconomic conditions and nutritional status of mothers and children have been tested. These indicators do not require expensive resources in terms of personnel or equipment, can be reliably assessed in "one shot" field examination, and are easily interpreted.

Among the measures used in the INCAP study are anthropometric measures of the mother (height, head circumference and arm circumference) and a housing scale as a measure of the socioeconomic condition of the family. Mothers of low birth weight babies were found to be typically small in stature and head circumference. In addition, their houses tended to be of relatively poor quality. The efficacy of these variables to predict high risk of low birth weight babies has been validated through a food supplementation

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program, part of the INCAP study design. The proportion of low birth weight babies found among women at risk, as defined by these variables, was significantly lower among women with similar characteristics receiving adequate food supplementation during pregnancy.

The validity of INCAP's risk indicators, however, was established under practically non-reproducible conditions. Therefore, there is still need for simple indicators which would allow for the definition of risk categories under less controlled conditions and in the absence of many accurate measures.

The purpose of the present Subproject is to investigate the utility of a brief census-like instrument to detect the mother-child population at high risk of malnutrition and mortality in a Mayan community in Guatemala.

A set of maternal anthropometric measures (maternal height, head circumference and arm circumference) were selected. In addition, in order to determine family socioeconomic status, a house score similar to that used in the INCAP study was obtained. This variable was a simple scaled observation of the materials used in building walls, ceiling and floor, and the existence of a separate kitchen and a wood stove. A description of the housing scale and the scoring system is presented in Table 2. In addition, the local assistant's rating of the wealth of the family as high, medium or low socioeconomic status was obtained. Reliability between informants was high.

TABLE 2  
SCALE FOR HOUSE SCORE

Item	Item score	Description
Floor	0	Dirt
	1	Cement
Walls	0	Cane, <i>bajareque</i> *
	1	Adobe, wood
Ceiling	0	Straw
	1	Corrugated tin, tile
Kitchen	0	One-room dwelling
	1	Separate
Cooking	0	Floor hearth
	1	Raised cooking hearth

Possible range= 0 — 5

\* Walls made with cane stalks, stone and mud.

Finally, child mortality rates within the family were expressed as percentages of the dead children under 2 and 5 years of age relative to the total number of children born in the family. Table 3 presents the association between child mortality within the family and the maternal anthropometric measurements and the socioeconomic status of the family. As shown in this table, there is a significant negative association between child mortality and the maternal and family characteristics.

Data collected in another field study, the Patulul Project, confirmed the strong negative association between maternal stature and child mortality, suggesting that the maternal height is a valid risk indicator for selecting families at risk.

TABLE 3  
 RELATIONSHIPS BETWEEN MATERNAL ANTHROPOMETRIC MEASURES,  
 HOUSE SCORE AND MORTALITY RATES WITHIN THE FAMILY,  
 STANDARDIZED BY AGE

House score	Maternal height	% mortality < 2 years	Maternal head circumference	% mortality < 2 years
Low	Low	22.7	Low	23.4
	High	20.0	High	19.4
High	Low	19.8	Low	18.3
	High	17.0	High	16.8

House score was broken into low: 0-2; high: 3-5.

Anthropometric measures were broken into low: deciles, 1-6; high: 7-10.

Percentages of the dead children under 2 years of age relative to the total number of children born in the family.

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Uterine height, obtained by traditional birth attendants is utilized as a means to evaluate fetal growth and to select high risk pregnancies (Patulul and San Juan Sacatepéquez Projects)

## PROGRAM XI

# STATISTICAL ACTIVITIES

*Dr. M. A. Guzmán*

During 1981, the activities of the Division of Statistics, under the frame of reference provided by the institutional program structure, can be summarized as follows:

### Development of human resources

The following actions have been developed in compliance with the responsibilities of the Division within the context of the academic program of the Institute:

1. A continuous 4-week seminar covering special topics in experimental statistics was conducted for graduate students in the Course of Food Science and Technology.
2. Supervision and guidance was provided in the Mathematics and Statistics Courses of the School of Nutrition, and in the Course in Elementary Statistics of the Graduate Course in Public Health with Emphasis on Nutrition and Mother and Child Health.
3. Advisory services and guidance were provided to 8 undergraduate students in the preparation of their theses, and to 12 graduate students in the preparation of their research protocols and/or reports of field practices as required in the curriculum. Additionally, statistical assistance was provided to 4 students from the Faculty of Chemistry and Pharmacy of the University of San Carlos who carried out research projects in the Institute prior to the preparation of their graduation theses. Three fellows of United Nations University also received statistical assistance in connection with their research activities in the Institute.

An important component in the development of human resources is the continuous assistance and statistical advice provided to the professional staff in the course of the preparation or analyses of the projects of their responsibility.

### Technical cooperation

The technical cooperation offered to the Member Countries was carried out through two operational channels: the first relates to the planning and execution of seminars and/or short courses in Statistics; the second channel relates to statistical assistance provided for specific in-country projects, both in their formulation and development stages, and during their execution and evaluation.

In Guatemala, the technical cooperation activities can be summarized as follows:

1. Development of a continuous seminar on Experimental Statistics for graduate students in the Department of Obstetrics and Gynecology of the Guatemalan Institute of Social Security. This seminar had a duration of one month and benefitted 34 students.

2. Planning and delivery of a short course in Applied Statistics for the Biological and Chemical Sciences, for members of the Professional College (a professional association) of Chemists and Pharmacists of Guatemala. This course, which lasted one month, created the need for the preparation of a first draft of a Manual on Statistical Procedures. Thirty six professional (chemists and pharmacists) attended the daily lectures prepared for the course.

3. Provision of advisory services and statistical consultation for: two undergraduate students from the Faculty of Chemistry and Pharmacy of San Carlos University; two undergraduate students from "Universidad del Valle"; and eight students in the graduate course in Obstetrics and Gynecology of the Guatemalan Institute of Social Security. These services were also extended to professionals of the Guatemalan Institute of Social Security in connection with a cooperative research project between that Institute and INCAP.

In Nicaragua, the technical assistance in Statistics related exclusively to specific projects and may be summarized as follows:

1. Food and Nutrition Surveillance System for the Education Sector. Assistance was provided in the development of methods for the project and for the purpose of defining, selecting and strengthening permanent activities as required for the development of a practical and functional food and nutrition surveillance system incorporated within the regular activities that are the responsibility of the education sector.

2. Food and Nutrition Surveillance System for the Health Sector. Basically, the Division of Statistics of INCAP collaborated in the development and evaluation of proper methods for the collection of information and covered aspects related to design, sampling, data processing and administration of field operations. In particular, special efforts were dedicated to the integration of the surveillance activities in the health sector with those of education. Through these efforts, and in the course of implementing the respective food and nutrition surveillance systems, it was possible to establish a basis for the free exchange of experience and information by the two sectors.

3. "PRONORTE" project. Professionals of the Division participated in the identification of areas for cooperation in the development of the "PRONORTE" project, with particular attention to the selection of criteria and components to be used for the evaluation of the project. It should be mentioned, incidentally, that it was in a department of the northern region in Nicaragua (Madriz), where a first approximation to the practical application of integrated and coordinated actions in the field of food and nutrition surveillance was jointly attempted by the health and education sectors.

## Research

The research activities of the Division originate in the Division itself or else are carried out in cooperation with other Divisions, as joint projects or as part of their projects.

### *Research projects originated within the Division*

1. Sensitivity and reliability of indicators of nutritional status commonly used in the development of food and nutrition surveillance systems.

Three studies were concluded in 1981 and summaries of the results have been presented to WHO, the sponsoring organization, as progress reports:

- Characteristics and properties of class definition schemes using different anthropometric indicators of nutritional status: Comparison of the Waterlow, Rutishauser and similar schemes with the Gómez classification using data from longitudinal and cross-sectional studies of the nutritional status of children.

- Methodological studies in Honduras: Field trial of methods for the collection and evaluation of anthropometric data.

- Design and implementation of food and nutrition surveillance systems in Nicaragua (see Technical Cooperation).

## 2. Studies of physical development in Santa María Cauqué.

Specific and coordinated activities were carried out to rescue the anthropometric data collected in Santa María Cauqué in previous years. This information will permit the study in a continuous fashion of the patterns of growth and development in this community of Indians of Mayan extract. Concomitantly with these efforts, a scheme was designed to permit the collection of anthropometric data in years to come, utilizing computer assistance for the purpose of defining required times for the collection of anthropometric measurement sets.

### *Research projects conducted in cooperation with other Divisions*

1. Studies of the interrelation of the physical capacity, nutritional status and energy requirements of adult human subjects. The activities developed in connection with this project relate primarily to the analysis of information already available to date. Different analytical schemes have been proposed which are at present in the process of execution in collaboration with the Division of Human Nutrition and Biology.

2. The research activities developed with other Divisions basically relate to the support that the Division of Statistics can provide for the design, analysis and interpretation of results of specific projects. Among others, the following projects received statistical support during 1981:

- Studies of the fecal contamination of the home environment
- Studies of factors that contribute to the hardening of beans during storage
- Methodological studies in connection with the evaluation of diets in adult human subjects
- Study and evaluation of different methods that can be used in the determination of tannins.

### **Other activities**

In compliance with the responsibilities of the executive secretariat for the Planning and Coordination Council (CPC), summaries of proceedings were prepared for 29 sessions. During the year, 22 new projects were processed. The recording of actions (alerting) required in connection with 56 active projects was expedited during 1981 utilizing computer assistance and a specially designed control board.

*Publications:* Five scientific reports were prepared for publication or presentation in scientific congresses or meetings. Some of these reports have already been published (see *Suplemento del Informe Anual, 1981*).

## SYMBOLS AND CORRESPONDING AGENCIES

AGROINDRA	Department of Agroindustries of the Ministry of Agrobusiness Development (Nicaragua)
AID	Agency for International Development (U.S.A.)
BCIE	Central American Bank of Economic Integration
BID	Bank for International Development
CARAOL	Cooperativa Agropecuaria Regional Alianza de Oriente Limitada (Honduras)
CARE	American Cooperative for Release Everywhere
CEPAL	Economic Commission for Latin America
CFTRI	Central Food Technological Research Institute (Mysore, India)
CIERA	Center for Studies and Research of the Agrarian Reform (Nicaragua)
CIMMYT	International Center for the Improvement of Corn and Wheat (Mexico)
CIPAN	Interministerial Commission for Food and Nutrition (Nicaragua)
CONADI	National Investment Corporation (Honduras)
CONASAL	National Salt Corporation (Nicaragua)
CONSUPLANE	Superior Council of Economic Planning (Honduras)
CPC	Planning and Coordination Council, INCAP
DIFOCOOP	Bureau of Cooperative Development (Honduras)
DIGESA	General Bureau of Agricultural Services of the Ministry of Agriculture, Livestock and Food (Guatemala)
FAO	Food and Agriculture Organization of the United Nations
ICTA	Institute of Agricultural Science and Technology (Guatemala)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IGSS	Guatemalan Institute of Social Security
IILA	Italian-Latin American Institute (Italy)
INISA	National Institute of Health Research (Costa Rica)
MIDA	Ministry of Agricultural and Animal Husbandry Development (Panama)
NCHS	National Center for Health Statistics (Atlanta, Georgia, U.S.A.)
OCAF	Control Office for Family Allowances (Costa Rica)

PAHO	Pan American Health Organization
SAPLAN	System of Analysis and Planning for Food and Nutrition (Honduras)
SEVEN	Nutritional/Epidemiological Surveillance Education System (Nicaragua)
SIN	Nutrition Information System
SINAPS	Integrated System of Nutrition and Primary Health Care in Rural Areas of Guatemala
UNAN	National University of Nicaragua
UNICEF	United Nations Children's Fund
UNDP	United Nations Development Program
UNU	United Nations University (Tokyo, Japan)
UTTA	Unit of Food Technology Transfer, INCAP
WFP	World Food Program
WHO	World Health Organization (Geneva, Switzerland)
WHP	World Hunger Programme of the United Nations University

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