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(101) Kan.State Univ. Food and Feed Grain Inst.

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FINAL

PROGRESS REPORT NO. 6

Improving the Nutritive Value of Cereal Based Foods

Agency for International Development
Contract No. AID/csd-1586

CONTRACTOR

The Food and Feed Grain Institute
Kansas State University
Manhattan, Kansas 66506

Submitted Sept. 30, 1975, covering period January 1973-March 31, 1975

IMPROVING THE NUTRITIVE VALUE OF CEREAL BASED FOODS

Progress Report No. 6

Table of Contents

Improving the Nutritive Value of Cereal Based Foods

AID/csd - 1586

Report Summary

A. 1. Improving the nutritive value of cereal based foods
AID/csd - 1586

2. Dr. William J. Hoover, Principal Investigator

Contractor: Kansas State University
Food and Feed Grain Institute
Shellenberger Hall
Manhattan, Kansas 66506

3. Contract Period (as amended): Dec. 1, 1973 to March 31, 1975

4. Period covered by Report: January 1, 1973 to March 31, 1975

5. Total A.I.D. funding of contract to date: $1,162,457.00.

6. Total expenditures and obligations through previous contract year -- $100,000.00 (8 months).

7. Total expenditures and obligations for current contract year: $232,000.00.

B. Narrative Summary of Accomplishments and Utilization

Soy fortified wheat flour products based on products developed in this project are now purchased under PL-480 Title I and II Food for Peace programs and are finding usage in school lunch and other institutional feeding programs. The fortified breadstuffs including bread, buns and cookies are the basic product in the school lunch programs in some 35 countries. Exports are at the level of 200 million pounds this year and in recent months have exceeded the export of unfortified wheat flour.

The main effort in the project currently is to establish soy fortified flour on a commercial basis for institutional feeding programs or for the general population in several developing countries. Feasibility studies looking at the technological, economic, and marketing situations in seven countries were conducted. El Salvador and Equador were selected as the best prospects for early introduction of fortified flour on a national basis and plans to proceed with that introduction were developed.

Work continued to perfect recipes and methods for optimizing the production of high protein buns and cookies.

Limited investigations were carried out on processing other protein resources including sunflower seed flour and isolate, chickpea flour and isolates, rapeseed flour, Buffalo gourd seed, and extruded full fat soy flour. Milling of triticale and grain sorghum flours as breadstuff ingredients were also accomplished.

Improving the Nutritive Value of Cereal Based Foods

AID/csd - 1586

PROGRESS RESEARCH REPORT

A. Project Objectives

The general objective of this research project is to improve the nutritive value of cereal based foods in North Africa and Pakistan by supplementation and process modification without decreasing the food acceptability to the general consuming public in those areas.

As the technology for fortifying breadstuffs evolved, the worldwide implications of the results were recognized. The objectives were broadened to include evaluation and development of protein rich fractions from indigenous crops, implimentation of usage of soy fortified wheat flour products in institutional feeding programs, and conducting of economical evaluations or cost-benefit studies of fortified cereal-based foods in selected countries.

1. Specific Objectives for the Current Contract Period

a. Expand use of high protein bread technology to other LDC's through close cooperation with A.I.D. Project Manager.

b. Select target countries for initiation of programs leading to implementation of commercial fortified bread products.

c. Conduct economic evaluations or cost-benefit studies of fortified cereal-based foods in selected countries.

d. Continue application of fortification technology to cookies, pasta and other traditional cereal based foods.

e. Continue evaluation of additional protein resource materials and protein concentrates from legumes.

B. Accomplishments to Date

1. Prefeasibility Studies

The major effort during the period was the conducting of prefeasibility studies in seven selected countries to determine the technological, economical, and marketing potential of commercial success of soy fortified flour based breadstuffs as a nutritional intervention.

A systematic selection or screening program was initiated to pick nine or ten countries which could be considered "best bets" to evolve successful commercial or government sponsored fortified wheat flour programs. A total of 41 countries were evaluated including 7 from Southeast Asia, 6 from Near East-South Asia, 12 from Africa and 16 from Latin America. Secondary data and information was gleaned from FAO Reports and Bulletins, U.S.D.A. publications including FAS country reports, ICCND nutritive surveys, and marketing reports of Great Plains Wheat and Western Wheat Associates.

Factors assessed included: Population (Total, Percent Rural, Percent under 15); Economic level as indicated by Per Capita Gross National Product; Nutritional Status (Total calories per capita per day, calories from cereals and tubers per capita per day, protein in grams per day per capita, and animal protein in grams per day per capita); Net Wheat Per Capita Consumption and Trend; Wheat Supply (domestic vs. Import); Protein Resources; Price Relationships of Wheat, Other Grains, and Protein Resources; Government Interest or Commitment to Nutrition; Status of Milling Industry (capacity, location, and level of technology); Status of Baking Industry (capacity, location, and level of technology); Status of Edible Protein Source Industry (capacity, location, and level of technology); Pertinent Laws and Regulations; Government

Controls of Supply and Price; Local or International Nutrition Programs; and Institutions for Composite Flour Technology.

The results of this audit is shown in the tables for each geographic area (pages 5-8). Three independent systems of scoring or rating the countries based upon weighing the factors and then assigning numerical scores to each factor for each country were developed by Dr. O. J. Scoville, Dr. W. J. Hoover, and by Dr. W. J. Hoover and P. R. Crowley. Although there was some variation of countries appearing in the "Top Ten" and in the rank order of the three rating systems, nine countries seemed to stand out as "best bets". It was recognized even from the secondary data that each country evaluated had perhaps one or more critical deficiency or limiting factor and that no country stood out as a sure thing for the implementation of a soy fortified flour program.

The nine countries selected for prefeasibility studies were (alphabetical order) Brazil, Colombia, El Salvador, Equador, Iran, Korea, Morocco, Peru and Turkey.

Country on site studies have been conducted in Brazil (W. J. Hoover, P. Gormely - 2 weeks); Colombia (W. J. Hoover, P. Gormely and E. E. Alt, USDA - 1 week); El Salvador (W. J. Hoover, P. Gormely and E. E. Alt, USDA - 1 week); Equador (W. J. Hoover, P. Gormely - 1 week); Iran (W. J. Hoover - 1 week); Peru (W. J. Hoover, P. Gormely - 1 week); and Turkey (W. J. Hoover, P. Gormely - 2 weeks and Dr. C. C. Tsen - 1 week).

Morocco was deferred to last because earlier studies during the project had determined much of the information needed to evaluate the country. Morocco was not visited because of time limitations as the termination date of the project approached. Korea was not visited as the Nutrition Group in the Economic Research Service of USDA working under a PASA agreement with the Office of Nutrition, TAB was investigating

Country AID Involvement	POPULATION Total	POPULATION Rural	POPULATION Under 15	PER CAPITA GNP	Total calories	% Calories from cereals & tuber	% NEEDS Protein	Protein from animal sources	NET WHEAT PER CAPITA CONSUMPTION AND TREND	WHEAT SUPPLY Domestic	WHEAT SUPPLY Import	PROTEIN RESOURCES	PRICE RELATIONSHIPS	GOVERN INTEREST OR COMMITMENT TO NUTRITION	INSTITUT FOR COMPOSITE FLOUR TECHNOLOGY	STATUS OF MILLING INDUSTRY CAPACITY	STATUS OF BAKING INDUSTRY	STATUS EDIBLE PROTEIN SOURCE INDUSTRY	LOCAL OR INTERNATIONAL NUTRITION PROGRAMS	PERTINENT LAWS AND REGULATIONS	GOVERN CONTROLS ON SUPPLY AND PRICE
N E S A	1000	%	%	$	cal/day	cal/day	gms/day	gms/day	lbs/year	1000 mt	1000 mt	1000 mt	$/mt			mt/day					
Afganistan	17,125	82	no data	80	2060 [1]	1765	65.4	7.8	352	1915	69										
India	550,376	68	41	110	1990 [2]	1586	49.4	5.6	100 [2]	23,247	3,423	Dry beans 2090 Dry peas 759 Chickpeas 5247 Lentils 355 Pigeon peas 1841 Groundnuts 5800 Rapeseed 1963 Sesame 4600 Other pulse 1150		Modern Bakeries Prog.	CFTRI - Mysore GFW Baking School	12,000 216 roller mills	biscuits bread Modern Bakeries 250,000 loaves/day Britannica, 135,000 loaves/day in Delhi Rapid increase in retail bakeries.				
Nepal	11,040	92	40	80	2030 [1]	1776	52.0	6.7	25	150	10										
Turkey	35,232	69	42	310	2760 [1]	1953	77.9	14.8	422.4 (140.2F)	12,600		Dry beans 155 Dry peas 5 Broadbeans 43 Chickpeas 120 Lentils 105 Soybeans 13 Groundnuts 40 Rapeseed 7 Sesame 410 Sunflower 396 Other pulses 16			Ege University Izmir, Turkey	60% modern mills capacity 40% stone mills Modern, 2000 + mt	1 biscuit plant (1964) Thousands of small bakeries				
W. Pakistan	131,325 W. Pak less 53,514	70 incl. Bangla-desh	44	100	2410 [2]	1997	54.9	9.9	89.5	6,388		Dry beans 93 Chickpeas 480 Lentils 70 Pigeon peas 3 Groundnuts 135 Rapeseed 380 Sesame 300 Other pulse 210			PCSIR - Lahore W.Pakistan Ag. University	8796 46 roller mills	[illegible] Karachi [illegible] Many small bakeries				
Iran	28,662 30,000 growing 3.1%	46	46	380 700	2030	1547	55.2	11.7	228 [a] 170 kg	3,500 5,000		Beans 11 Chickpeas 45 Lentils 37 Soybeans 50 20 Sesame 80 Sunflower 50 100 Cottonseed 350				45 commercial mills 1900 mt 1700 grain flour (1963) 3000 mt	40% bakeries for bread [illegible] firms Many small bakeries	5 oilseed crushing companies Importing 110,000 T of crude soy oil 60,000 T of veg. oil Import no beans Oil consumption increasing 12% per year. Some refining capa. 200 T cap/day	Limited soil program by CARE	No trade restrictions	

Country AID	POPULATION Total	POPULATION Rural	POPULATION Under 15	PER CAPITA GNP	Total Calories	NET NEED Cal. from cereals & tubers	NET NEED Protein	Protein from animal source	NET PER CAPITA CONSUMPTION AND TREND	WHEAT SUPPLY Domestic	WHEAT SUPPLY Import	PROTEIN RESOURCES	PRICE RELATIONSHIPS	GOVERN INTER OR COMMITMENT TO NUTRITION	INSTITU OR COMPOSITE FLOUR TECHNOLOGY	STATUS OF MILLING INDUSTRY CAPACITY	STATUS OF BAKING INDUSTRY	STAT EDIBL PROTEIN SOURCE INDUSTRY	LOCAL INTERNATIONAL NUTRITION PROGRAMS	PERTI LAWS AND REGULATIONS	GOVERN CONTROLS ON SUPPLY AND PRICE
AFRICA	1000	%	%	$	cal/day	cal/day	gms/day	gms/day	lbs/year	1000 mt	1000 mt	[illegible]	$/mt			mt/day					
Algeria	13.723	56	47	300	1890[1]	1523	55.7	6.6	193	1.600		Dry beans 4 Dry peas 2 Broadbeans 16 Chickpeas 18 Lentils 9				Modern Mills, 2000 mt/day 300 days-2 shifts (63)60% total remainder in small mills	small bakeries 50,000 mt of biscuits (1963)				
Ethiopia	25.314	85	44	80	1980[2]	1465	66.3	11.0	46.2	840		Sesame 700 Dry beans 74 Dry peas 130 Broadbeans 143 Chickpeas 189 Lentils 109 Soybeans 6 Groundnuts 24 Other pulses 60				23 corn mills 3,000 stone mills (1964) 233 mt/day	small bakeries 1 biscuit 3 pasta plants (1964				
Ghana	8.632	55	45	310	2070[1]	1770	43.0	7.3	12.3			Groundnuts 70 Other pulses 8				1 large mill (1965) 146 mt/day	85%bakery bread 10%cookies,cake 5% home use 1 biscuit factory. Few large bakeries,many small.				
Ivory Coast	4.916	81	43	310	2430[1]	2055	59.1	12.9	27			Dry beans 4 Groundnuts 43 Other pulses 7				1 mill 133 mt (1964)	17 bakeries 1 large 36,000 loaves per day (1964)				
Kenya	10.811	80	46	150	2200[1]	1701	68.0	15.9	15.4	210		Groundnuts 2 Sesame 30 Sunflower 3 Other pulses 270				11 mills 366 mt	40% bread bakeries mechaniz. 2 large bakeries 70% flour,bread 10% cake and biscuit 20% home use				
Liberia	1.179	74	37	24.	2280[1]	2012	41.4	8.5	6.2			Groundnuts 2									
Morocco	15.579	61	46	250	2130[1]	1618	57.7	10.0	200.6	2.210		Sunflower 21 Dry beans 5 Dry peas 42 Broadbeans 190 Chickpeas 100 Lentils 22	Wheat flour .69 (lb/kilo) Pasta (bulk) 1.27 Chickpeas .97 Rice 1.93 Broadbeans 71 Wheat 16	School lunch program. Ministry of Education, Ministry of Health		45 Modern Mills 3,263 mt/day 5,000 village mills	Retail or neighborhood Toll bakeries No wholesale bakery	Sunflower meal available. Chickpea or broadbean flour industry would need to be developed.	CRS-AID School Lunch program, 900,000 persons AID Work for Food, 100,000 mt of wheat	No additives to bread	Fixed price on bread. Controlled price on commercial flour.
Nigeria	67.795	67	43	120	2290[1]	1816	59.9	8.4	5.7			Cowpeas 700 Soybeans 33 Groundnuts 1100 Sesame 200			Fed. Inst. of Ind. Research, Lagos						
Tunisia	5.271	46	46	250	2200	1547	62.9	10.9	213.4	470		Broadbeans 24 Chickpeas 13 Lentils 1				20 corn mills 1000 mt/day	Flour consumpt. (1964) 120,000 mt bread 30,000 mt pasta 1 000 mt biscuit				
Uganda	8.549	86	no data	130	2160[1]	1597	55.9	15.1	7.7			Sesame 230 Dry beans 270 Dry peas 1 Chickpeas 2 Pigeon peas 40 Cow peas 63 Groundnuts 34				1 mill (1964) 24 mt/day	30 small bakeries 1 biscuit plant				
Zaire	17.433	78	no data	90	2040[1]	1640	32.7	8.9	32.1	3		Dry peas 80 Soybeans 2 Groundnuts 200 Sesame 50				1 large new mill (1973)					
Tanzania			no data	100					3.7Kg[1]												

Country: Alle involvement	POPULATION Total	Rural	Under 15	PER CAPITA GNP	NUTRITIONAL Total calories	Calories from cereals & tubers	Protein	Protein from animal sources	NET WHEAT PER CAPITA CONSUMPTION AND TREND	WHEAT SUPPLY Domestic	Import	PROTEIN RESOURCES	PRICE RELATIONSHIPS	GOVERNMENT INTEREST OR COMMITMENT TO NUTRITION	INSTITUTION FOR COMPOSITE FLOUR TECHNOLOGY	STATUS OF MILLING INDUSTRY CAPACITY	STATUS OF BAKING INDUSTRY	STATUS OF EDIBLE PROTEIN SOURCE INDUSTRY	LOCAL OR INTERNATIONAL NUTRITION PROGRAMS	PERTINENT LAWS AND REGULATIONS	GOVERNMENT CONTROLS ON SUPPLY AND PRICES
ATIN AMERICA	1,000	%	%	$	cal/day	cal/day	gms/day	gms/day	lbs/year	1000 mt	1000 mt	1000 mt	$/mt 1961-65			mt/day					
olivia	4,930	58	42	180	1760[1]	1363	45.8	12.1	77	62		Broadbeans 7 Groundnuts 9	Wheat 70 Corn 71 Beans 190								
razil	93,565	44	43	420	2820[1]	1942	66.8	21.4	57	2,056	1,168	Soybeans 2,218 Dry beans 2,430 Sesame 40 Broadbeans 75 Groundnuts 850	Wheat 99 Corn 31 Cassava 8 Soybeans 59		Dept. Agric., Rio	11,500	2 lg. bakeries Thousands of small shops.	Soy flour now in production.		Add 2%-5% cassava or corn flour at mill. No "bread improvers" but malt.	Price control on bread. Import quotas on wheat.
olombia	22,800	40	47	340	2140[2]	1475	50.0	25.5	44	78	336	Soybeans 130 Dry beans 50 Dry peas 30 Sesame 315 Other pulse 30	Wheat 125 Rice 130 Corn 85 Beans 330 Soybeans 130 Cassava 54		6% baking school IIT, Bogota T. de Buckle	1,700 30% for pasta	13,000 bakeries 90% manual				
osta Rica	1,800	45	48	560	2370[2]	1554	62.0	26.8	60		77	Dry beans 14 Sesame 1	Corn 66 Beans 160			500 1 mill	350 bakeries 98% small shops			Private sector corn import wheat	Price support on corn & sorghum. Some ceilings on consumer yields.
ominican epublic	4,325	61	47	350	2060[1]	1207	50.1	21.5	51		132	Dry beans 32 Broadbeans 6 Sesame 3	Corn 60 Cassava 42 Beans 270			515 1 mill	400 bakeries 2 mechanized				
cuador	6,093	54	48	290	1970[2]	1306	45.5	15.5	43	60	100	Dry beans 30 Sesame 27 Peas 16 Broadbeans 16 Groundnuts 8	Wheat 77 Corn 67 Beans 175			827 3 coastal mills 22 mills in Sierra reg.					
l Salvador	3,700	61	45	300	1850[2]	1393	45.2	12.5	49.8		92	Beans 25 Sesame 85	Corn 65 Beans 155		6% baking school	410 50% bread, 45% sweet, red [illegible] for imported wheat crop. 50,000	250 bakeries (240 small shops)				Govt. price support on corn & sorghum.
uatemala	5,180	63	46	360	2020[2]	1600	50.5	12.7	34	32	69	Beans 63 Sesame 60 Broadbeans 3	Wheat 130 Corn 56		ICAITI Guatemala City	600 23 mills	2,000 bakeries 1,200 in Guat City. Manual.				30% of wheat milled must be local.
uyana	763	32	46	340	2080[4]	1472	46.5	17.9	80		33		Rice 65		Pollard	200 new mill					
aiti	4,867	77	38	110	1930[1]	1504	47	4.7	17			Beans 19	Corn 90			200 1 mill	160 bakeries				
onduras	2,582	67	46	257	2200[2]	1632	55	15.5	33		50	Sesame 9	Corn 50			355 5 mills	200 manual bakeries		United Fruit pilot trials of soy beans. (Comayagua)		
icaragua	2,044	56	48	430	2330[2]	1588	63.2	20.7	25		58	Beans 57 Sesame 7%	Corn 62 Beans 175			220 A flour mill at Managua for imported wheat & local corn	400 bakeries 80% are semi-mechanized.				
anama	1,464	43	43	730	2370[1]	1554	58.2	26.3	47		43	Beans 5	Corn 75			325 3 mills	1,000 bakeries 3 are highly mechanized (99% P.C. prod.)				
araguay	2,386	53	46	260	2540[2]	1620	65.4	29.0	86	39	62	Soybeans 52 Dry beans 37 Peas 3 Broadbeans 3 Groundnuts 20	Wheat 7.1 Corn 3.7 Soybeans 7.1 Cassava 2.2 Rice 8.7 Potato 7.5		Univ. Nat'l de Asuncion Inst. de Ciencia						Must add 5% cassava flour at mill.
eru	14,072	46	45	450	2190[1]	1657	54.6	19.1	46	127	680	Beans 65 Broadbeans 23 Peas 20 Chickpeas 3 Groundnuts 5	Wheat 68 Corn 69 Beans 155 Cassava 25		Univ. Agraria, Lima	[illegible] (1963) 5 large mills	1 pasta plant 2 lg. bakeries 3 bisc. plants 70% bread flour 20% for pasta 10% biscuits				
uguay	2,852	17	28	820	2740[2]	1376	90.8	62.8	190	388		Beans 2 Sunflowers 49	Wheat 51 Corn 58			1,000 (1963) 35 large mills	30% households 67% bread [illegible] pasta, 3 bad small plants.				

Country AID Involvement	Total	Rural	Under 15	PER CAPITA GNP	Total calories	Calories from cereals & tubers	Protein	Protein from animal sources	NET WHEAT PER CAPITA CONSUMPTION AND TREND	WHEAT SUPPLY Domestic	WHEAT SUPPLY Import	PROTEIN RESOURCES	PRICE RELATIONSHIPS	NATIONAL INTEREST OR COMMITMENT TO NUTRITION	INSTITUTE FOR COMPOSITE FLOUR TECHNOLOGY	STATUS OF MILLING INDUSTRY CAPACITY	STATUS OF BAKING INDUSTRY	STATUS OF EDIBLE PROTEIN SOURCE INDUSTRY	LOCAL OR INTERNATIONAL NUTRITION PROGRAMS	PERTINENT LAWS AND REGULATIONS	GOVERNMENT CONTROLS ON SUPPLY AND PRICE
Southeast Asia	1,000	%	%	$	cal/day	cal/day	gms/day	gms/day	lbs/year	1000 mt	1000 mt	Kind	$ mt			mt/day					
Indonesia	119,917	70	42	80	1950[1]	1581	428	5.2	9.7		393F 605	Soybeans 1 Groundnuts 4				7100 3 large mills 1 million tons per year	Biscuits O.K. Bread, antiquated, primitive. Biscuits: 10% of flour, Year, bread: 80% all-purpose flour, 11-12% protein.				
Korea	32,422	53	39	250	2490[1]	2177	72.4	9.4	80[1]	363	1,672	Dry beans 31 Soybeans 230 Groundnuts 6 Rapeseed 27 Sesame 120 Other pulses 6			WHA Baking School, Seoul	5,000 23 mills Modern	Range from adequate to primative. Rapidly improving				
Laos	2,850	78	?	120	2040[1]	1832	44.6	5.2	2.2			Groundnuts 1									
Okinawa	947		?								58										
Philippines	38,480	70	47	210	2040[1]	1612	53.2	20.6	33		540	Dry beans 25 Cow peas 5 Soybeans 1 Groundnuts 1			Food & Nutr. Res. Center, Manila WHA Baking School, Manila	3000 7 large mills	Good biscuit industry. Bread bakeries generally small & primative. New bakeries beginning to appear.				
Thailand	35,814	76	43	200	2210[1]	1790	50.5	12.3	7[1]		44	Dry beans 23 Soybeans 90 Sesame 220			Kasetsart Univ.	280 3 mills	Few good bakeries in Bangkok, remainder are primative.				
Vietnam	18,362	74	no data	20[1]	2200	1883	48.6	11.1	11.2			Dry beans 12 Soybeans 7 Groundnuts 2				500 2 large mills					

and assisting the implementation of the commercial production of soy fortified bread by the Sam Lip Foods Company of Seoul, Korea. Mr. P. R. Crowley and Mr. E. E. Alt were leading this effort with personnel working under this contract providing technical support.

Following a careful analysis of each of the seven countries, it was determined that there is a practical potential for nutrition intervention using protein fortified and vitamin and mineral enriched breadstuffs in each of the countries. There appeared to be no compelling reason why such a program could not be successful in anyone of the seven if a carefully developed implementation program were developed and if a genuine interest in and support for such a nutrition intervention plan were developed by the Government of any of the countries.

In fact, the use of soy fortified flour appears to be the most practical and most economical massive nutritional intervention program that could be carried out in any of the nine selected countries.

All factors considered, however, lead to the selection of Ecuador and El Salvador as the countries most likely to introduce a soy fortified flour program in the immediate future. Subsequently a second visit to Ecuador was made by W. J. Hoover and E. E. Alt of USDA. Mr. Alt revisited El Salvador and subsequently Mr. Alt and Dr. Fred Barrett of USDA have conducted baking demonstrations there.

The results of the prefeasibility studies are given in Appendices A through G.

2. Application of Fortification Technology to Cookies, Buns and other Breadstuffs

During the period work continued which resulted in perfecting methods and recipes for producing protein fortified cookies and buns for school

lunch programs. Acceptability tests were conducted with children in the Manhattan, Kansas school system. The fortified cookies and buns were found equally as acceptable as unfortified controls.

a. Extruded Soy Products from Whole and Dehulled Soybeans Cooked at Various Temperatures for Bread and Cookie Fortification

A newly developed extrusion cooker, the Brady Crop Cooker, was employed to extrude soy products used in the study. The cooker, easy to install and operate and low in cost, could be advantageously used in developing countries to produce soy products for fortifying uses. The study was undertaken to evaluate such extruded soy products prepared from whole and dehulled soybeans cooked at various temperatures used as fortifiers for bread and cookie flours.

For making 12% soy fortified breads, the baking quality of samples cooked at low temperatures was better than that of those cooked at high temperatures. Acceptable bread could be made from wheat flour fortified with whole or dehulled soy products up to 20% by adding 0.5% SSL. However, the whole soybean product tended to reduce the loaf volume and to lower the grain score more than did the dehulled soybean product fortified at higher levels.

When the extrusion-cooked soy product in the form of flakes was used directly as a fortifier, yellowish-brown spots formed in the fortified bread crumb and crust. Roller-mill grinding of the soy products (to pass a 20W or 36W screen) eliminated the defect. Also, the ground product greatly improved the grain score of fortified breads. The findings suggest that whole soybean can be used to produce extruded soy products so as to eliminate the dehulling process and reduce the production cost.

Acceptable chocolate chip, coconut, oatmeal, and sugar cookies could be prepared from wheat flour fortified with either whole or 12% dehulled soybean products. Dehulling and grinding were found to be not required for preparing such cookies.

b. High-protein Breads from Wheat Flour Fortified with Peanut Products

Peanuts are produced in many developing countries such as India, Nigeria and Senegal, where soybeans are not generally grown. The study was conducted to develop acceptable high-protein breads from wheat flour fortified with peanut products instead of soy products for those countries.

The protein content of bread was raised to 30.4, 43.5, or 68.8% over the control bread by fortifying it, respectively, with 10, 15, or 25% peanut flour. However, peanut flour was found deficient in lysine, methionine, threonine, and valine; its protein quality was low. Adding soy flour could improve the nutritional quality of such fortified breads. PER values (corrected), obtained with rats' feeding tests, were (a) 1.14 for the control bread, (b) 1.32 for 15% peanut fortified bread, (c) 1.79 for bread fortified with 10% peanut flour and 5.5% soy flour, (d) 1.89 for bread fortified with 5% peanut flour and 11.0% soy flour, and (3) 2.15 for 16.6% soy fortified bread. Peanut fortified bread retained softness well during storage. Its crumb appeared much darker than that of wheat bread.

c. Using Indigenous Flours and Starches as Bread Supplements in Developing Countries

In many countries like Brazil and Indonesia, where the supply of nonwheat flours and starches from indigenous crops is abundant,

use of locally available cassava and corn flours and starch is important. Supplements could cause adverse effects on dough properties and bread quality. However, by using a modified bread-making process and adding a surfactant, ethoxylated monoglycerides, sodium stearoyl-2 lactylate or sucrose tallowate, we prepared acceptable bread from wheat flour supplemented with up to 20% non-wheat flour or starch from several crops indigenous to developing countries. Work is under way to evaluate the staling rate of such supplemented breads and their nutritive and organoleptic properties.

3. A System for Soy Fortification of Wheat Flour

In each country study the specific questions of how can an existing wheat flour mill be modified to produce soy fortified flour and what will be the cost were asked. To answer these questions, a prototype system was evolved from the experience gained and installations made in U.S. mills that are manufacturing soy fortified wheat flour for P.L. 480, Title II programs.

The following system for soy fortification of wheat flour is based on a mill producing 150 metric tons (3300 cwt) of flour per day. The equipment is sized to add 6% or 12% soy flour to the wheat flour stream.

The formulations are as follows:

Soy flour level	12%		6%	
Wheat flour - 11% min protein	183.67	kg.	183.67	kg.
Soy flour - defatted 50% min protein	22.67	kg.	11.33	kg.
Emplex	1200	gms.	551	gms.
Calcium Carbonate	760	gms.	760	gms.
Malted Barley Flour	500	gms.	500	gms.
Potassium Bromate Mix	37	gms.	37	gms.
Enrichment - Vit. A	33	gms.	33	gms.

The six ingredients can be added to the flour stream anywhere between the flour scale in the mill and bulk load out. Continuous mixing on stream will minimize handling of ingredients and segregation of materials with different bulk densities. A separate feeder for each ingredient is placed above a mixing conveyor.

The soy flour would require storage bins above the feeder because of the large amount used per day. This would also necessitate handling the soy flour in bulk quantities. The other ingredients could be handled in 50 or 100 lb. bags since smaller quantities are used.

The quantities per hour are as follows:

Soy flour level	12%	6%
Soy flour	770.31 kg.	384.92 kg.
Emplex	41.08 kg.	18.66 kg.
Calcium Carbonate	25.74 kg.	25.74 kg.
Malted Barley Flour	16.93 kg.	16.93 kg.
Potassium Bromate	1.25 kg.	1.25 kg.
Enrichment - Vit. A	1.11 kg.	1.11 kg.

The feeders, mixing conveyor and rebolt sifter required are listed below:

1. For calcium carbonate, Emplex and Malt. (3 feeders)

   Wallace and Tiernan Volumetric Feeder;
   Series A-690
   $1520.00 each; F.O.B.; Belleville, N. J. 4,560.00

2. For Potassium Bromate and Enrichment mix.
   (2 feeders)

   Wallace and Tiernan Roll type volumetric feeder;
   Series A-378
   $1135.00 each; F.O.B.; Belleville, N. J. 2,270.00

3. For Soyflour. (2 feeders)

   Drawer Conveyor-Type Feeder
   Style J#2A
   $1727.00 each; F.O.B.; Buffalo, N. Y. 3,454.00

4.	Mixing conveyor 9" - cut & folded flight 20 ft. long with drive $1200.00; F.O.B.; St. Louis, Mo. Design Mfg. Co.	1,200.00
5.	One Bar Nun Sifter. #462 Model MB. $6698.70; F.O.B.; Buffalo, N. Y. B. F. Gump Div. of Blau Knox Food & Chemical Equipment, Inc.	6,698.70
	TOTAL	$18,182.70

All feeders are supplied with totally enclosed motors. Each soy flour feeder is calibrated so that one is used for the 6% level and two for the 12% level. The Emplex feeder would have two settings, one for the 6% and one for the 12% level. After mixing, the fortified flour must be sifted to ensure there are no lumps or foreign objects from the equipment. If there is a rebolt sifter before packing or bulk load out the sifter in the estimate may be left out.

Installation costs are difficult to identify since some mills may have existing bins that can be used for soy flour storage. If storage is not available new bins will have to be purchased or built. The cost of installation can vary depending on whether outside contractors or local mill wrights do the work.

4. Processing of Protein Resources

a. Sunflower Seed Flour Proteins

From the previously established mill flow an improved sunflower seed flour has been milled. Proximate analysis indicates protein of the sunflower seed flour to be 45.3% and that of the sunflower seed flour protein isolate to be 73.3%. It is believed the quality and quantity of the sunflower seed flour protein isolate can be improved.

Both the sunflower seed flour and its protein isolates contain high amounts of unsaturated fatty acids such as oleic (31%), linoleic (48%) and the saturated fatty acid stearic at 8%. There is very little change in the fatty acid relationship when the protein isolates are made. The presence of such quantities of unsaturated fatty acids may present some problems in storage, but this has not been tested in the present study. However, this does point up some good nutritional qualities in these products.

The results of the amino acid analysis indicate a decrease in the cystic-cysteic acid value for the sunflower seed flour protein isolate and an increase in the tyrosine and phenylalanine values compared to sunflower seed flour. These changes may be attributed to loss of water soluble acid, nonprecipitable proteins and the prolamine fraction during isolate preparation.

Results of the peptization studies, by the Oborne series, indicate globulins as the major protein of the sunflower seed flours.

Of the gel-filtration studies, it was found that sodium acetate buffer (0.002 N, pH 3.8) gave the better resolution. Likewise, the anionic gel-system, pH 9.3 was best in using disc-electrophoresis for study of the sunflower seed flour protein isolate.

It was somewhat disturbing to find that both the sunflower seed flour and its protein isolate contained a trypsin inhibitor. The full results of this part of the study are incomplete.

b. Rapeseed Flour Proteins

The problem of toxin in the rapeseed protein and rapeseed flours has not been resolved. We find that the toxic factors

can be greatly reduced by steaming or hot water treatment, but not completely removed. Many other treatments have been tested but none has really hit the mark we would like, and that is zero level. We have not made any animal feeding trials thus far.

c. Chickpea Flour Proteins

Problems on the extruding of the chickpea flour proteins and its protein isolate have not been resolved. The temperature and pressure range for obtaining good texturization without browning or burning of the finished products is very, very critical. Oil, water or certain glycerides do not relieve the problem, however, there is some improvement with an oil and water emulsion and thorough blending. Blending chickpea protein with protein from other legumes before preparation for extrusion shows some promise.

d. Gourd Seed Protein

Work that was not supported under the AID Project but which may be of interest was experiments evaluating gourd seed as a potential protein and fat source. The buffalo gourd seed used is adapted to arid climates and production projection by Curtis (Ford Foundation) indicates potential yields can be in the neighborhood of 2000 pounds per acre. Work to date has shown that the gourd seed contains 30% to 35% fat which is high in linoleic acid (70% to 72%) and contains approximately the same level of protein, 30% to 35%.

When the hull is removed, this yields a concentrated source of protein. The protein of the gourd seed is lower in lysine than soybean protein but has a higher level than found in sunflower seed. It is high in arginine. It may be a better source of methionine than soybean protein.

The status of this work to date has been preliminary fractionation and milling studies are planned to develop procedures for dehulling the material. The dehulled, defatted meats from the gourd seed contain between 55% to 60% protein and preliminary studies with sieving have indicated that this can result in protein levels between 65% to 70%. Future plans are to evaluate the nutritional value of this protein using rats and a determination of protein characteristics including its possible use in textured vegetable protein materials.

5. Milling Studies

a. Triticale Milling

Methods of milling a great many varieties of triticale were developed using the miag multomat mill at 120 lb. of grain per hour.

In 1974, a large sample of triticale grain, 5600 lb., was milled in the K.S.U. pilot mill. With modification, this first large scale milling test was quite successful.

A 69.07% flour yield was obtained indicating that a flour mill arranged to mill soft wheat could be adapted to the milling of triticale. A commercial rye mill should do quite well on triticale.

All 23 flour streams were sampled for 5 minutes, weighed and analyzed for moisture, protein and ash.

A cumulative ash curve can be plotted for comparison with previous tests with the smaller multomat mill or with subsequent large scale tests with different triticale samples or with research into better conditioning methods, grinding procedures, etc.

b. Grain Sorghum Milling

A small German wheat scourer has been adapted to the debranning or scarifying of sorghum grain. This enables us for the first time to perform this function with relatively large samples of sorghum on a continuous basis.

Whether this operation results in better sorghum grits and flour from dry milling has not been determined.

C. Dissemination and Utilization of Research Results

A major effort has been made to quickly disseminate project findings through traditional technical and trade press publications, participation

in technical meetings, conferences and workshops, correspondence, and material exchange, and a large number of visitors and trainees.

Publications

Tsen, C. C. and W. J. Hoover, High-Protein Bread from Wheat Flour Fortified with Full-Fat Soy Flour. Cereal Chem. 50:7 (1973).

Tsen, C. C., High-Protein Cookies. Snack Food 63 (4):36 (1974).

Tsen, C. C., E. P. Farrell, W. J. Hoover and P. R. Crowley, Extruded Soy Products from Whole and Dehulled Soybeans Cooked at Various Temperatures for Bread and Cookie Fortifications. Cereal Foods World, In Press, 1975.

Tsen, C. C., G. Medina, and D. S. Huang, Using Indigenous Flours and Starches as Bread Ingredients in Developing Countries, Proc. 4th International Congress of Food Science and Technology, In Press, 1975.

Tsen, C. C., P. R. K. Reddy, W. J. Hoover, and P. R. Crowley, High-Protein Breads from Wheat Flour Fortified with Peanut Products, Proc. 4th International Congress of Food Science and Technology, In Press, 1975.

Tsen, C. C., Fatty Acid Derivatives and Glycolipids in High Protein Bakery Products, J. Am. Oil Chemists Soc. 51:81 (1974).

Tsen, C. C., C. N. Majibian, and G. E. Inglett, Defatted Corn-Germ Flour as a Nutrient Fortifier for Bread. Cereal Chem. 51:262 (1974).

Tsen, C. C., E. M. Peters, T. Schaffer, and W. J. Hoover, High Protein Cookies I Effect of Soy Fortification and Surfactants, Bakers Dig. 47(4):34 (1973).

Chung, O. K., and C. C. Tsen, Changes in Lipid Binding and Distribution During Dough Mixing. Cereal Chem. 52:4 (1975).

Tsen, C. C., Proceso para mejoras el valor proteinico del Balillo, National Council of Science and Technology, Mexico City (1973).

Chung, O. K., and C. C. Tsen, Changes in Lipid Binding and Protein Extractability During Dough Mixing in Presence of Surfactants, Cereal Chem. 52:4 (1975).

Tsen, C. C., W. J. Hoover and E. P. Farrell, Baking Quality of Triticale Flours, Cereal Chem. 50:1 (1973).

Madl, R. L., and C. C. Tsen, Proteolytic Activity of Triticale, Cereal Chem. 50 pp. 215-219 (1973).

Farrell, E. P., C. C. Tsen and W. J. Hoover, Milling Triticale into Flour, Triticale: First Man-Made Cereal, AACC pp. 224-233 (1974).

Tsen, C. C., Bakery Products from Triticale Flour, Triticale: First Man-Made Cereal, AACC pp. 234-242 (1974).

Madl, R. L., and C. C. Tsen, Trypsin and Chymotrypsin Inhibitors in Triticale, Triticale: First Man-Made Cereal, AACC pp. 168-182 (1974).

Hoover, W. J., Status of the Milling and Baking Industries in Africa and Asia, Cereal Science Today 19:4 (1974).

Millers National Federation. Soy Fortified Wheat Flour. National Press Bldg. Washington D.C. (1973).

Tsen, C. C, W. J. Hoover and P. R. K. Reddy, Nutritional Improvement of Cereal Based Foods. Proc. International Congress of Nutrition, Kyoto, Japan, In Press (1975).

Hoover, W. J., Use of Soy Proteins in Bakery Products, J. Am. Oil Chemists Soc. 52 (April 1975).

Technical Meetings at Which Papers were Presented

American Association of Cereal Chemists, St. Louis, Missouri
October 1973

American Association of Cereal Chemists, Montreal, Canada
October 1974

American Association of Cereal Chemists, Regional Meeting,
Chicago, Illinois April 1975

American Association of Cereal Chemists, Regional Meeting,
New York, New York April 1975

World Soybean Conference, Munich, Germany
October 1973

International Congress of Nutrition, Kyoto, Japan
August 1975

International Congress of Food Science and Technology
Madrid, Spain September 1974

American Oil Chemists Society, Annual Meeting
New Orleans, Louisiana April 1973

American Oil Chemists Society, Annual Meeting
Mexico City, Mexico April 1974

World Soybean Research Conference
Champaign, Illinois August 1975

Participation in Workshops and Seminars

AID Nutrition Conference, Tunis, Tunsia
September 1973

Grain Marketing Workshop, Hutchinson, Kansas
March 1973

Grain Marketing Workshop, Manhattan, Kansas
March 1974

Grain Marketing Workshop, Belleville, Kansas
March 1975

Bakers Seminar, Mexico City, Mexico
April 1974

Seminar, Instituto de Tech. de Alimentos, Campinos, Brazil
April 1974

Seminar, USDA, Washington, D.C., 1973

Bakers Advisory Committee, USDA, Albany, California
February 1974

Correspondence and Material Exchange

A large volume of correspondence with workers in the field from all areas of the world has been established and continues. Samples of all products have been furnished upon request and samples of high protein materials have been tested when submitted to Kansas State University.

In addition to the seven selected countries studied in the prefeasibility studies, a continuing correspondence and assistance effort during the period has involved the following countries:

Korea	Iraq	Hong Kong
Japan	Lebanon	Australia
Taiwan	Israel	Canada

Guam	Egypt	Mexico
Philippines	Tunesia	Guatemala
Indonesia	Algeria	Honduras
Vietnam	Nigeria	Costa Rica
Thailand	Zaire	Venezuela
Bangladesh	Sudan	Guyana
Sri Lauka	Kenya	Bolivia
India	Ethiopia	Paraguay
Pakistan	Morocco	Argentina
Chile	Jamaica	Dominican Republic
Nicaragua	Trinidad	Haiti
Jordan	Bulgaria	Holland
England	Denmark	Spain

That means a worldwide technical information exchange involving at least 55 countries.

Visitors

Many workers from overseas have visited our laboratories and reviewed and discussed results and the possible application to their countries. These represent government, industry and the scientific community from the following countries:

India	Indonesia	Guatemala
Pakistan	Algeria	Spain
Japan	Iran	Colombia
Taiwan	Bulgaria	Peru
Mexico	Australia	Ecuador
Brazil	Chile	

Several visitors have come for specific training and spent from two days up to one year working in our laboratories. These persons have come from Taiwan, Colombia, Ecuador and Mexico.

D. Work Plan for the Coming Year

This represents the final reporting period for the current contract and thus no work plan for the coming year is formally projected.

In each of the seven countries surveyed in the study, there appears to be a real opportunity to achieve a significant and successful nutritional intervention through the use of soy fortified wheat flour on a continuing and commercially viable basis. The probability of success or the near term initiation of such a program varies from country to

country, but the opportunity to exploit the results of this AID sponsored research project exist in every one of these countries.

In addition, at least five countries which were not included in the original list of countries, i.e., Chile, Egypt, Jamaica, Honduras, and Costa Rica should be visited and studied to develop prefeasibility analyses.

A new project to provide technical assistance to AID and through AID to cooperating countries has been proposed. Specifically, in calls for providing technical assistance in planning and implementing programs for improving the nutritional value of cereal based foods through (1) fortification with protein-rich foodstuffs and/or enriching with vitamins and minerals, and (2) improvements in the processing and marketing systems for cereal based foods.

It is believed that unless the program of technical assistance proposed is initiated, AID will not have an adequate response and support capability to sustain the interest evolving in developing countries for soy fortified wheat flour as a nutritional intervention.

At the present time, development of such a nutritional intervention program is not a part of the basic ongoing agricultural and food programs in the USAID missions. Unless high priority and support is provided by the Office of Nutrition of the Technical Assistance Bureau, the enthusiasm and interest created in the developing nations for soy fortified flour will wane and the initiation of the use of the product for nutritional improvement will not come to fruition.

The proposed program of technical assistance will sustain and increase the multitude of technical assistance activities that were initiated during

the latter stages of project 1586 and which have already served as a world-wide focal point in this area. Loss of this point of focus through lack of financial support at this time will be critical to the ultimate success of these potential nutritional intervention programs.

E. Involvement of Minority Personnel and Women

The following minority personnel and women have been employed on the project during the current reporting period:

Dr. C. C. Tsen, Professor
Dr. R. C. Robinson, Associate Professor
Mr. Carlos Sanchez, Instructor
Mrs. Phyllis Faulk, Secretary

Research Associate
Miss Kusum Patel

Research Assistants

Miss Carolyn H. Geng	Miss Louetta Bauck
Miss Cathleen N. Mojibian	Mrs. Donna Medlin
Mrs. Karen Penner	Mrs. Linda Wallingford
Miss Edna Peters	Mrs. Rebecca Longbottom
Mr. C. S. Rao	Mr. Den-Shun Huang
Mrs. Merlene Ryan	Mrs. Teresa A. Shaffer

Graduate Research Assistants

Mr. Koo Chung	Mr. Wan Shiang Wu
Mr. Chuan Kao	Miss Maneepun Saipin
Mr. Abdur R. Khan	Mr. Charles Ke
Mr. Leh-Yeu Ling	Miss Kusum Patel
Miss Nipa Somnapan	

No problems were encountered in connection with their employment. Kansas State University has a well functioning equal opportunity employment policy.

F.

SMITHSONIAN

SCIENCE INFORMATION EXCHANGE, INC.

SIE NO.

NOTICE OF RESEARCH PROJECT

Supporting Agency		Agency's Number
AGENCY FOR INTERNATIONAL DEVELOPMENT	Contract No: and/or Control No:	AID/csd 1586

Title of Project

IMPROVING THE NUTRITIVE VALUE OF CEREAL BASED FOODS

Principal Investigator	School or Division	Department
DR. WILLIAM J. HOOVER	KANSAS STATE UNIVERSITY	Food and Feed Grain Institute

Name and Address Inc. Zip Code	Food and Feed Grain Institute KANSAS STATE UNIVERSITY MANHATTAN, KANSAS 66506	Period For This NRP: Start Date: Jan. 1, 1973 End Date: March 31, 1975 Annual Funding: $174,435

Summary of Project

Technology has evolved from this project that allows the protein fortification of wheat based breadstuffs to provide greatly improved nutritive value without changing organoleptic acceptability or appreciably increasing the cost of the foods. Soy fortified wheat flour products based upon this research are being used in institutional feeding programs in over 35 countries. In 1974-75 over 200 million pounds of soy fortified flour was purchased for the Food for Peace program under Title II, P.L. 480. The main effort currently is to establish soy fortified flour as a continuing and commercially viable nutritive intervention in several countries. Prefeasibility studies were conducted in Brazil, Colombia, El Salvador, Ecuador, Iran, Peru, and Turkey. El Salvador and Ecuador were selected for further study and as immediate candidates for implementation of country wide commercial introduction of soy fortified flour. Research continued to perfect recipes and procedures for fortified breads, buns, cookies and pasta products. Limited investigations continued on processing of protein concentrates from several potential sources of plant protein.

G.

FISCAL REPORT

Contract AID/csd - 1586

12-1-73 through 3-31-75

Previous Budget $930,457.00 Previous Expenditures $930,781.62

	Firm Budget 12-1-73 to 3-31-75	Expenditures 12-1-73 to 3-31-75
Salaries	118,750.00	121,272.45
Consultants	2,000.00	-0-
Equipment & Books	17,000.00	13,022.70
Supplies	11,000.00	12,531.03
Travel & Trans.	15,000.00	10,397.10
Other Direct Costs	9,825.00	6,867.98
Overhead	58,425.00	59,666.05
	232,000.00	223,757.31
Subtotal		1,154,538.93
Travel Paid by AID		23,318.85
Total	1,162,457.00	1,177,857.78

PRELIMINARY EVALUATION OF POTENTIAL OF SOY FORTIFIED WHEAT FLOUR FOR NUTRITIONAL IMPROVEMENT

BRAZIL

Prepared for Project csd/1586
by
William J. Hoover
and
Patrict J. Gormely

TABLE OF CONTENTS

PRELIMINARY EVALUATION OF SOY FORTIFIED WHEAT FLOUR FOR NUTRITIONAL IMPROVEMENT

BACKGROUND

Nutritionally improved bakery products have become technologically possible through research efforts performed at Kansas State University and further developed under a contract with the Office of Nutrition, Technical Assistance Bureau, United States Agency for International Development entitled "Nutritional Improvement of Cereal Based Foods."

Prior to these research efforts, the addition of soy flour to wheat flour in amounts sufficient to increase substantially the protein content of the resulting bakery products resulted in products with poor quality and, as a consequence, low consumer acceptability. The research efforts determined that the use of sodium stearoyl-2-lactylate (SSL) in the soy fortified flour allows the production of nutritionally improved products without loss in organoleptic quality.

As a practical result of this project, soy fortified flour (SFF), containing either 6% or 12% defatted toasted soy flour and enriched with vitamin A, niacin, thiamin, riboflavin, calcium and iron, is being purchased through Food for Peace programs, P.L. 480 Title II, for use in institutional feeding programs sponsored by voluntary agencies or host governments in approximately 20 countries.

At the present time, efforts under this project are focused on the question of use of the SFF technology beyond institutional feeding programs. Specifically, we are now attempting to determine if adoption of the SFF technology for commercial or institutional purposes would be efficient in the immediate future in one or more countries. As a first step in this determination we used readily available information about USAID-assisted countries in order to pick out nine countries to be the subjects for more detailed "pre-feasibility" studies. We are now in the process of carrying out the pre-feasibility evaluations on these nine countries.

(The following report is the evaluation for Brazil.) At the end of the pre-feasibility studies we hope to be able to identify two or three countries in which complete feasibility studies leading perhaps to large-scale pilot projects for the evaluation of the viability of SFF products would be carried out.

In making the pre-feasibility studies, we use a number of assumptions. We assume that it is possible to specify within usable limits the amounts of nutrients (e.g., calories, protein, vitamins, minerals) required by individuals. We further assume that it is an appropriate objective for a society to create a situation in which all its members are able to consume the required amounts of nutrients. An implication of this assumption is that it is not necessary to estimate the benefits of adequate nutrition: benefits are assumed to exist, and if they were to be measured would be found to be greater than the costs of providing adequate nutrition. In this view the nutrition problem for a society is one of providing the required nutrients efficiently, that is, at the lowest possible cost.

New technologies for providing nutrients have been developed in the past and still newer ones will be developed in the future. In some cases more nutritious forms of agricultural raw materials (e.g., high lysine varieties of corn, manioc, sorghum) will be developed. In others more nutritious foods using already existing ingredients (e.g., SFF products) will be developed. The question that arises in regard to the use of a new technology is whether or not it is an efficient provider of nutrients. Before it is used, each new technology should be examined to determine if in fact it is an efficient way of providing nutrients. Many things are technically possible but not economically efficient.

No single technological improvement will solve all the nutrition problems of a society. But each technology that is adopted should be a component of an efficient system to provide nutrients.

It needs to be stressed that the evaluation of a technology is not directly related to the existence of a particular nutritional deficiency. Even if all members of a society are consuming protein in required amounts, so that there exists no protein deficiency, it still makes sense to search for and to introduce technologies that provide protein at lower cost. The existence of protein deficiencies may make more urgent the introduction of lower cost protein, but deficiencies are not a necessary condition.

Our pre-feasibility evaluations are preliminary attempts to determine the efficiency of the SFF technology in particular societies. A full-fledged feasibility study will need to marshal facts necessary (1) to decide if the SFF technology in principle is an efficient provider of nutrients, and if so, (2) to discover the practical problems that will have to be overcome in order to put the technology into use. We hope to decide whether such full-fledged studies are warranted in particular countries.

SUMMARY

Protein--calorie malnutrition has many causes. Low income levels and lack of concern about nutrition on the part of consumers can lead to too low a demand for and inadequate intakes of protein and calories. Nutrients may be high priced due to low agricultural productivity and the unavailability of nutritious varieties of agricultural raw materials and nutritious forms of processed foods. These causes of malnutrition can be addressed by general increases in per capita income and nutrition education leading to increased demand for nutrients, and through technological improvements that lead to increased supplies of nutritious agricultural raw materials and more nutritious processed foods. Some of these approaches will work over the long-term (e.g., increases in per capita income) and some in the short-term (e.g., protein fortification of existing foods).

Due to the complexity of the protein-calorie malnutrition problem, there is no single approach to its solution. Many approaches will be needed. It was not our purpose to compare wheat flour fortification with the other possible approaches. We have made a preliminary examination of the potential usefulness in Brazil of wheat flour fortification. On the basis of this preliminary examination we think that protein fortification (and simultaneous vitamin and mineral enrichment) of wheat flour offers a useful approach that can be implemented in the short-term. The more extensive study that we recommend would attempt to test this preliminary conclusion.

Wheat flour based foods form a substantial and basic part of the diet of most Brazilians except those in the rural areas of the west and north. Wheat flour, more than any other basic food ingredient, lends itself to fortification or nutritional intervention because it is processed in a relatively small number of large mills.

Brazil is blessed with a large and increasing protein resource in soybeans. This resource represents a great potential for improving the diet via food grade soy flour, soy concentrate, and soy isolate. Defatted toasted soy flour represents the least expensive commercially available source of nutritionally valuable protein in most countries and this will be particularly true in Brazil when domestic production begins in 1975.

The technology of soy flour fortification of wheat flour is now highly developed. The adaptation of Brazilian flour mills for soy flour fortification and vitamin and mineral enrichment of wheat flour is thought to present little difficulty. The use of soy fortified flour is compatible with Brazilian baking methods and will not significantly alter the quality of bakery or pasta industry products in Brazil.

Some alternative levels of nutritional intervention with soy fortified wheat flour are:

a. Fortification and enrichment of all wheat flour produced by mills having a capacity of over 5,000 metric tons per year.

b. Fortification and enrichment of all wheat flour produced by large mills marketing to a specified geographic region with high nutritional need, i.e., northeast Brazil; the urban centers.

c. Fortification and enrichment of all wheat flour purchased by the Government of Brazil for specific institutional programs, i.e.; school lunch program, hospitals, mother-child health centers, military personnel.

d. Fortification and enrichment of wheat flour for specific commercial users and customers.

e. Various combinations of b, c, and d above.

The wheat and breadstuffs industry in Brazil is subject to much government regulation. It is clear that a high priority must be given by the Government of Brazil to nutritional improvement before any of the above levels of intervention can be realized.

Strong leadership through INAN must be effected by working closely with the Ministry of State Planning, Ministry of Finance, Ministry of Agriculture, and the Wheat Control Board toward achievement of any of the above stated objectives.

RECOMMENDATIONS FOR SPECIFIC ACTION BY U. S. A.I.D.

1. Determine INAN's view on protein fortification as soon as possible after a new director of INAN is named.

2. Request under Title II, P.L. 480, as soon as possible, a substantial shipment (at least 500,000 lbs.) of 12% soy fortified flour to permit acceptability studies and other evaluations in the school lunch program during the current fiscal year.

3. Encourage (or sponsor) studies at ITAL in Campinas to determine the best technological combination of wheat flour, manioc flour, and soy flour from the standpoint of product acceptability. This information will assist the planners in the adoption of a formulation that will be based upon technological, economic, and political factors.
4. Conduct a series of seminars and baking schools at Brasilia, Rio de Janeiro, and Campinas on soy fortified flour under the sponsorship of SAPRO. Some of the staff for these programs could be provided under the KSU contract 1586.
5. Determine the status of the International Bank for Reconstruction and Development (IBRD) proposed for support of nutritional programs in Brazil. Determine the possibility of IBRD as a funding source for the various levels of nutritional intervention for soy fortified flour in Brazil.
6. Conduct a detailed feasibility study under the KSU contract 1586 and/or the USDA PASA program for bread fortification. This study would be conducted by close collaboration with INAN and other agencies of the Brazilian Government. Such a study would amplify the subjects covered in this report and fully analyze the economic effects of the alternative levels of intervention.
7. Provide further technical assistance (millers, bakers, cereal chemists) as needed, when a specific program is developed.

Preliminary Evaluation of Potential
of Soy Fortified Wheat Flour
for Nutritional Improvement

Brazil

POPULATION AND INCOME [9/10/11]

Brazil is the fifth largest country in the world in land area, with a total land area slightly smaller than the U. S. Brazil's population in 1970 was approximately 95 million, and it was increasing at an annual rate of approximately 2.8%. At that rate the population would reach 125 million by 1980. The rapid growth rate has resulted in a young population. It is estimated that 42% of the population is under age 15, 53% under age 20, and 69% under age 30.

Approximately 50% of Brazil's economically active males are engaged in agriculture, 20% in manufacturing, construction, mining, and utilities, 10% in services, 9% in commerce, and the remaining 11% in other activities

In 1970 approximately 56% of Brazil's population was in urban areas.

1971 per capita gross domestic product (in current prices converted at official exchange rate) was approximately $450. Over the period 1960-1970 total output grew by about 80% and per capita income increased by about 30%. Most of the growth occurred in the late 1960's, and rapid growth has continued into the 1970's.

NUTRITIONAL STATUS AND NEED

It is not possible to determine with precision the current state of nutrition in Brazil because well controlled nutritional surveys have not been conducted for several years. The following summary is from a Department of State airgram dated June 11, 1973, drafted by F. Hagel giving "Information on P.L. 480 Title II to be included in FY 1975 Field Budget." We believe it to be an accurate summary of the available nutrition surveys.

"(a) Nutrition Status
Available Brazilian surveys showing the extent of the country's existing levels of nutrition consist of two rather comprehensive major studies and several lesser studies confined to local problems. The studies are briefly analyzed below:

(1) The Interdepartmental Committee on Nutrition for National Development (ICNND); Northeast Brazil - Nutrition Survey, May, 1965.

This survey, undertaken in Northeast Brazil, covered 16 urban and rural sites in 6 states. Embracing all population segments, it sampled 5,538 people, including 963 children in the 0-5 age group.

Considered the most comprehensive of any study yet done on Brazilian malnutrition on a regional basis, it includes biochemical, anthropometric, and clinical data. Its principal conclusion is that marginal malnutrition characterizes Northeast Brazil's population, due mostly to insufficient production of food for nutritionally adequate diets. As a result of the discovery of widespread diet deficiencies of calories, protein, Vitamin A, and riboflavin, the study also concluded that protein deficiency and parasitic infestation probably play a larger role in anemia common to Northeast Brazil than dietary iron deficiency.

(2) A present ongoing study entitled: The Inter American Investigation of Mortality in Childhood is being carried out by the Pan American Health Organization. Four geographical areas were selected: Recife, Ribeirao Preto, Sao Paulo, and Franca. The first site is urban and is located in the Northeast. The other three sites are all located in the state of Sao Paulo, the last one being rural. The study shows the importance of malnutrition as a principal or associated cause of death among children from 0-5 years old.

Percent of Child Death Due to Nutritionally Related Diseases:

	Under 1 year	1 year	2-4 years
Recife	37.1%	15.5%	4.1%
Ribeirao Preto	15.8%	2.9%	1.3%
Sao Paulo	20.1%	3.0%	0.7%
Franca	13.6%	18.6%	18.2%

For detailed information see PAHO's publication Investigation Interamericana de Mortalidad en la Ninez - Informe Provisional Septembre 1971, pages 143, 144,145 and 146.

(3) From 1967 to 1969, a smaller local study of malnutrition among pre-school children was carried out in 5 localities by the Institute of Nutrition of the Federal University of Pernambuco in Recife. The study covered the sugarcane growing region of the state of Pernambuco and the children were those of the sugarcane plantation workers. It showed that 20% of the children from 0-4 years suffered from 2nd and 3rd degree malnutrition and that only 30% were considered normal by the Gomez classification of weight and age.

(4) The PAHO files in Washington contain a study of malnutrition done in the city of Sao Paulo by A. C. de Silva showing that infant mortality had increased from 60 per 1000 live births in 1961 to 84 per 1000 live births in 1969. The study states that this increase was due primarily to a rapid migration of low-income workers from the Northeast and from surrounding rural areas to the city of Sao Paulo. The study also showed that malnutrition was a basic or contributory cause of infant mortality in 20% of the cases. The da Silva study included a sample of 469 children from 0 to 5 years in the three identifiable zones of the city: center, intermediary and periphery.

(5) Dr. Joao Bosco Salomon of the Department of Nutrition at the Federal University of Brasilia carried out, in 1969-70, a study among children 0-2 years old in Sobradinho, a satellite city of Brasilia. This is a semi-urban area of working class people. He found that from the first year to the second year of life, incidence of malnutrition increased from 16.2% to 62.1%. This increase was probably due to parasite and other infections from contaminated water which prevented adequate utilization and absorption of nutrients.

(6) Diaconia Nutrition Project Report - Jan. 1972

Diaconia is the Brazilian voluntary agency counterpart to Church World Service/ Lutheran World Relief. The project, aided by an AID grant to CWS/LWR, combated malnutrition through the establishment of nutritional recuperation centers in the zona da mata (humid tropical zone) in the state of Pernambuco. Three sites were selected for study: one urban and two rural. The centers attended only poor children and admitted a total of 441 children suffering second and third degree malnutrition based on the Gomez classification.

Infant mortality due to malnutrition was reported to be as high as 60% of all infant deaths in some cities and the problem was generally more severe in urban than rural areas. However, it was found that in Northeast Brazil, malnutrition in the rual areas sometimes reaches the severity found in urban areas. In the majority of these studies, the Northeast seems to be the most affected by protein caloric malnutrition. The most vulnerable group is from 0-5 years.

Based on the above studies, the Brazilian Congressional Record (Diario do Congresso Nacional, Secao II, November 1972) discussed the nutritional situation in Brazil and defined nutritional deficiencies.

The following were the nutritional deficiencies in order of priority:

a. Protein-Calorie Malnutrition - This is given first priority due to its contribution to the high rates of infant mortality and its irreversible effects on growth. It is found principally in the Northeast, but also occurs in the lower-income sections of large cities throughout Brazil among infants and pre-school children.

b. Vitamin A Deficiency (Xerophthalmia) - Considered critical because it causes irreversible blindness and is relatively easy to prevent through a nutrition intervention program. The disease is found in the sugarcane growing areas among pre-school children, but it is also assumed to be widespread in all nutritionally deficient groups.

c. Nutritional Anemia - Classified as important due to its widespread incidence and the important role it plays, along with infectious diseases, in limiting work capacity. Found in all regions among the working population and among women who have borne children.

d. Endemic Goiter (iodine deficiency) - This condition still exists in large numbers of the population, although there exists a simple means of preventing it. It is generally found in mountainous regions among women of child-bearing age.

Summary: From the above it can be seen that Northeast Brazil is the most affected region and that the most vulnerable groups are infants and pre-school children. Since these studies were undertaken, the malnutrition picture has not significantly changed. Protein-calorie malnutrition is still widespread in its effect, along with infections or other diseases, result in a high morbidity and mortality rate.

CALORIE AND PROTEIN INTAKE ESTIMATED FROM FOOD CONSUMPTION SURVEYS

The most comprehensive information about food consumption in Brazil is that provided by the large number of family budget surveys conducted by the Getulio Vargas Foundation during 1961/1963. The results are reported in Food Consumption in Brazil (published for the U.S.D.A., ERS, by the Israel Program for Scientific Translations, 1970).[5/]

The national results are disaggregated into three regions (Northeast, East, and South) and, for each region, into urban areas and rural areas. Results for each of these six geographical components are further disaggregated into nine income classes. Brazil's 1960 population of 71 million is thus distributed into 54 geographical-income groups. (See Table 1)

Although the study does contain an impressive amount of disaggregation, it must be noted that a still finer breakdown is required for a really adequate nutrition analysis. Brazil is so big that further geographical disaggregation would probably show additional significant differences in food consumption patterns. In addition, seasonal variations in food consumption are not available from the study. And most importantly, there is no breakdown of the population

by age groups, so useful conclusions concerning adequacy of calorie and protein intake of different ages cannot be obtained. At a minimum, an adequate nutrition analysis requires food consumption information disaggregated by geography, income level, season, and age.

TABLE 1. Brazil's 1960 Population, by Income Class and Geographic Region (000)

Income class (from low to high income)	Northeast		East		South	
	Urban	Rural	Urban	Rural	Urban	Rural
1	410	1,760	321	675	81	336
2	911	1,738	507	1,069	216	432
3	1,738	3,345	1,804	2,295	1,195	1,858
4	1,291	1,932	1,675	1,981	1,570	1,749
5	1,209	1,749	2,009	1,509	2,490	2,209
6	897	1,945	2,571	1,806	2,896	2,769
7	442	833	1,528	1,227	1,936	1,232
8	378	554	1,200	1,765	1,716	1,227
9	59	94	420	472	520	421
TOTAL	7,337	13,949	12,035	12,798	12,619	12,229

Source: Food Consumption in Brazil, p.5

For each of these 54 groups information is presented on average daily person consumption of food items (35 food items for urban areas and 30 food items for rural areas). By means of conversion factors (calories and proteins per unit weight of the food items) the report estimates average daily per person calorie and protein intake.

Table 2 shows average calorie intake of the 54 groups. (The really striking differences in calorie intake of the various income classes within each of the six geographic regions shows how average figures are useful for a geographical region. National averages that ignore regional differences are even less useful.)

For each of the geographical regions, calorie intake is positively related to income level. Except for the South-Rural region, the lower income classes

fall below 2,000 calories per person per day, clearly an inadequate calorie intake. At the lower income levels, urban intake is below rural intake.

Table 2. Daily Calorie Intake Per Person by Income Class and Geographic Region, 1960 (in kilocalories)

Income class (from low to high income)	Northeast		East		South	
	Urban	Rural	Urban	Rural	Urban	Rural
1	1,237	1,503	1,184	1,424	1,485	2,385
2	1,497	1,812	1,531	2,103	1,735	2,895
3	1,997	2,135	1,876	2,211	1,967	2,499
4	2,323	1,820	2,091	2,720	2,048	2,863
5	2,415	2,282	2,225	2,673	2,361	2,974
6	2,863	2,373	2,630	2,920	2,473	2,999
7	3,310	3,381	2,824	3,058	2,782	3,777
8	4,040	2,868	3,273	3,042	3,085	4,155
9	4,288	2,901	3,750	4,102	3,168	4,772

Source: Food Consumption in Brazil, pp. 17-18.

Using some calorie intake as a "standard" of calorie intake adequacy, we can identify which of the 54 geographical-income groups fall below the standard. Using the population figures in Table 1 we can then estimate the number of people in Brazil contained in geographical-income groups the consumption of which falls below the standard of calorie intake adequacy. The following analysis uses 2,450 calories as a standard (this is the standard suggested in the report).

Almost one-half (25 of 54) of the geographical-income groups have average daily per person calorie intake below 2,450 per day. These 25 groups contain 34.3 million people or 48% of Brazil's 1960 population. Thus, just under half of Brazil's population is contained in geographical-income groups that have average calorie intakes below the standard. (This analysis allows us to present another illustration of how inadequate disaggregation can produce misleading figures. The report says that 27 million people fall below the standard, but this

figure comes from ignoring the available geographical breakdown. By averaging within income groups, 7 million people that our analysis shows are contained in geographical-income groups having below standard intake, are "averaged up" to above standard intake.)

The calorie intake figures differ substantially from one geographical region to another. (See Table 3.) In the Northeast, very large proportions of both urban and rural populations are in income groups with below standard calorie intake. About one-half of the urban populations in the East and in the South are in such income groups. Only in South-Rural is the below standard intake proportion of the population low.

Table 3. Calorie Deficiencies by Region

Geographical Region	Population (000)	Population (000) in income classes having below-standard calorie intake	%
Northeast-Urban	7,337	5,559	75.8
Northeast-Rural	13,949	12,469	89.4
East-Urban	12,035	6,316	52.5
East-Rural	12,798	4,039	31.6
South-Urban	12,619	5,552	44.0
South-Rural	12,229	336	2.7
TOTAL	70,967	34,271	48.3

Source: Tables 1 and 2.

Table 4 shows average daily per person protein intake (in grams) of the 54 geographical-income groups. Of course, the expression of protein intake solely in terms of quantity ignores protein "quality" (amino-acid composition and bioavailability), and therefore the protein figures are more difficult to interpret in terms of adequacy. (With a great deal of effort one could use the data in the report on consumption of individual food items along with information on

amino-acid composition of foods to estimate the protein intake in terms of "quality.")

The table shows a positive relationship between income and protein intake, within each geographical region. At the lower income levels, urban intake is below rural intake.

Using 55 grams of protein per day as the "standard," it can be seen that 11 of the 54 geographical-income groups have average protein intake figures that are below standard. These 11 groups contain 9.5 million people, or 13.3% of Brazil's 1960 population. 9 of the 11 groups are urban.

Table 4. Daily Protein Intake Per Person, By Income Class and Geographic Region, 1960 (in grams).

Income Class (from low to high income)	Northeast		East		South	
	Urban	Rural	Urban	Rural	Urban	Rural
1	36.4	50.7	32.4	35.3	37.2	64.6
2	45.8	55.2	40.5	56.3	44.4	81.1
3	64.3	67.7	52.8	57.5	51.4	72.3
4	80.2	57.8	62.4	70.7	54.5	85.8
5	83.6	79.3	67.0	67.3	65.4	98.5
6	98.5	81.8	83.9	79.4	69.8	95.0
7	114.1	113.9	92.5	80.0	84.5	122.5
8	151.1	99.9	108.4	80.3	94.3	126.3
9	147.9	87.7	135.9	126.5	104.0	166.5

Source: Food Consumption in Brazil, pp.21-22.

Table 5 shows the regional incidence of below-standard protein intake.

It was mentioned above that measuring protein in terms of quantity and ignoring the amino-acid composition of foods made interpretation of these protein statistics difficult. In addition, another factor has to be mentioned.

In addition to the fact that these protein statistics ignore protein quality

(the amino acid composition), there is another serious problem. We have seen that the report indicates that calorie inadequacies are more extensive than protein inadequacies. (Calorie-deficient geographical-income groups include the 11 protein-deficient groups plus 14 others.) But when calorie intake is below adequate levels some protein is used for energy and is not available as protein. Therefore it is very likely that the protein intake figures for the groups having inadequate calories are overestimates. Protein inadequacy is likely to be more widespread than the estimates mentioned above indicate.

Table 5. Protein Deficiencies by Region

Geographical Region	Population (000)	Population (000) in income classes having below-standard protein intake	%
Northeast - Urban	7,337	1,321	18.0
Northeast - Rural	13,949	1,760	12.6
East - Urban	12,035	2,632	21.9
East - Rural	12,798	675	5.3
South - Urban	12,619	3,062	24.3
South - Rural	12,229	0	0
TOTAL	70,967	9,450	13.3

Source: Tables 1 and 4.

WHEAT-PRODUCT CONSUMPTION PATTERNS

Most of the following information was obtained from "The Brazilian Bakery Industry"[1/]. Emphasis is upon bread and other bakery products, which in 1970 apparently utilized about 70 percent of available wheat supplies.

It is estimated that about 70% of Brazil's people eat bread products. There are large variations in use of baked products from one region to the other, and even from one local area to another. Brazil's total consumption of bread and bakery products in 1970 was about 2,100,000,000 kilos or 22 kilos per capita.

Consumption of bread and other bakery products in Brazil in 1970, by regions, was as follows:

	Kilos	Per Capita
Sao Paulo/Parana	840,000,000	32.4 kilos
Rio/Guanabara	342,000,000	37.5 kilos
Central/West	186,000,000	9.6 kilos
Southern	324,000,000	33.3 kilos
Northeast/Amazon	408,000,000	13.6 kilos
TOTAL	2,100,000,000	22 kilos

Total bread consumption in Brazil was stagnant in the late sixties, and possibly showed even an over-all reduction. This does not necessarily mean that wheat or wheat flour products have been on the decline. In some areas, such as the Northeast and parts of the Central West, consumption of macaroni products and biscuits and crackers is increasing, while bread consumption remains constant. Of the total flour milled in Brazil, 70% is for the bakery trade, 25% for the pasta-macaroni industry, and 5% for the biscuit-cracker industry.

There is a tendency in many consuming centers--in cities like Rio, Sao Paulo and Porto Alegre, and in some interior areas--for bakeries to increase their varieties. Whereas "bisnaga" at one time represented almost 95 percent of all bread products, its tendency toward rapid staleness is causing it to give way to special buns, biscuits, softer blends (socadura), English cakes and several others. In Sao Paulo and Rio de Janeiro items like "sandwiches," "otrradinhas" (bread toasts), pretzels, and hotdogs and hamburgers are becoming important.

Earlier we used the report on Food Consumption in Brazil to examine the 1960 average daily per person calorie and protein intake of 54 geograhical-income groups. The report also shows the average amounts of "wheat equivalent" (in bread, wheat flour, macaroni, and biscuits) and bread consumed by each of the 54 geographical-income groups. This information also shows the average amounts of "wheat equivalent" (in bread, wheat flour, macaroni and biscuits) and bread consumed by each of the 54 geographical-income groups. This information allows us to determine the share of total Brazilian wheat equivalent and bread consumed by the geographical-income groups that averaged less than 55 grams of protein per day:

Northeast Urban	8.6% wheat	9.5% bread
East Urban	13.4% wheat	14.3% bread
South Urban	18.2% wheat	18.0% bread
Northeast Rural	5.2% wheat	4.3% bread
East Rural	1.6% wheat	0.9% bread
South Rural	0	0

Weighting these proportions by the absolute amounts of wheat equivalent and bread consumed, we find that the "protein-deficient" population of Brazil consumed 9.8% of the wheat equivalent and 13.4% of the bread in Brazil in 1960.

Unfortunately, there is no information available to indicate the current consumption levels.

WHEAT SUPPLY

Table 6 shows wheat production, wheat imports, and total wheat supply for the period 1962 to present. Prior to the period shown, during the 1940's and 1950's, wheat production went through a boom. Production went from very low levels in the early 1940's to more than 1,000,000 MT in 1955 and then declined to less than 400,000 MT in 1963. The decline was due to a series of years with unfavorable weather along with an increase in disease and pests.

A dramatic recovery got underway in the late 1960's and production exceeded 2,000,000 MT in 1971. The recent expansion of production has been stimulated by a high government-guaranteed price to the producer and loans to wheat producers. New wheat varieties have been introduced. Positively related to the recent expansion of wheat production is the expansion of soybean production. Much of Brazil's wheat is grown on the same land (soybeans are planted after the wheat harvest) and uses the same machinery[8/].

Throughout the 1960's wheat imports substantially exceeded domestic production. Brazil is one of the world's largest wheat importers and is Latin America's largest single importer. The U.S. and Argentina are Brazil's major suppliers.

Table 6. Wheat Supply

Year	Domestic Production 1,000 MTons	Domestic Production 1,000 HA	Imports 1,000 MTons	Total 1,000 MTons
1962	706	743	2,191	2,897
1963	392	793	2,175	2,567
1964	643	734	2,609	3,252
1965	585	767	1,876	2,461
1966	615	717	2,379	2,994
1967	629	831	2,343	2,972
1968	856	970	2,611	3,467
1969	1,374	1,407	2,362	3,736
1970	1,844	1,895	1,941	3,785
1971	2,132	2,261	1,688	4,393
1972	680	2,000		
1973	1,900 (prel)			
1974	1,500 (est)		2,700	4,200

Sources: 1962-1971: FAO, Production Yearbook, 1972, p.52.
1972: FAO Monthly Bulletin of Agricultural Economics & Statistics, November, 1973, p. 22.
1973: USDA, FAS, World Agricultural Production and Trade--Statistical Report, Sept., 1973, p. 20
Great Plains Wheat, Inc., Annual Marketing Plan, FY 1972-73
"O Estado de S. Paulo," May, 1974.

PROTEIN RESOURCES

Brazil is a major producer and the second largest exporter of soybeans. It is one of the few developing countries with a significant indigenous source of vegetable protein for use in supplementing or fortifying cereal based foods for nutritional development. Table 7 shows the increase in soybean production since 1961.

Table 7. Soybean Production, 1961-1973.

	000 Metric Tons	000 HA
1961	271	241
1962	342	314
1963	323	340
1964	305	360
1965	523	432
1966	595	491
1967	716	612
1968	654	722
1969	1,057	906
1970	1,059	1,319
1971	2,218	1,859
1972	3,666	2,336
1973	4,800 prelim. est.	3,046 prel.

Sources: 1961-1970: FAO, Production Yearbook, 1972, p. 112; 1970, p. 228; 1966, p. 207.
1970-1973: USDA, FAS, World Agricultural Production and Trade--Statistical Report, Oct. 1973, p. 16.

STATUS OF BAKING INDUSTRY

A survey of the baking industry was conducted in 1970 and the resultant report[1/] gives a very good and reasonably current picture of the baking industry in Brazil.

"Bakery Product Mix and Specialties

As recently as 1950, all Brazil was on a "bisnaga" binge. Bread was identified only by the varying size of the French-style loaf in any part of the country. The other wheat flour products were pasta products and a small percentage of crackers and biscuits. The typical Brazilian bakery unit... used only primitive equipment:

Slow-speed mixer
Dough break
Small moulder
Make-up table
Dough boards and racks
Wood-fire oven
Bun-cutter
Hobart-type cake mixer

The typical bakery of 1950 used six 50-kilo bags of flour daily. Some bakeries ranged up to about 30 bags of wheat flour daily. Over 95 percent of all bread production was in the form of "bisnaga."

Ten years ago, 1960, some bakeries in Sao Paulo and Rio de Janeiro introduced "American type" buns and rolls, then extended into other specialties, including sweet buns, sweet cakes, pound cakes, and "house-biscuits." This changed the whole trend because the demand for these specialties became immediate. "Pao de Forma" (pan bread or American loaf) was slower catching on because it took more mixing time and more special preparation and ingredients so that bakers at first did not venture much into this new type of convenience bread.

Today, the panorama is different, as 1970 shows an increasing demand for even more specialties, and fully 20 percent of the bakery industry produces a series of bread varieties. An approximation of bakery varieties, as found in different areas in Brazil follows:

	Percent
French-type (bisnaga) bread loaves.....	80
Soft-type (socadura) buns	4
Sweet buns and rolls.....	4
American-type loaf.....	1
Wholewheat breads.....	1
English-type pound cake (Bolo Ingles).....	2
Rye-type breads.....	1
Gluten-type breads.....	1
Bakery-type home-made biscuits/crackers.....	4
Other variety: Italian, German, Flat/round cakes, cakes, cupcakes, etc.....	2
Total	100

Source: GPW Rio estimate

(Not all bakery units make all these varieties; some still make over 90 percent of "bisnagas," especially the smaller ones (6 to 10 bags daily production). Others make even 30 to 35 percent of specialties, particularly bakeries now using 20 to 25 sacks daily who have developed a large store clientele and also sell many other food-drink products as a bakery-shopping center.)

Demand/Supply Aspects and Product Limitations

For this analysis, bakery products relate to that portion of wheat-based products that are produced by bakery or baking units, separate from other wheat-base products made by macaroni and biscuit/cracker plants or those industries. In this respect, the typical Brazilian bakery unit is not an industry in itself but a simple establishment run by a family, probably handed down over the years from father to son, with the various bread varieties sold over-the-counter with little "repartidor" (distributor-middleman) involvement. Some units supply only a local clientele, mostly neighbors, within two or three blocks of the bakery shop. A few others have begun to distribute their products to supermarkets (superettes), but these are limited to city areas like Rio de Janeiro, Sao Paulo, Porto Alegre, Curitiba and Belo Horizonte, where gradually "pan bread" (Pao Americano) is gathering importance

in eating habits.

On a regional basis, bakery units vary in dimension. An appraisal of the present situation by region, is given below:

	No. of Bakery Units Using Daily Approx.						Total No. of Bakery Units
	3	6	15	20	25	300	
	sacks of 50 kilos of flour each						
Sao Paulo/Parana	1,300	4,000	800	200	100	1	6,401
Rio/Guanabara	800	1,500	300	80	50	1	2,731
Central/West	460	900	150	40	20	-	1,570
Southern	1,164	1,500	200	60	30	-	2,954
Northeast/Amazon	1,200	2,000	300	80	40	-	3,620
Total	4.924	9,900	1,750	460	240	2	17,276

Some estimates have been made in the past that Brazil has possibly over 30,000 bakery units. This number includes the various pastry shops (pastelarias), sweet/candy units (confeitarias) and pizza-specialty outlets (pizzarias-sorveterias) which should be identified separately from the bakery units whose main production is bread (bisnagas) and related specialties and which buy flour mostly in 1-kilo family-package size from wholesalers and not in industrial sizes of 50-kilo bags. These special "confeitarias" and "pastelarias" are not included in the above figures. A "guestimate" of the number of these shops in Brazil could run into 20,000 or more.

Additives and Government Controls

By government decree, the flour mills are permitted only to add from 2 to 5 percent of cereal mixes to the wheat flour milled. In 1970, other additions to improve the quality of flour, the baking performance or such other objectives were permitted. The bakery cannot add any ingredient as a "bread-improver," other than malt.

Separate sections will deal with specific bakery mixes and pricing. Basically, the only control in pricing rests with the popular French-type loaf. Specialties usually reach what the market can absorb, regardless of any special enrichment, additives or other ingredients to improve quality. ...

As indicated earlier, the Brazilian Government controls the pricing and distribution of many food products, the objective being to give the consumer the lowest possible price. As far as the bakery industry is concerned, it is affected mainly by the controls the government exercises for wheat purchases and restriction of wheat quotas to flour milling units, which in turn supply the bakery trade.

Raw Material and Pricing Limitations

In Brazil bread products are made from different types of flour: "pure flour" (made from 100 percent wheat), mixed flour (made from a combination of wheat-manioc, wheat-corn, wheat-manioc-corn, usually at percentages ranging from 2 to 5 percent of foreign mix with 95 to 98 percent of wheat, depending on the mill's milling problems at time of purchase). The system causes serious problems for the baker, who never knows what type of flour-mix, or percentage-mix of wheat-manioc-corn he is getting, unless he specifically buys "pure flour." To explain:

Regular flour. This customary flour for the bakery trade is packed in 50-kilo cotton bags and is a mixed-flour blend of wheat and manioc or corn. Manioc is usually blended with the wheat, but some mills are using corn-flour and corn-starch, where more convenient. This is the typical bag of flour bought by the baker. This, in speaking about 50 kilos of flour, it includes anything from 2 to 5 percent, or an average of 3 percent, of mix other than wheat. The baker can buy this flour regularly. Purchases are done normally on a weekly basis, payment at sight. In the Rio Grande do Sul and Santa Catarina areas, and in Sao Paulo, there is great competition among flour mills, so that business is done on 30-day, even 60-day terms, and the price range indicated above may be discounted, depending on client, location, freight, convenience, and other considerations.

Pure flour. This is a term used to identify a flour from 100 percent wheat. The baker in any area prefers to get this flour, if available, even if higher in cost--which it is. As a general rule, government decree does not permit a flour mill to produce 100 percent wheat flour for industrial purpose (in 50-kilo bags) for bakery or other such uses (macaroni and cracker industries). But the flour mill can produce "pure granulated flour" (called in Brazil semolina instead of farina; the same type of flour with varying degrees of granulation is called "semolada," something like a blend between fine flour and granular flour). So the baker, to improve his product quality, buys semolada or semolina to secure 100 percent wheat flour. He needs this quality to produce his bread specialties, which the regular mixed flour cannot give him. This pure flour is more expensive, sells at Cr$78.70 ($12.26) per 50-kilo bag in Rio de Janeiro.

Domestic Packaged flour. Semolina or semolada are not always available to the baker because flour mills produce limited amounts (5 percent of total flour milling) for the pasta industry. Therefore, he must resort to securing his pure wheat flour by another and peculiar route. Flour mills are "permitted" to produce 1-kilo packaged flour for domestic (home) use, normally packed in cartons or ten 1-kilo paper bags. So the baker must buy this expensive package to give "quality" to his product mix. The price to the baker for this carton is Cr$15.04 per 10 kilos, or Cr$75.20 per 50-kilo bag equivalent (Rio basis), approximately US$11.70 per 50 kilos. It is surprising that most bakeries specializing in bread products buy this 1-kilo package, both in the greater Rio and Sao Paulo areas, and pay the high price. Industries like Plus-Vita of Rio and Pullman of Sao Paulo buy a combination of semolada and mixed flour, with occasional purchases of 1-kilo bags for their special cakes and sweet buns."

Recently, SSL and CSL were permitted as dough conditioners. It was stated that the regulations are not difficult to change as the food composition committee meets every 14 days.

Since 1970, a number of the larger baking units have installed high speed mixers of the Tweedy type and generally introduced some semi-automatic equipment. Two important bakery companies are: Industrial Panificadora (Plus Vita), Rio de Janeiro; and Panificadora Brasileiro (Pullman), Sao Paulo. These companies produce American pan bread exclusively and have grown significantly in recent years. The Campbell-Taggart Baking Company, of Dallas, Texas recently entered into a joint venture with Industrial Panificadora.

The impression, in the cities, is that the bisnaga now makes up considerably less than the 80% attributed to it in 1970.

Each of the major cities in Brazil has an association of bakers. There is a national bread congress sponsored by these associations every two years with a normal attendance of 500-1,000 bakers.

> "Very influential also to the bakery trade are the two Brazilian monthly bakery magazines, each with a distribution of around 20,000 copies. They usually coordinate programs with bakers for promotion of products, advertising, assistance and intermediation with other industries and related matters. Most bakers read one or the other magazine, or both. These two magazines are:
>
> Industria de Panificacao: Rua Conselheiro Furtado, 208 - Sao Paulo/Sao Paulo, Milton Coatti, Director
>
> Revista Brasileira de Panificacao: Av. 13 de Maio, 47/Conj. 1205 - Rio de Janeiro/Guanabara - ZC 06., M. C. Dias Morgado, Director."

STATUS OF THE SOY PROTEIN INDUSTRY

The soy crushing industry has grown rapidly in recent years with all of the U. S. industry leaders except the Staley Company taking an active part. Specifically, Ralston Purina, Anderson Clayton, Central Soya, Cargill, Archer-Daniels-Midland, and Sambra (Bunge-Bourne) are all operating mills producing

defatted soy meal and crude or refined soy oil. As would be expected with a recent and rapidly developing industry, the level of technology and plant equipment is good.

In 1956, Sanbra built the first edible soy product plant in Porta Allegre. This plant had the capability of producing edible soy grits and soy flour. Due to a lack of markets, the plant was later dismantled.

Currently, a company called Incobrasa is producing soy flour but it is reported to be of poor quality.

Sanbra is now producing a soy concentrate and a soy isolate. The Marschall Division of Miles Laboratores de Brazil is advertising the availability of Texturized Vegetable Protein in the food trade journals. Several other companies are known to be exploring the production of TVP in Brazil

Archer-Daniels-Midland, headquartered in Campinas is currently constructing a soy flour plant which should be in production in 1975.

STATUS OF SSL, VITAMINS AND MINERALS

Sodium stearoyl-2-lactylate (SSL) is currently produced in the United States, Netherlands and Japan. SSL is currently being imported and marketed in Brazil by Industria Quimico de Sinteses e Fermentacoe S. A. Substantial quantities are being used by bakers in the major markets as a dough and bread quality improver. The current price of SSL in Brazil is Cr$22/kilo in small quantities and Cr$20/kilo for large quantity orders. Apparently, plans are underway for the production of SSL to begin in Brazil during 1975. This could lead to a price reduction. According to Crowley[6/], none of the vitamins and minerals under consideration for fortification are manufactured in Brazil and, therefore, they must be imported. Crowley reported (1973) the cost (f.o.b.) U. S. $ per kg to be: Vitamin A (palmitate, 230M I.V./g), $12.50; Niacin, $4.50; Riboflavin, $30.00; Thiamine (mononitrate), $20.00; and Iron (reduced, $0.75. Import duties (15%), industrial (IPI) tax (4%), circulation (ICM) tax (15%), and freight, port,forwarding, and

insurance charges (10%) increase the cost significantly. In a government sponsored or government financed project, usually no import duties or taxes will be levied against vitamins and minerals.

STATUS OF MILLING INDUSTRY

The milling industry in Brazil is modern. No new mills have been built in recent years as the industry is operating at only 50-60% of capacity. The allocation system (discussed below) has resulted in the allocations being essentially franchises or licenses to be in the milling business. Thus, a firm wishing to enter the business must buy a franchise of an existing milling company in addition to its physical facilities.

The present mills would have little difficulty in producing a soy fortified flour as they already have the capacity for macro-blending of manioc flour with wheat flour. The addition of microfeeders for the Emplex, vitamins and minerals would involve minor technological problems and minor initial capital expenditures.

At the present time the milling industry is subject to a wheat allocation system, based on Decree-Law number 210 of February 27, 1969 which established regulations for wheat distribution, milling, and trade of wheat and wheat products. The following description of the operation of the system is from the Annual Marketing Plan, 1972-73 of Great Plains Wheat Inc.[3/].

> "SUNAB is the government agency which determines the yearly quotas of wheat for each mill based on the milling capacity of each mill. This capacity is checked by having the mill run at full capacity at a 78% extraction rate for two hours and if the actual milling capacity of the mill does not correspond with that originally filed at SUNAB, the mill has its quota reduced to reflect the tested capacity. The silo capacity is also considered in establishing quotas.
>
> Each year a new physical check is performed by an inspection commission from SUNAB and new quotas established according to the total wheat consumption established for the year and the mills capacity and silo space. There are two types of quotas - the common and the specific - which combined establish the total quota for each mill. If during the annual physical check the previous milling capacity is not met and/or storage

facilities were not improved, when required, the mill can lose the specific quota.

The quotas are allocated on a volume basis without consideration of origin of the wheat. The mills have no control over the type of wheat they receive and mill.

SUNAB has a massive distribution problem which creates unusual market and consumption patterns. Regional imbalances of wheat supplies may result in separate regional pocket markets, some with super-abundant consumption and others with bare-consumption requirements. Timing of deliveries of wheat purchases to flour mills to meet actual requirements, in an area as large and complex as Brazil, is not an easy task, especially considering the inadequate transportation and communications facilities, inavailability of sufficient storage space in certain areas, and lack of people trained in wheat handling.

. . . . . .

For wheat allocation purposes the Decree-Law divides Brazil into 8 consumption areas which are:

	Tons Allocated for 1972
Zone 1 - Amazonas, Para, Maranhao, Acre & Territories of Amapa, Rondonia and Roraima	111,000 - 4 mills
Zone 2 - Piaui, Ceara, Rio Grande do Norte, Paraiba, Pernambuco and Territory of Fernando de Noronha	396,000 - 7 mills
Zone 3 - Alagoas, Sergipe and Bahia	228,000 - 5 mills
Zone 4 - Expirito Santo & Minas Gerais (excluding the Triangulo Mineiro)	225,000 - 5 mills
Zone 5 - Guanabara & Rio de Janeiro	531,000 - 6 mills
Zone 6 - Goias, Mato Grosso, Distrito Federal and Minas Gerais (only the Triangulo Mineiro)	99,000 - 5 mills
Zone 7 - Sao Paulo and Parana	1,353,000 -49 mills
Zone 8 - Santa Catarina and Rio Grande do Sul	507,000 -197 mills
TOTAL	3,450,000"

GOVERNMENT CONTROLS ON SUPPLY AND PRICES

WHEAT

The government exercises extensive control over the wheat and flour markets in Brazil. The government, through the Bank of Brazil, SUNAB (National Supply Agency), and the Brazilian Wheat Board, purchases all domestically produced wheat and purchases all of Brazil's wheat imports, and sells wheat to the mills. At least until recently the price of imported wheat was below the price charged the mills, and the price paid domestic wheat producers was above the price charged the mills. The government had no serious financial problem with this system. The revenues obtained from selling cheaper imported wheat to the mills were paid out to domestic producers. Consumers of wheat subsidized producers of wheat. The domestic prices of wheat and wheat products were kept artificially high by the system.

Recent events may have altered these price relations. As we understand the sequence of events in recent months, world-market price increases caused the import price to move above not only the price charged to millers, but even above the price paid to domestic producers. The producer price was increased in early 1974 and at the moment is above import prices. As of April 1974 the price charged by government to mills was below both the price paid by government for imported wheat and for domestic wheat.

Wheat-flour and bread prices as of February, 1974 were:

	Rates Cr$6.415	/ US$1.00
Wheat per metric ton (to mills)	734.00	114.41
Plus ICM (Circulation Tax) for		
imported wheat Cr$109.68	843.68	131.51
domestic wheat Cr$129.53	863.53	134.61
Wheat flour (5% manioc or other bakeable mix) 50 kilo bag	67.22	10.47
Semolina (granulated farina)	78.70	12.26
Flour (family use) 1 kilo package	1.504	0.234
Bread (French-type bisnaga) 50 grams	0.17	0.026
100 grams	0.25	0.038
150 grams	0.50	0.077
280 grams	0.78	0.12

SOYBEANS

By fixing a low domestic price of soy oil, the Government encouraged exports of soybeans early in 1974. The domestic crushers stopped grinding in March-May, thus causing a domestic edible vegetable hortage. Price relief occurred during May, 1974, and the domestic bean crushers again began to operate and buy beans competitively. The official government price was 51 Cruzeros per 50 kilo sack. In mid-May, 1974 the free market price was about 56-60 Cr/60 kilo sack. Producers claimed this was still not enough to cover production costs.

Official prices in May, 1974 were:

Crude Soybean Oil	Cr$3,221/M.Ton
Refined Soybean Oil	Cr$4,274.10/M.Ton
Soybean Meal (48% protein)	Cr$800/M.Ton
Soybean Meal (48% protein pellets for export)	Cr$130/M.Ton

PROJECTED COSTS OF SOY FORTIFIED WHEAT FLOUR (ENRICHED WITH VITAMINS & MINERALS)

In this section, the cost of adding soy flour and vitamins and minerals to wheat flour is estimated. Current market prices and the official exchange rate were used for this analysis. We recognize that a more complete analysis would need to take into account the possibility that these market prices (except perhaps for soy flour) differ from the true "social" (or "shadow") prices. We first present estimates of current market prices for ingredients. Then, the added costs (or savings) per ton at various levels of soy flour fortification was computed.

The current price of blended flour (95% wheat-flour + N+, 5% manioc flour) in Brazil is controlled at Cr$1,344/M.Ton. Pure wheat flour sold in the form of farina is Cr$1,574/M. Ton.

Defatted toasted soy flour (minimum protein of 50%) is not currently produced in quantity in Brazil. Thus, only a rough estimate of its price when it becomes available in 1975 can be made. In the U.S., the price relationship between 49% protein soybean meal and soy flour in recent months was examined and was found to fluctuate rather widely with soy flour roughly 30% higher than soy meal. Although it may be on the low side, Cr$1,000/M. Ton was selected as the example cost in the following calculations. This represents a 25% higher price than the current export price from Brazil of pelleted 49% soybean meal (Cr$800/MT).

These estimates of wheat flour prices and soy flour prices indicate that in Brazil soy flour could well have a market price below wheat flour. This may be due in part to policies that keep Brazil's domestic wheat prices above world levels. In addition, the fact that Brazil imports wheat (and thus the domestic price should be the world price including transport costs) and exports soybeans (and thus the domestic price should be the world price excluding costs)

will cause the ratio in Brazil of soy prices to wheat prices to be below the world-market price ratio. This is another subject that requires further analysis.

SSL (Emplex) is currently imported into Brazil and sold in large quantities for Cr$20/kg or Cr$20,000/M. Ton. This price includes import duties and taxes of approximately 45%.

Crowley[6/] has estimated the vitamin and mineral premix cost to fortify a metric ton of flour to be Cr$14.1. This price includes about 34% for import duties and taxes.

Based upon these raw material costs, Table 8 illustrates the ingredient costs or savings of fortifying blended wheat flour and pure wheat flour at three levels of soy fortification; 5%, 10%, and 12%.

Table 8. Additional Cost of Ingredients Per Ton for Soy Fortified Flour Enriched with Vitamins & Minerals

Base Flour	5% Soy Fortified Flour[a]		10% Soy Fortified Flour[b]		12% Soy Fortified Flour[c]	
	Actual Added Cost (or Sav.) Cr$/MT	%Added Cost (or Savings)	Actual Added Cost (or Sav.) Cr$/MT	% Added Cost (or Savings)	Actual Added Cost (or Sav.) Cr$/MT	% Added Cost (or Savings)
Blended Flour (95% wheat 5% manioc)	49.93[d]	3.72	69.80[d]	5.19	62.97[d]	4.59
	18.90[e]	1.41[e]	21.35[e]	1.59	14.52[e]	1.08
Pure Wheat Flour (farina price)	37.34[d]	2.37	45.36[d]	2.88	33.96[d]	2.16
	6.31[e]	0.40	(3.09[e])	(0.19)	(14.49[e])	(0.92)

[a] formula: 95 parts base flour; 5 parts soy flour; 0.3 parts SSL; and 0.2 parts vitamins and minerals.

[b] formula: 90 parts base flour; 10 parts soy flour; 0.5 parts SSL; and 0.2 parts vitamins and minerals.

[c] formula: 88 parts base flour; 12 parts soy flour; 0.5 parts SSL; and 0.2 parts vitamins and minerals.

[d] Based on current market prices (given in text)for wheat flour, soy flour, SSL, and vitamins and minerals).

[e] Based on current market prices for wheat flour and soy flour, a price of Cr$11,200 per ton for SSL and Cr$9.31 for the mineral and vitamins needed to enrich one ton.

Obviously, there are additional costs of blending and mixing at the mills. Presumably, the mills are now equipped technologically to blend the macro ingredients because they already blend in manioc flour. There would be an initial cost for installation of feeders for the SSL and the vitamins and minerals. Crowley estimated the initial cost of equipping 81 mills supplying about 80% of the flour of Brazil to be about $500,000. The equipment for the SSL would be about $250,000. On a per ton basis these costs are negligible and are ignored in the illustration

Crowley reports that the 81 mills having a production of over 5,000 tons per year could supply fortified and enriched flour to the nutritionally critical areas of the North and Northeast, essentially supply all of the supply in the Eastern states, and most of the flour in the South.

The additional ingredient cost to fortify at 12% soy flour and vitamins and minerals the 2,700,000 metric tons of blended wheat flour produced by these mills would be Cr$170,019,000 or $26,116,589 per year. This compares with a cost for just the vitamin and minerals of Cr$38,100,000 or $5,861,538 per year. Because the soy flour is lower priced than the wheat flour, all of the additional cost is due to the cost of SSL and the vitamins and minerals. If the government would waive the import duties and taxes for SSL and vitamins and minerals, the additional cost for the same level of fortification for the 2,700,000 metric tons of blended wheat flour would be Cr$39,204,000 or $6,022,120 per year. (This last computation is based on the assumption that SSL, after the waiving of taxes and duties and the beginning of domestic production costs Cr$11,200 per ton and the assumption that the cost of vitamins and minerals needed to enrich one ton costs Cr$9.31)

To supply the school lunch program with fortified flour for 12,000,000 children for 140 days (100 grms flour/child/day) would require 168,000 metric tons of product. The additional ingredient cost over regular flour at current prices would be Cr$10,578,960 or $1,625,032 per year. If the government waived the import duties and taxes for the SSL and vitamins and minerals, the additional cost would only be Cr$3,439,360 or $374,710 per year.

The price of SSL in Brazil is as high as any location in the world--2½ to 3 times the price in the U. S. Undoubtedly, when domestic production is realized the price could be reduced. From another viewpoint, the cost of SSL is already being absorbed by the baking industry in the Rio and Sao Paulo area as many bakers are using the product in their current production. In these cases the SSL would not represent an additional cost to the final bread cost.

The additional cost of soy fortified flour is partly offset or sometimes more than offset when it is converted to finished food forms. For example, bakers experience an increase in wet dough yield of 6-7% when using soy fortified flour for bread. In cookies, a savings can be realized by a lower shortening requirement when using soy fortified flour.

Thus, the real cost or savings of nutritional improvement via soy fortified flour is very difficult to pinpoint at this time without a detailed analysis which would be made during a full feasibility study.

Linear Programming Analysis of the Efficiency of SFF Bread

This section reports on a preliminary, very limited analysis of SFF bread as an efficient source of nutrients. The analysis uses a linear programming procedure. The linear programming procedure takes a specified nutrient requirement, and the unit prices and nutrient composition of available foods, and, on the basis of this information determines the least-cost combination of foods that

satisfies the nutrient requirement. The analysis reported here consists merely in determining if SFF bread is included in a least-cost diet.

The nutrient requirement used here specifies the required amounts of calories, total protein, and the following essential amino acids; lysine, threonine, tryptophan, and methionine + cystine. (Amino-acid requirements follow FAO/WHO recommendations[12].) The list of available foods and their prices was obtained from Food Consumption in Brazil. Data for the city of Sao Paulo were used, and to the extent that the foods available in Sao Paulo and their relative prices are not typical of other cities, or of other seasons, the results are useful only for Sao Paulo. Fourteen foods were included: rice, beans, bread, potatoes, beef, fish, eggs, milk, cheese, bacon, oranges, bananas, oil, and sugar. Nutrient composition information was obtained from USDA, Handbook No. 8[13] and FAO, Amino-Acid Content of Foods.[14]

With the above specification of the problem, the linear programming procedure determined that the least-cost (Sao Paulo) diet consisted of four foods: bread, bacon, oil, and sugar. (Oil entered the least-cost diet due to an assumed upper limit on the quantity of sugar allowed in the diet.)

The efficiency of SFF bread was then tested by including it in the list of available foods, and determining at what price it would enter the least-cost diet. It was found that if the price of SFF bread did not exceed the price of "regular" bread by more than 13% that SFF bread replaced "regular" bread in the least-cost diet. It is recognized that the analysis here reported is limited. In addition to referring only to Sao Paulo at one moment in time, it takes no account of the need for variety in human diets. The relative prices used are market prices, and to the extent that these are not accurate reflections of relative social values, or would change substantially if demand/supply conditions changed, the results are limited. In spite of these limitations, it appears that the linear programming approach may be useful in determining the economic efficiency of the SFF technology in different environments. A full-

study would be able to go much farther in analyses of this sort.

GOVERNMENT COMMITMENT TO NUTRITION

The following detail is taken from a Department of State airgram[4/].

"In 1972, the President of Brazil declared nutrition to be a national priority, and established the National Food and Nutrition Institute (INAN) with responsibilities to coordinate and set norms and standards for all nutrition activities and programs including research. INAN is a semi-autonomous organization, responsible to the Ministry of Health,but many of its programs require the cooperation of other ministries such as Education, Agriculture, Planning, and Labor. Of its 1973 budget of $74 million, 87 percent has been allocated to food assistance and nutrition education, while school feeding represents 55 percent, and maternal-child feeding 32 percent. Yet, the priority area has been declared to be maternal/child feeding. The justification for spending more than half the budget on school feeding is that it is an already on-going program which must be maintained while planning is being carried out for new programs which will eventually receive a larger share of INAN's budget. After months of planning, INAN has developed the following programs which they hope to implement by July 1, 1973:

(1) SAMI - (Supplemental Maternal-Child Feeding): INAN hopes to reach 2 million infants, pre-school children, and pregnant and nursing mothers in Northeast Brazil, through this program. It is aimed at providing calories, and protein, if needed, through rice, beans, cornmeal, and sweet potatoes to be distributed through the Brazilian Food Company (a Federal Government food distribution agency), and state health posts. Nutrition education will be included as part of the supplemental feeding program. Infants and pre-school children will be weighed and measured to establish baseline data for future evaluation. Criteria for selection of the target group is discussed on page 16.

(2) UCEN - (Community Nutrition Extension Units): These units will operate through already existing health posts and will include nutritional recuperation centers as annexes to the posts. Approximately 30-50 children will be attended at any one time by each center and nutrition education will be given to mothers of these children. There are 50 UCEN's planned for 1973 to be located almost exclusively in the Northeast. Operation of the centers will be through state health programs.

(3) Nutrition Education - This INAN program is currently being developed. Manuals are being prepared to help orient those people teaching nutrition education in the SAMI and UCEN programs. A mass media campaign to reach all segments of the population is being prepared with the help of the Public Relations Office of the Presidency. In addition, MOBRAL, which is responsible for the national literacy campaign, will incorporate nutrition education materials into their primers. Projected numbers of people to be reached are not available.

(4) Food Production Incentives - The fourth INAN program to be carried out in cooperation with the National Rural Extension Service (ABCAR), provides incentives to small landholding farmers to increase food production. Surplus food, if not sold on the open market, will receive a guaranteed market from the Brazilian Food Company, and entity of the Ministry of Agriculture and will be distributed in supplementary feeding programs.

Future Nutrition Policy: This section is based on information found in INAN's program, PRONAN (The National Food and Nutrition Program), which is still in draft form. PRONAN target groups are infants, preschool children, and pregnant and nursing mothers. Its overall objectives are the following:

1. Reduce infant mortality due to malnutrition;
2. Reduce protein-calorie deficiencies among infants and children up to 6 years of age;
3. Increase the resistance of these vulnerable groups to infection and other diseases;
4. Improve the food habits of pregnant and nursing mothers independent of economic levels; and
5. Promote breast-feeding for at least the first 6 months of life.

Criteria for selection of target groups are:

1. Families in the lowest income brackets;
2. Families with the most children;
3. Families with the highest degree of malnutrition; and
4. Less-developed geographic areas where there is a lack of adequate food supply.

Activities include.

1. Installation of 100 nutritional recuperation centers in 1973;
2. Recuperation of 25% of target groups by means of food supplements supplied through feeding at schools of pre-school children;
3. Conduct nutrition education to the maternal-child group; and
4. Promote incentives for increasing local production of subsistence families.

Food supplements will meet:

30% of daily requirements of principal nutrients of pregnant and nursing mothers: numerical goals: 250,000 for 1973 and 275,000 for 1974.

50% of daily requirements of infants and pre-school children up to 3 years old: numerical goals: 700,000 for 1973 and 780,000 for 1974.

30% of daily requirements of pre-school children from 4-6 years; numerical goals: 600,000 for 1973 and 870,000 for 1974.

The Brazilian government will purchase and accept donations of basic food in order to meet these goals.

Objectives of Nutrition Education are:

1. Progressively modify the criteria of selection and utilization of food.
2. Publicize the availability of low cost nutritious foods during the harvest season;
3. Adopt more effective methods for food preservation;
4. Observe norms of hygiene in the conservation and preparation of food;
5. Choose forms of food preparation, which besides being more appetizing and less costly, are more effective in preserving nutritive value;
6. Serve to different members of the family, foods which are in agreement with their qualitative and quantitative nutritional requirements.

Agencies responsible for Nutrition Education are;

1. The Public Relations Office of the Presidency of the Republic (AERP) which will develop radio and television messages:
2. SUNAB which will conduct consumer education by radio;
3. ABCAR which will provide home extension to the rural housewife;
4. MOBRAL which will provide nutrition education in adult literacy classes; and
5. Private industry which will promote nutrition education through advertising."

In spite of the high hopes expressed in the above analysis made in June of 1973, the first year of operation under INAN was a frustrating one with apparently little real progress made toward realization of the goals established. This, of course, is to be expected in a new organization to some degree, but apparently strong leadership was lacking. The first Director resigned and in August 1974 a new Director is yet to be named. Until a new Director takes over INAN not much assistance from that organization to a program of improving the nutritional value of breadstuffs through fortification can be expected.

School Lunch Program

In the meantime, a crisis faces the on-going school lunch program. In July, 1975, Title II P.L. 480 shipments to Brazil may be phased out completely. By that time, the Brazilian government must take over the funding of the project. More importantly, they must come up with commodities and diets to meet their stated goals.

The most recent publication of the Superentendencia Da Nacional de Alimentacao Escolar[1/] states an operating goal for providing 12 million school children lunch for 140 days. It calls for the lunch to be: 350 calories; 7 gms. of protein (NPU=1); Vitamin A, 650 I.U.; Vitamin B_1, 0.2 mg; Vitamin B_2, 0.2 mg; Vitamin B_3, 2.5 mg; and iron, 2.0 mg.

A contract bakery program to provide fortified buns or bread made from soy fortified flour is one of the most practical means to accomplish these goals at a minimum cost.

INTERNATIONAL NUTRITIONAL PROGRAMS[4/]

"Role of Other Donors: Several donor organizations have provided and are providing assistance to Brazil in nutrition-related areas.

The World Health Organization / The Pan American Health Organization (WHO/PAHO): Has for a number of years provided technical assistance to the Institute of Nutrition in Recife with the objective being the strengthening of its capacity to deal with regional nutritional problems. Under the leadership of the past WHO/UNICEF consultant, Dr. Ivan Beghin, experimental nutrition rehabilitational centers were tested in the Recife area. Although project evaluations have not conclusively proven the cost/benefit advantages of this activity in comparison with others, INAN plans to use a related concept in its new UCEN program. Further, a PAHO/WHO nutrition advisor is presently carrying out needed nutrition research in the Northeast giving special attention to Vitamin A deficiencies.

The United Nations' Children Fund (UNICEF): is active in nutrition education activities. Their resources support courses in the state of Pernambuco for upgrading state health department nutritionists. Equipment and scholarships are provided for a school lunch training center in Belo Horizonte and Fortaleza. An ABCAR training program in nutrition education for medium and high level nutritionists also receives UNICEF support.

A Food and Agriculture Organization (FAO): A nutritionist-economist is presently working with the Getulio Vargas Foundation in Rio de Janeiro developing models for food consumption surveys. An integrated FAO/PAHO/UNICEF team held a recent seminar in Brazilia on the inter-relationships of nutrition, agriculture, and national planning.

The World Food Program: in cooperation with the school lunch program, is providing a small input to school feeding in the less developed areas of the Sao Francisco Valley in the Northeast. Their program provides 10,000 tons of commodities annually and reaches about 300,000 children.

The World Bank: is presently considering a nutrition loan of an unknown amount to Brazil. As currently envisaged, the loan will support: 1) nutrition education activities; 2) pilot projects testing several delivery mechanism designed to reach high priority groups; 3) nutrition surveys and evaluations; and 4) food fortification activities."

INSTITUTIONS FOR COMPOSITE FLOUR TECHNOLOGY

Some 35 institutions in Brazil are involved with on-going research projects for the food sector. Eleven of these have programs involving the nutritional value or improvement of foodstuffs.

Two institutions are known internationally for their programs dealing with composite flour technology. The Center for Agriculture Technology of Food (CCTA Ministry of Agriculture) in Rio de Janeiro has conducted studies of manioc and breadmaking with particular emphasis on the substitution of manioc flour for wheat flour.

The Institute of Food Technology (ITAL, Campinas) has conducted extensive studies on the protein enrichment of pasta products and to a lesser degree on breads. They are currently conducting research on full-fat soy flour. This Institute has the personnel and physical facilities for research as well as conducting training programs for millers and bakers on the technology of soy fortified flour.

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IMPRESSIONS ON THE POTENTIAL FOR FORTIFIED WHEAT FOODS IN COLOMBIA

POPULATION

Colombia has a population approaching 25 million. The annual growth rate is around 3%. It is estimated that almost one-half of the population is under 15 years of age. The rural population is 40-45% of the total. The urban proportion is increasing; the major cities are growing very rapidly. About 75% of the population is of mixed (Spanish and Indian) ancestry, 20% of Spanish ancestry, 5% of African ancestry, and 1% of Indian ancestry.

GROSS NATIONAL PRODUCT

The per capita gross national product is around $400 and is projected to be increasing 4.3% yearly. The average figure must be carefully interpreted because incomes are very unequally distributed. (One study showed that 40% of the urban population could not afford an adequate diet even by spending 100% of their income on food.)

NUTRITIONAL STATUS

The U.S. Interdepartmental Committee for Nutrition in National Defense (ICNND) carried out a detailed diet and nutrition survey in 1960. The results are still probably valid. Diets vary, with altitude being a major determining factor. At high altitudes, important food items are wheat, potatoes, corn, and sugar. At lower altitudes, important food items are rice, plantains, manioc, corn, and sugar.

The ICNND survey of food consumption of 40 families in 9 locations revealed that the calorie intake was clearly below requirements. The survey included blood tests. It was found that the serum albumin level--regarded by some as a

good indicator of protein nutrition states--was "deficient" or "low" (where "low" means at the bottom of the normal range) for some 60% of the persons sampled.

In 1967 the National Institute of Nutrition published a summary of 10 surveys of nutrition status. The survey had been carried out in 10 different locations covering diverse diets. The families included in the survey were classified by socio-economic status into four categories. The surveys showed "inadequate" calorie and protein intake for all but the "high" socio-economic category.

These studies indicate the existence of serious food and nutrition problems. The USAID 1974 Colombian Health Sector Analysis says that malnutrition is a serious health problem in Colombia. There is chronic sub-nutrition in more than 50% of the adult population, with marked deficits in the consumption of calories, proteins, and vitamins. The USAID report says that in studies of children under 6, two-thirds displayed some degree of malnutrition.

WHEAT CONSUMPTION

Per capita total wheat consumption is currently about 44 lbs. per year and has been increasing at a rate of 5.7-6% per year. About 87% of the flour milled is used for bread. The 1974 per capita consumption of bread is estimated at 39 lbs/yr. Bread consumption varies greatly from urban to rural areas with about 64 lbs/capita/year consumption in Bogota, 60 lbs/capita/year in Medellin, Cali, and Barranguilla, and about 15.5 lbs/capita/year outside the major cities.

WHEAT SUPPLY

Imports amounting to around 450,000 metric tons represent about 90% of total wheat supply. The domestic production of wheat has declined from a level of 140,000 metric tons in 1960 to a level of 50-60,000 metric tons in recent years. No major increase in domestic production is expected. The imported wheat is hard red winter wheat from the United States.

PROTEIN RESOURCES FOR FORTIFICATION

Soybeans and sesame represent the major vegetable protein resources for fortification in Colombia. Little information was obtained about the present or potential utilization of sesame as a food protein resource. Soybean production has been increasing rapidly in both acreage and yield over the last decade to the current production level of 150,000 metric tons. Some industry representatives predict Colombia could become a major exporter of soybeans and soy products. Presently, soybeans or soymeal are not imported although the domestic production of soymeal is not sufficient to fulfill the demand from the poultry industry.

PRICE RELATIONSHIPS, GOVERNMENT PRICE SUPPORTS AND PRICE CONTROLS

Prices of major agricultural crops are supported by the Government of Colombia through IDEMA, an agency which also imports all grain commodities and in turn sells to the processing industries. The wheat industry is rigidly controlled with a controlled price of 3,800 pesos/ton for wheat to the mills and a controlled price of 4,040 pesos/ton which the mills can charge for flour. Mills operate on an allocation of wheat. Since September, 1973, the wholesale price of bread produced by the larger baking firms has been frozen at the June 15, 1973 level.

For several years, IDEMA charged millers a price for wheat over the purchase price and apparently used the differential to support the price of domestic wheat at a level above the world market price. Currently, with the price support for local wheat at 5,000 pesos per ton and the purchase of imported wheat at high world market prices the government finds itself in a major dilemma. In effect, the government is subsidizing the price of wheat at an annual cost in 1974 of

about $20 million to maintain an unrealistically low cost for bread and other wheat based foods. Planners now favor a government policy aimed at reducing the consumption levels of wheat.

While the miller has not necessarily suffered from this situation, the baker has as his cost of ingredients other than flour has also soared. The cost-price squeeze on the baker has left no alternative but to decrease the weight of bread units sold at the same price.

STATUS OF FLOUR MILLING INDUSTRY

There are 105 flour mills in Colombia with an aggregate annual capacity for milling 1.2 million tons of wheat. The industry is operating at only 40% of capacity. Actually, only about 75 mills are operating with the other 30 marketing their wheat quota to the operating mills. There is a shortage of flour at the controlled price and bakers are apparently paying a premium over the established price to obtain enough flour to maintain or expand their share of the bread market.

STATUS OF THE BAKING INDUSTRY

The major cities have at least one large wholesale bakery. These major firms are generally well-designed and managed although still not fully mechanized. The medium sized bakery is emerging. These operate as a retail bakery but distribute to other stores and institutions as well. These bakeries are partly mechanized, but still depend upon a great deal of "handwork." Hundreds of small bakeries are still operating with over 4,000 estimated in the city of Bogota alone. In the current economic squeeze, many of these small shops are disappearing and the surviving larger units are claiming a larger market share. A wide variety of breadstuffs are produced and consumed but the most predominant form is a bun containing 8-12% shortening and 12% sugar.

STATUS OF PROTEIN INDUSTRY

Five major soy mills are now producing soy oil and soybean meal in Colombia and apparently have sufficient excess capacity to accomodate the expected increased demand over the next few years. Three of these firms are now capable of producing edible defatted lightly toasted soy flour suitable for use in soy fortified bread.

INTERNATIONAL NUTRITION PROGRAMS

Colombia receives about 60,000 metric tons of food per year primarily through Food for Peace via CARE and CRS. The World Food Program is also an important source. Recipients include 1.7 million school children, 0.7 million preschoolers and 0.3 million mothers. Buns produced from soy fortified wheat flour form the backbone of the CARE and CRS school lunch programs this year. Food for Peace (P.L. 480) shipments are destined to be phased out within the next 2 or 3 years, if possible.

GOVERNMENT COMMITMENT TO NUTRITION

The recently elected government has stated its major priorities to be education, health, and nutrition. Stated nutritional goals over the next 4 years are to reduce external food support by 10% each year and increase the coverage of the mother-preschool group by 10% each year. Little or no emphasis has been given to the problem of replacing the commodities now used in the school lunch program. The current thrust is to develop a series of cereal-vegetable protein flours to serve as a gruel or beverage base for the feeding programs under the name "Bienestarina." These products are based on the "Incaparina" prototype. A feasibility study for this development is just getting started at the Instituto de Investigaciones Technologicas. Product development, acceptability, and costs are yet to be determined.

A Committee for National Food Policy has been established and involves the National Planning Department and the Ministries of Agriculture, Public Welfare, Public Health, and IDEMA. Nutritional programs and commodities used therein will ultimately be determined by this policy group. One goal now is to reduce wheat consumption. The nutritional programs will be aimed at the lowest 20% economic class and as wheat is thought to be consumed by the middle and upper class, the planners do not see wheat foods as the right vehicle for nutritional programs.

GOVERNMENT REGULATIONS

Compositional regulations on bakery products either do not exist or are quite liberal. There are currently no restrictions on dough conditioners or other additives to baked foods. Actually, there is a 15 year old law requiring the 5% addition of soy flour to wheat flour. To this time, it has not been used as a legal instrument because until quite recently edible soy flour was not domestically available.

SUMMARY

The technical status of the milling and baking industry and the availability of soy flour make the production of soy fortified flour technically feasible and possibly economically attractive for the major urban centers in Colombia. Such a locally produced product could readily replace the soy fortified flour used in the school lunch programs and be used in general distribution for nutritional improvement.

An in-appropriate response to the current wheat problem could override these positive aspects. Government planners feel they must either remove the subsidy on wheat imports and allow the price of wheat and wheat products to rise, or limit directly the importation of wheat. Direct limitations on wheat would,

of course, reduce the attractiveness of wheat as a means for nutritional improvement. It appears that the more appropriate policy response would be to remove the wheat subsidy and allow the price of wheat to the millers to reach a realistic level, even though wheat consumption would be reduced somewhat as its price increased relative to other foods. (It appears that with a realistic exchange rate and realistic price relationships, Colombia could be an exporter of rice, soybeans, and corn, and an importer of wheat.)

RECOMMENDATIONS

1. A soy fortified bread "pilot" nutrition project should not be carried out in Colombia unless the current wheat "dilemma" is resolved.
2. The potential role of soy fortified flour in nutritional programs is not well understood in Colombia and some continuing educational effort should be maintained through the AID Mission Nutrition Officer, TAB Office of Nutrition, and KSU personnel.
3. Short-term technical assistance should be provided to the Instituto de Investigaciones Technologicas for their composite flour and "Bienestarina" projects, if requested.
4. Individual bakeries indicated an interest in commercially merchandizing a protein fortified bread. This should be encouraged by providing information and technical assistance support on a limited basis.

POSTSCRIPT TO THE REPORT ON COLOMBIA

In September 1974, the government of Colombia removed the subsidy on wheat. The result was a 47% increase in the cost of wheat and a sharp rise in the cost of bakery products. The consumption dropped about 25%, but then began to increase again. One estimate is for wheat imports for 1975 to be only about 9% under 1974 levels.

The current price or consumption situation is not known. It does appear that breadstuffs are such a staple part of the diet now in Colombia and even at the subsidy free price are reasonably priced in relation to other foods that they will continue to be an important source of nutrients. Breadstuffs are the most convenient vehicle for protein fortification and vitamin and mineral enrichment.

The removal of the wheat subsidy makes soy fortified wheat flour appear relatively much more economically attractive than at the time of the survey trip. It has been reported that wheat flour is now selling at 9,600 pesos per ton and domestically produced soy flour is selling at 9,500 pesos per ton. Considering the increased bakers yield and lower shortening requirements with soy fortified flour, protein fortified bakery products should now be possible at less cost than those based on wheat flour alone. Add to this the fact that domestically produced soy flour used at a 12% replacement level would lower wheat requirements by 16%.

This drastically altered economic situation makes it seem advisable that an additional assessment of the situation in Colombia be made.

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IMPRESSIONS ON THE POTENTIAL FOR FORTIFIED WHEAT FOODS IN EL SALVADOR

POPULATION

El Salvador has a population of about 4 million. The annual growth rate is in excess of 3%. About 90% of the population is of mixed Indian-Spanish ancestry and about 10% is of pure Indian ancestry. About 40% of the population is urban. About 45% is under 15 years of age. More than three-fourths of the population live in the central highlands and valleys. The population density is the Highest in the mainland Western Hemisphere.

INCOME

Income is about $400 per capita. Agriculture accounts for 60% of the labor force, and about one-third of GNP. Coffee is the most important crop and export. Other important crops are corn, rice, beans, sugar cane, sorghum and cotton.

NUTRITIONAL STATUS AND DIETS

INCAP carried out a nutrition survey between 1965 and 1968. In the rural areas, the average daily per capita consumption of foods was found to consist of corn tortillas (528 grams), rice (27 grams), sugar (41 grams), wheat bread (26 grams), meat (37 grams), legumes (59 grams), milk and milk products (190 grams), and small amounts of other foods. It was estimated that calorie intake averaged 2,146 calories and protein intake 68 grams.

The survey showed that in urban areas, the average diet consists of corn tortillas (249 grams), rice (55 grams), sugar (38 grams), wheat bread (66 grams), meat (77 grams), legumes (52 grams), milk and milk products (237 grams), and small amounts of other foods. Calorie intake averaged 2,209 calories, and protein intake 70 grams.

The INCAP survey showed that average calorie and protein intake was generally adequate, but that the average did conceal inadequate consumption in many families.

Food availability statistics and apparent per capita consumption of various foods suggests poor and deteriorating nutritional status. Present meat consumption averages 13 lb/yr. Overall calorie intake and food availability is being reduced as population grows. Land being fully cultivated. Largest crops are cotton, coffee and sugar for export and do not add to local food resources. Potential for increased food crop production most likely will come from multiple croppings. Currently, meat, dairy products, wheat, corn, and other cereals are being imported to supplement domestic production. Food imports will necessarily increase to feed the population. Note: According to the 1969 INCAP Study, 80% of all children under 5 years of age in rural areas are suffering from some degree of malnutrition. The quantity of wheat in the diet has grown significantly in recent years.

WHEAT CONSUMPTION

Wheat, although imported, forms an important part of the diet with a per capita consumption of more than 30 lbs. per year. Wheat is consumed primarily as French bread or as "pan dulce." Consumption of American-type bread and rolls is increasing in the cities. Cookies and pastas are also important. About 50% of flour is used for bread and buns and about 50% for pan dulce and cookie products. Wheat consumption per capita has been rather level the last 5 years.

WHEAT SUPPLY

All wheat is imported from U.S., with 50% being 15% protein Dark Northern Spring Wheat and 50% being Western White Wheat of about 9% protein.

PROTEIN RESOURCES

Low red meat, chicken and dairy products consumption means that most proteins are derived from grains (largely corn) and beans. Best consumption figures are 9 years old (INCAP) and current situation is thought worse. Large potential protein resource exists in cottonseed. Presently cottonseed meal from oil crushers is either exported or used in animal feed. Degossypoled and detoxified cottonseed is not available. No other large and economically feasible priced protein resource appears to be available. Soy production is possible but not likely to emerge as major crop. Protein fortification of wheat flour should be based upon imported soy flour until local resource or industry can be developed.

PRICE RELATIONSHIPS, GOVERNMENTAL PRICE SUPPORTS AND PRICE CONTROLS

Prices of wheat, soy products and other imports are tied to world market prices. There is no import duty on wheat if price goes above a certain minimum level. Soy meal heavily taxed unless only for poultry feed to protect local cottonseed meal. Local crops relate to world market prices but there is a large seasonal fluctuation because of lack of storage and lack of funds of IRA to control enough grains to really support prices. Government controls maximum price of wheat flour and basic price of bread. As prices have increased, baker has reduced size of unit sold but held price per unit constant. Bakers are caught in a price-cost squeeze as all ingredient costs have gone up in last two years.

STATUS OF FLOUR MILLING INDUSTRY

Two excellent mills that are apparently operating at 50% capacity supply entire country.

STATUS OF BAKING INDUSTRY

Two large fully automatic bakeries, 250 medium-size partly mechanized bakeries, and many small handicraft shops make the industry. 230 of the bakeries are organized into a cooperative which provides its members with purchasing power and technical and management assistance. A baking school to train bakers, sponsored by Great Plains Wheat, is located in San Salvador.

STATUS OF PROTEIN INDUSTRY

No plant for producing edible protein concentrate exists. Protective import duties will likely prevent importation of soybeans for local processing into oil soy meal, and edible soy flour.

INTERNATIONAL NUTRITION PROGRAMS

CRS and CARITAS have had a food distribution program based on Food for Peace commodities. This has largely been a school lunch program with some distribution to mother-child health centers. World Food Program also distributes some commodities. School lunch program will apparently end at the end of the current school year. AID is trying to restructure programs to reach the most needy and non-institutionalized children under 5 years as the first priority. Future of all programs regarding size, type of recipients, products, goals and sponsors are not clear at present.

GOVERNMENT COMMITMENT TO NUTRITION

Nutrition was strong plank in President's program two years ago. Three months ago CONAPLAN was charged with developing a national nutritional strategy plan, but has assigned only one man on a part-time basis to the project. He is relying heavily on INCAP for guidance and only suggestion to date is for an INCAPARINA-type product to be produced in a new plant to be built and operated by the government to distribute the food to preschool children on an "emergency" basis.

GOVERNMENT REGULATIONS

The milling industry is controlled primarily by competition on quality. Liberal and modern laws require vitamin and mineral enrichment (one of very few developing countries) and permit the addition of dough improving additives by both the miller and the baker.

SUMMARY

The "climate" for wheat flour fortification appears to be better in El Salvador than in the other countries surveyed thus far. The milling and baking industries, the voluntary agencies and government officials warmly and even enthusiastically received the idea of fortified bakery products as one way of quickly interjecting more protein and thus improving the general nutritional status of the country. A declared emergency in nutrition exists, and fortification of bread and all flour products is an immediate intervention, requiring no new facilities or new systems of distribution. While corn and beans are the backbone of the diet, it was emphasized that wheat products are an important daily part of the food intake of all classes of people.

The distribution and sale of baking foods does reach even the smallest "tienda" in the more remote villages and are packaged in small units to fit the purchasing power of the poor.

It appears that protein fortification of all wheat flour and/or that used for special nutritionally deficient institutional groups can be quickly and easily achieved through existing commercial channels. Soy fortified flour can also serve as a basic ingredient for distribution to the very poor and non-institutionalized needy. It can be used directly for preparation of "flour tortillas," mixed into corn tortillas or as an "atole" beverage base. It can also be used for the further preparation of cereal based fortified mixtures such as "frescavida," using locally produced corn flour, for example, in addition to the soy fortified wheat flour.

RECOMMENDATIONS

1. A sizable quantity of soy fortified flour should be brought into El Salvador under Title II P.L. 480 to be used for acceptability study, demonstrations, and evaluation.
2. Short-term technical assistance should be offered to the millers for design of the mixing system.
3. Technical assistance in the form of demonstrations and training at the MOLSA baking school should be provided for the baking industry.
4. The Government of El Salvador should be urged to permit the duty f importation of soy flour and SSL for this nutritional program.
5. Assistance should be provided to CONAPLAN to properly place this program into the national plan for nutrition.

6. Assistance should be provided to CONAPLAN and the voluntary agencies to develop products based upon soy fortified flour and to develop schemes for their commercial and noncommercial distribution.

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IMPRESSIONS ON THE POTENTIAL FOR
SOY-FORTIFIED WHEAT FOODS IN ECUADOR

POPULATION

Ecuador's population (1974) is about 7 million and is increasing at an annual rate in excess of 3 percent. The urban population is about 40 percent of the total. The proportion under age 20 is about 55-60 percent. The coastal region and the Sierra region each contain about one-half of the population--a very small proportion lives in the eastern lowlands. Over half of the population is engaged in agriculture.

GROSS PRODUCT AND INCOME

GNP in 1973 (current prices) was approximately $2.4 billion (U.S. $1=S/25). GNP per capita was approximately $350, but was very unequally distributed. Total income has increased rapidly in recent years due largely to increases in crude petroleum exports and externally-determined petroleum prices. Agricultural production accounts for about one-fourth of total production. Aggregate agricultural production has increased very slowly in recent years.

WHEAT CONSUMPTION

Wheat consumption increased from about 110,000 MT annually in the years 1960-61 to about 150,000 MT annually in 1970-71. Consumption in 1973-74 is estimated to have been about 190,000 MT. Average annual per capita consumption is therefore about 27 kg (60 lbs). Average wheat consumption is higher in urban areas than in rural areas. Even if only two-thirds of the wheat is consumed in the urban areas (probably a low estimate) it is likely that average per capita consumption in Ecuador's

urban areas is at least 100 lbs. per year. On a flour basis (assuming 75% extraction) urban per capita consumption is at least 75 lbs. per year, or about 100 grams/day.*

About 75% of flour is consumed in the form of bread, 5% in cookies and crackers, and 20% as noodles and other pasta products. The rather rapid increase in wheat consumption in recent years is due to changing eating habits, increasing personal income, and (since October 1973) a government subsidy on wheat imports which has kept the cost of flour based products artificially low.

WHEAT SUPPLY

In 1960-61 domestic production accounted for about 60 percent of total wheat supply, and imports for 40 percent. Domestic production of wheat was in the range 50-80,000 MT per year throughout the 1960's, but has declined in the early 1970's to an estimated 40,000 MT in 1974. On the other hand wheat imports, which were in the range 40-50,000 MT in the early 1960's, increased to about 100,000 MT in the early 1970's. Estimated imports in 1974 are 150,000 MT. Therefore, domestic production now accounts for only about 20 percent of total wheat supply. The government has initiated credit and certified seed programs to stimulate domestic production and is expecting increased acreages next year.

*If the 100 grams of flour were soy-fortified flour, there would be large protein intake from flour alone. The 100 grams of soy-fortified flour would provide 16 grams of protein, of which 488 mg. is lysine. For an adult (70 kg) this represents 40 percent of total protein requirement (40 g) and about 55 percent of the lysine requirement (880 mg). For a 10-12 year old (37 kg) this represents one-half of total protein requirement (30 g) and about one-third of the lysine requirement (1624 mg).

GOVERNMENT PRICE POLICY FOR WHEAT AND ITS IMPACT ON WHEAT CONSUMPTION

The only significant government intervention in agricultural markets appears to be in wheat. Recent government policy has had the effect of keeping the price to consumers below the world-market level. Current wheat imports (80 percent of total wheat supply) cost Ecuador about $220/MT, but are sold to mills at approximately $130/MT. Unlike some other countries, Ecuador has not allowed this subsidy to reduce the price paid to domestic producers of wheat. Domestic producers are paid a "reference" price comparable to the world-market price. An implication of this is that the probable removal of the subsidy on imported wheat is unlikely by itself to increase producer-price and stimulate domestic production. The removal of the subsidy will increase the price paid by mills, and consequently bakers and consumers. It is difficult to estimate accurately the probable rise in final product prices upon removal of the subsidy. (See our estimates below.) One knowledgable source estimates a 10 percent price increase and not much subsequent decline in wheat consumption. Wheat products are likely to remain an important part of urban diets.

CALORIE-PROTEIN STATUS

It is probably impossible to summarize in a useful way the calorie-protein intake status in a population as diverse as Ecuador's. To the extent that intake differs among regions between urban and rural, among income classes, among age groups, and among seasons of the year, average figures that combine sub-totals are without operational meaning. From the point of view of this project the important question is the extent of flour consumption by persons having inadequate protein intake. Ideally, we would like to know the protein-deficient groups in the population and the extent

of their flour consumption in order to determine if an increase in the protein in flour would help remove protein inadequacies. This type of information is not available.

There are available studies that lead to the conclusion that some protein deficiencies exist in Ecuador. It is also known that flour consumption is widespread (at least among all income groups in urban areas). Without being able to quantify, it is probably accurate to say that some flour is consumed by some protein-deficient persons.

Because estimates below will show that increasing the protein in flour will be practically without additional cost to Ecuador it really is not essential to determine with precision the overlap between people who are protein deficient and people who consume flour.

Some surveys (notably the ICNND survey of 1959) reveal widespread deficiencies of certain micro-nutrients (e.g. riboflavin, thiamine, vitamin A, and calcium). Widespread consumption of flour makes vitamin and mineral enrichment of flour an attractive solution to these deficiencies.

COST OF SOY-FORTIFIED FLOUR

An attempt is here made to estimate (1) the cost to Ecuador of soy-fortified flour and (2) the cost to the Ecuadorian baker of producing one metric ton of bread.

The following assumptions are used:

1) Price of imported wheat, c.i.f. Ecuador $220/MT.
2) Price of soy-flour, vitamin and mineral enriched, including SSL, c.i.f. Ecuador $350/MT.
3) Extraction of wheat flour from wheat, 76 percent.
4) Price of domestic wheat, $220/MT.

5) Subsidized price of imported wheat to flour mills, $128.76/MT.

6) Proportion of imported wheat to domestic wheat, 77.3:22.7.

7) Millfeed sold from mills at $52.80/MT.

At the present time, with subsidy, the flour mill in effect buys a wheat blend that costs $149.47/MT. From this the mill obtains .76 MT of flour and .24 MT of millfeed. At present the mill sells flour for $220/MT and millfeed for $52.80/MT. Therefore the mill obtains $179.87 for the product of one MT of wheat (= .76 x 220 + .24 x 52.8). The mill has a margin of about $30/MT of wheat milled. This figure is used in later computations.

Without subsidy, the flour mill will buy wheat (imported and domestic) at $220/MT. One MT of wheat yields .76 MT of flour and .24 MT of millfeed. Assume millfeed still sells for $52.80/MT. The unsubsidized cost of one MT of flour to Ecuador can be determined as follows. It requires 1.32 MT of wheat to yield 1 MT of flour (= 1.32 x 176). This wheat costs Ecuador $290.40 (= 1.32 x .220). It costs $39.60 to mill (= 1.32 x $30). It yields .317 MT of millfeed (= 1.32 x .24) worth $16.73 (= .317 x $52.80). One MT of wheat flour therefore costs Ecuador $313.27 (= $290.44 + $39.60 - $16.73).

One MT of soy-fortified flour consists of .88 MT of wheat flour and .12 MT of imported soy flour. It costs Ecuador $317.68/MT (= .88 x $313.27 + .12 x $350). On this basis, soy-fortified flour costs $4.41/MT more than wheat flour. This small increase in cost leads to a substantial improvement in protein content.

The cost of flour estimated above is the important figure from the point of view of society. It is also useful to estimate some costs from the point of view of the baker. Using the above-determined flour costs we can determine the raw material (flour, sugar, yeast, shortening, etc.) cost of producing one MT of standard formula bread.

At the present time the price to the baker of subsidized wheat flour is $220/MT. Using a standard formula for bread and current costs for other raw materials it can be shown that one MT of bread has a (current subsidized) raw material cost of $176.

Without subsidy, assume the price of wheat flour to the baker increases to $313.27/MT (from the cost estimate determined above). This forces raw material costs per MT of bread to $231/MT.

Without a subsidy on wheat, and using soy-fortified flour instead of wheat flour (with concurrent reduction in shortening requirement from 4 percent to 2 percent, and increased bread yield of 6 percent) the raw material cost per MT of bread is $211/MT. These estimates are summarized in the following table.

	Price/MT of flour	Price of raw materials per MT of bread
Current subsidized wheat	$220	$176
Unsubsidized wheat	$313.27	$231
Unsubsidized wheat soy-fortified	$317.68	$211

It is important to note that the 20 percent increase in raw material cost of soy-fortified flour over current subsidized raw material cost need not lead to a similar price increase of bread products.

At the current retail price of standard bread of $400/MT the "margin" over current subsidized raw material cost is $224/MT. Raw material costs are 44 percent of bread price. If "margin" remains constant in absolute amount at $224/MT of bread, an increase in raw material cost of 20 percent need lead only to an 8 3/4 percent increase in price of soy-fortified bread over current bread prices.

PROTEIN RESOURCES

All nutrition studies and food consumption data indicate low animal protein intakes and surprisingly low legume protein intakes. The majority of the protein consumed from the cereal grains with wheat being the largest single source. Potential Ecuadorian resources for protein rich foodstuffs for fortification of wheat flour are cottonseed, soybeans, sesame, and perhaps quinoa. Degossypoled and detoxified cottonseed is not available. Sesame production is increasing but not a major source of raw material, as yet. Quinoa represents an intriguing possibility but research into producing a saponin free protein rich flour must precede subsequent encouragement of a higher level of production and thus is not a factor until some time into the future, if at all. Soybean production is rapidly growing and is being encouraged by an AID supported program and several GOE programs. Although not now at a significant level, domestically produced soybeans appear to be the best local source of edible protein in the reasonably near future.

STATUS OF THE MILLING INDUSTRY

There are two coastal mills with over 5,000 cwt. 24 hr. capacity each and a third coastal mill with 330 cwt. capacity for a total coastal area capacity of 10,450 cwts/day. The Sierra region has 22 mills with daily capacities ranging from 100 to 550 cwts/24 hrs. for a total capacity of 7,800 cwts/day. The average extraction rate is 75 percent. Although at least some mills are equipped to add malt or enzymes and potassium bromate to flour they are not currently equipped with feeders for vitamin and mineral enrichment.

STATUS OF BAKING INDUSTRY

There is one large fully mechanized bread bakery, 10 medium sized semi-mechanized bakeries and many small bakeries which are mostly equipped with

at least a mechanical slow speed mixer. At least 10 pasta plants are producing a variety of noodle and other pasta products. One fully mechanized biscuit plant producing up to 8 tons/hr. of product has county-wide distribution and a second large biscuit company has recently entered the market. Two yeast companies are supplying the industry. A portable baking school to train bakers is available through one of the millers in Guayaquil.

Bread products are available in every form in Ecuador, but the most important form of bread is a soft bun or roll. This bun has about 4 percent shortening and 5 percent sugar, and generally made using the sponge-dough method. French bread forms only a small part of the production.

STATUS OF PROTEIN INDUSTRY

Five oilseed crushing and oil refining plants are operating at under capacity. None of these plants are currently equipped for producing edible proteins, such as, soy flour.

INSTITUTIONS FOR COMPOSITE FLOUR TECHNOLOGY

Personnel at the Instituto Investigaciones Technologias in Quito, in cooperation with the cereals laboratory of the Instituto National de Investigaciones Agropecuaries, (INIAP) have carried out research on composite flour using corn, potatoes, yucca, and rice flours and are familiar with protein fortification technology.

INTERNATIONAL NUTRITION PROGRAMS

PAHO has provided a Nutrition Advisor to the Ministry of Health. UNICEF has offered up to 2 million dollars for applied nutrition programs in three provinces. WFP is providing commodities worth over $550,000 to the Agrariar Reform Institute and has been asked to supply rolled oats for the new

Mother-Child-Health (MCH) program. The UNDP is considering a request for $550,000 of processing equipment for the MCH food program. AID provides $120,000/year for the Institute of Nutrition, is providing consultation service for a mass media nutrition education program, and is providing commodities through PL480, Title II for the Institutional feeding programs carried out by CARE and CRS reaching up to 360,000 children.

GOVERNMENT COMMITMENT TO NUTRITION

There is evidence that the government is giving increasing priority to nutrition. The Nutrition Division of the Ministry of Health has been very active the last two years. A Mother-Child-Health program was inaugurated in December 1974 and the budget request to support this program in 1975 is 2 million dollars. By the end of 1974, 180 centers will reach about 300,000 people or 25 percent of the vulnerable group. Proposed legislation will create a Superior Council of National Policy for Food and Nutrition and already the Planning Board has a coordinator for food and nutrition policy.

GOVERNMENT REGULATIONS

Pricing regulations on both the milling and baking industry have been previously mentioned. Liberal laws permit the addition of dough improvers and other food additives by both the miller and baker and certainly flour enrichment would not be restrained legally.

SUMMARY

Soy-fortified wheat flour appears to be a logical, economical, and efficient nutritional intervention for Ecuador. The general importance of wheat flour based foods in the diet, the types of nutritional needs, and the existence of a basic commercial processing and distribution system for

wheat flour products all auger well for the fortification and enrichment of flour to have a quick impact on improvement of protein and vitamin and mineral intakes.

RECOMMENDATIONS

1. A more thorough feasibility study should be conducted as soon as possible to determine the advantages and disadvantages of establishing a law requiring the fortification and enrichment of all wheat flour in Ecuador.
2. Providing the results of the feasibility study continue to be positive, assistance should be offered to assist in the drafting of legislation requiring flour fortification and enrichment at the mills.
3. An action plan should be devised to provide technical assistance before and after adoption of the proposed flour fortification and enrichment laws including, but not limited to, the following: Short-term assistance to millers for design of the micronutrient feeder and blending system; training and demonstration programs for bakers on use of the new flour mixture; and the development of an educational or advertising program to educate the consumers about the nutritional advantages of consuming fortified and enriched flour based foods; and assist the Ministry of Health in properly placing the nutritionally improved wheat foods into their institutional and other feeding programs.
4. The Government of Ecuador should be urged to permit the duty free importation of soy flour, SSL and vitamins and minerals for this nutritional program.
5. Encouragement should be given to the domestic production of soybeans and to the adaptation of at least one processing plant to the production of soy flour.

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TECHNICAL SECRETARIAT FOR THE NATIONAL FOOD

AND NUTRITION POLICY - PONAN

Special Work Group

PROJECT OF FORTIFICATION OF WHEAT FLOUR IN ECUADOR

Document for discussion

March, 1975

INDEX

PRESENTATION

As the result of an initiative taken by the Agency for International Development (AID- Ecuador), Dr. William Hoover, Director of the Feedstuffs and Grain Institute of Kansas State University, USA, came to Ecuador in the past month of December with the purpose of exploring the possibility of establishing the consumption of wheat flour fortified with a certain percentage of soy flour. As a result of his stay, the above mentioned expert prepared a document called "Impressions of the potential in Ecuador for foodstuffs of wheat fortified with soy". This document was submitted for the consideration of the Ministry of Agriculture and Livestock, National Planning Board, Ministry of Health, ENPROVIT, CENDES, INLAP and certain industrial bakers.

Some of the institutions that were approached showed interest in developing this possibility, for which reason steps were taken towards another visit of Dr. Hoover who came to the country with Edward Alt Jr. of the Department of Agriculture of the United States.

The above mentioned experts arrived in Quito on March 10, 1975, and a work session was held with them to draw up a plan of activities for the period from the tenth to the twentieth of the same month.

This meeting was called by Mr. Manuel Arias, official of the National Planning Board and National Coordinator of the Committee on National Food and Nutrition Policy (PONAN). At this time, the outline which the work group was to follow was prepared and was set up in the following manner:

Economist Manuel Arias	JUNAPLA - PONAN
Miss Wilma Freire	JUNAPLA
Agronomist Mario Lalama	MAG-Grain program
Agronomist Carlos Basantes	MAG-Grain program
Dr. David Nelson	AID
Dr. William Hoover	Kansas State University
Mr. Edward Alt	USA Dept. of Agriculture

Consultations were made with officials of the following entities:

Agronomist Alfonso Herdoíza	CENDES
Chemical Engineer Juan Serrano	CENDES
Chemical Engineer Manuel Nieto	CENDES
Dr. Agronomist Enrique Ampuero	INIAP
Engineer Ligia de Benavides	I. Politechnic of Quito
Engineer Oswaldo Acuña	I. Politechnic of Quito

The present document has been drawn up with this background information, and submitted for the consideration of the National Government through its specialized organizations, so that they may analyze it and decide what is most convenient for the interests of the country.

It must be recognized, of course, that this is not a complete work, but it can offer the elements of basic judgement to reach a decision, after which it will be developed in terms of a feasibility study for it immediate implementation.

There is no doubt that this project is important for the country from the nutritional, economic and social point of view, for which reason we foresee that it will merit special attention from the Government Authorities and the private sector.

Within the context of the National Food and Nutrition Policy, this might be one of the projects of great and immediate national repercussion, and possibly, the pioneer of a series of priority actions which will lead to a progressive and firm solution of the serious malnutrition problem which large sectors of the Ecuadorean population suffer from.

I. BACKGROUND INFORMATION

Ecuador, because it is a developing country, has a serious malnutrition problem which principally affects pregnant and lactating mothers, and children under five years of age.

In accordance with the data provided by the National Institute of Nutrition, close to 40% of the pre-school children suffer from some degree of malnutrition. The problem is made worse because such a condition usually has associated pathology; gastroenteritis, bronchitis, bronchopneumonia and parasites which complicate the picture to the extreme of producing death, a situation which is very frequent in the poorer population group which lacks nourishment and which in our country represents approximately 70%.

The protein deficiencies detected by the National Institute of Nutrition are caused by a lack of proteins in the daily diet, both in quality as well as in quantity. The recommened consumption of proteins, is fifty-two grams daily in the case of a normal adult, and the average consumption barely reaches forty-six grams. There is also a marked deficit of iron, riboflavin, thiamine and Vitamin A at the national level. This deficit is even more acute on the Coast, because the average diet barey covers 50, 42, 31 and 86% of the requirements, respectively.

Faced with this alarming nutritional situation, the possibility appears that through the project of enriching wheat flour, a product which is consummed by all the population, the serious malnutrition problem may be mitigated to a certain extent. The information collected with reference to eating habits, show us that the diet of the Ecuadorean population. both in the urban as well as in the rural areas, is characterized by a high consumption of cereals. Among these we find, in significant proportion, the presence of wheat flour and its by-products.

This fact has obliged us to think of implementing a project for the fortification of wheat flour, so that the deficiently nourished population may count on a foodstuff which will provide nutrients which have been chronically deficient.

The project proposes the fortification with 12% soy flour of all the wheat flour in the country. This operation will be carried out progressively at a national level, starting from the more important centers of consumption, considering priorities and a calendar which will be established. The mixture assures that, for every hundred grams of said product there will be sixteen grams of proteins of which 488 milligrams are lysine, the substance which is the limiting factor in wheat flour.

Furthermore, this mixture provides Vitamin A, calcium, iron, niacin, riboflavin and thiamine, in significant amounts, nutrients which are found to be very deficient in the Ecuadorean diet.

In view of the priority which the Government is giving to nutritional problems, it is believed that this is the best moment to consider this program, as a logical economical and efficient nutritional program for Ecuador. Taking into account the role that wheat flour and its by-products have in the daily diet of the Ecuadorean population, the implementation of a processing and distribution system of these products, assures that the fortification and enrichment of wheat flour, will have an immediate impact on the improvement of protein, mineral and vitamin consumption, in the diet of the population that most needs it.

II. PRESENT NUTRITIONAL SITUATION

The Ecuadorean population has been growing at a rate of 3.4% annually, whereas the agricultural production, especially wheat, has been decreasing significantly until it has reached alarming levels. Faced with this precedent we find that the population suffers from progressive malnutrition because the miserable conditions in which the rural areas develop, are incompatible with the minimum concepts of human dignity. We may further add that it dedicates practically all its income to buying food and even so does not obtain a decent nourishment.

The economic cost of malnourishment of a woman during pregnancy or a child during his growing years, is not recovered when we consider that the under nourished adult lives to work only five, ten or fifteen years while the same individual, if he had been well nourished since his conception, might have worked and produced during thirty or fifty years at a much higher level of efficiency.

Studies carried out by national and international organizations give the following results:

TABLE 1

Availability of Foodstuffs and their Consumption by the Poor

Ecuador 1953-1954

Sampling	Calories	Proteins (in grams) Total	Animal	Observation
Otavalo	1967	55	2	
Cotocollao	1843	51	19	
Manta	1543	54	35	Provided in great extent by fish

	Calories	Proteins (in grams) Total	Animal	Observation
Average National Availability (1975)	1800	48	16	
Goal set by FAO and other Agencies	2500	52	25	

Source: FAO - BID (Agriculture in Latin America-Perspectives for its development). Drawn up by: Work Group.

All these considerations have led to conscientious thinking and reasoning about the initiation of a project of nutritional improvement taking as a starting point wheat flour and bread, enriched with soy flour in order to achieve important results with reference to protein nourishment and nutritional improvement.

III. WHEAT SITUATION

A decrease in national wheat production is observed, starting with the 1968-1969 agricultural year, which has had an annual rate of decrease of 12.1% up to the 1973-1974 agricultural year, as may be seen from the figures shown in Table 2. This decrease of internal production has been compensated by increasing importations to satisfy the demand for this cereal. The average rate of growth in the volume of importations for the period 68/69 - 73/74 is estimated at 15.1% cumulative annually reaching slightly more than 1.4 million hundredweights in the year 73.74.

TABLE 2

National Production and Imports of Wheat (thousands of hundredweights) Periods 1968-69 - 1974-75

Agricultural Year	National Production Total	%	Importations Total	%	Total
1968-1969	1,824.0	55,8	1,445.9	44,2	3,269.9
1969-1970	1,875.0	54,9	1,540.6	45,1	3,416.4
1970-1971	1,782.7	49,6	1,810.0	50,4	3,502.7
1971-1972	1,388.0	40,5	2,035.0	59,5	3,420.4
1972-1973	1,144.0	30,3	2,566.7	69,7	3,680.7
1973-1974	958.8	24,7	2,923.8	75,3	3,882.6
1974-1975 (1)	1,200.0	30,6	2,725.0	69,4	3,925.0

(1) Estimated

Source: General Directorate of Marketing and Enterprises, Ministry of Agriculture and Livestock.

Drawn up by: Work Group

With the purpose of having points of reference available on the amount of wheat used for the production of flour, it is necessary to take into account that a considerable proportion of the national production is used as seed and for consumption on the farms themselves. For this reason, in Table 3 the figures on the availability of wheat are presented as based on the purchases of national wheat by the mills.

TABLE 3

Availability and distribution of wheat for the Total Milling Industry of the country

1969 - 1975

(thousands of hundredweights)

ITEMS	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75
Availability:						
Supplies as of July 1						
National wheat	135.3	120.5	102.3	93.9	72.4	47.5
Imported wheat	71.4	119.3	186.3	132.8	231.2	354.1
National Product, acquired by mills	1,345.4	1,144.2	862.0	680.3	631.5	800.0
Imports	1,540.5	1,810.0	2,035.4	2,566.7	2,923.8	2,725.0
TOTAL	3,092.6	3,194.0	3,186.0	3,473.3	3,859.5	3,926.8
Distribution:						
Consumption	2,852.8	2,005.4	2,959.3	3,169.5	3,457.7	3,600.0
Supplies as of July 30						
National wheat	120.5	102.3	93.9	72.4	47.7	70.0
Imported wheat	119.3	186.3	132.8	231.8	354.1	256.8
TOTAL	3,092.6	3,194.0	3,186.0	3,473.7	3,859.5	3,926.8

Source: National Grain Program, Inter-Institutional Wheat Commission, 1974. Drawn up by: Work Group.

In accordance with the information contained in Table 2, the availability of wheat for national requirements has passed from approximately 3.4 million cwts. in the year 1969/70 to approximately 3.8 million cwts. in the year 1973/74, which represents an annual increase of 5.7%.

In this availability, the proportion supplied from the national production has decreased from 47.9% in 1969/70 to 18.2% in 1973/74.

With reference to the proportions of national and imported wheat milled we see that, faced with the decrease of the national production, the milling of national wheat has decreased in the manner shown in Table 4.

TABLE 4

Proportions of Total Wheat Milled from National and Imported Supplies and Final Availability

1969 - 1974

(Percentages)

Years	Proportion of Total Wheat Milled		Consumption	Availability Final Supplies
	National	Imported		
1969-1970	46,62	53,38	92,25	7,25
1970-1971	38,73	61,27	90,96	9,04
1971-1972	29,75	70,25	92,88	7,12
1972-1973	20,95	79,05	91,24	8,76
1973-1974	17,76	82,24	89,56	10,41
1974-1975 (1)	22,70	77,30	91,68	8,32

Source: Table 3; Interinstitutional Wheat Commission 1974.

(1) Estimated in accordance with Agreement N° 0583 of Sept. 5.
Drawn up by: Work Group.

Faced with this fact, the National Grain Program together with the Superintendency of Prices, hopes that for the agricultural year 1974-75 with the economic incentive that has been given to the farmer, the annual production will be over 1'200.000 cwts. from which the milling industry may use approximately 800.000 cwts.

The effective work of the National Grain Program in encouraging wheat production to satisfy the needs of the country, is increasing; thus it is hoped to recover areas which are now dedicated to other crops and which would be good for wheat; this action would permit an increase of as much as 20,000 hectares within five years.

GOVERNMENT POLICY WITH REFERENCE TO WHEAT PRICES

The National Government, conscious of the needs of the country, has mounted an extraordinary effort through the National Grain Program to improve the national production. This government decision has been implemented to boost the production of foodstuffs, because of the world shortage which is being felt in the country.

The delivery of large amounts of money through the National Development Bank, and the corresponding lines of credit placed at the disposal of the agricultural sector, as well as the setting of a support price for the farmers which in the case of wheat, in accordance with resolution N° 1-R of October 22, 1974, determines prices at the mill for the 1975 harvest at S/. 235 per cwt. for wheats of seventy points and up to S/. 265 per cwt. for wheats of 80 points. These constitute part of the measures which show the concern for developing and encouraging farming.

The price policy for the next few years, as has occurred in previous years, depends principally on a series of external and internal factors which demand adequate policy decisions. Among them the following must by emphasized:

a. Changes in wheat prices in the international market.
b. The results of the national wheat promotion policy.
c. The policy of the Government with reference to the maintenance of relatively low prices for bread and thus continuation of the present price levels of flour.
d. The benefits which have been obtained from the subsidy of imported wheat, and
e. The price levels of wheat and flour in the bordering countries.

As has been mentioned in previous paragraphs, the volume of wheat imports during 1974-75 has been foreseen at a lower level than those of 1973-74, in hopes of a perceptible recuperation of the national wheat production. While it is foreseen that this harvest will increase with reference to past years, its effect will not be sufficient to substitute to a significant degree the total requirements

of importation.

With reference to the maintenance of subsidies, we must recognize that it is an instrument of economic policy whose application must be only short term, as its long term existence cannot be considered an efficient solution to problems. The gradual reduction of the subsidy on imported wheat, together with practical measures directed towards substitution of imported wheat in the manufacture of bread, pasta and cookies, by means of other flours such as soy and products which the country has available, would seem desirable for the national economy.

The aspects described form a complex panorama within which those who make policies select the most effective measures.

IV. SITUATION OF THE CULTIVATION OF SOYA

The utilization of soy fortified flour does not necessarily imply greater expenditures for the national economy, because to a certain extent it would diminish the importation of foreign wheat, which in the last years has been increasing notably, with the resulting exit of foreign currencies.

The idea of using soya has a basic reason; the consumption of oils and vegetable lards has been increasing in the last fourteen years at an average annual rate of 8,9%.

Ecuador has been importing annually the majority of the raw material which the oil industry needs to manufacture the edible oils and fats.

There exists in the country excellent potential for the production of soya, in sufficient volume, to supply the increasing internal demand for oils.

The Ministry of Agriculture, through intensive work has obtained the following goals.

TABLE 5

Achieved Levels of Soya Production

Year	N° of Hectares	N° of Benefit. Farmers	Credit Granted
1973	1,227	30	4'983.385
1974	2,378	65	10'282.826
1975 (1)	8,600		

(1) Projected production.

Source: Development and Agricultural Diversification Program.

Drawn up by: Work Group.

It is necessary to underline and emphasize that, whereas this program of fortification of wheat flour will be started with importation of soya flour, it is no less true that in a very short period of time a national sub-product may be completely substituted thus contributing to the greater earnings of the farmer and the better nourishment of the consumer.

HISTORY OF THE DEVELOPMENT OF FLOUR FORTIFIED WITH SOYA

In 1969, the investigators of Kansas State University, under contract with AID, started tests to obtain the fortification of certain cereals with other enrichers to improve their nutritional quality. One of the most effective products was wheat flour fortified with soy flour, vitamins and minerals. The maintenance of baking quality was obtained through a dough conditioner called SSL.

The products of fortified flour, such as bread, cookies and pasta were evaluated with reference to their quality, acceptability, and nutritional content. Once these evaluations were finished in 1972, specifications for the product "wheat flour fortified with soya" were drawn up for the Program PL-480, Title II (program of donated foods). These specifications enabled the Department of Agriculture of the United States to acquire the product for the program and has resulted in the exportations of more than 200 million pounds of flour fortified with soya to more than thirty countries in the world, where it has been well accepted. Through the program of donated foods, Ecuador has received approximately five million pounds of flour fortified with soya, which has been used in all the country for the school and mother-child feeding programs. The product has been well received by the bakers of the country who have used it, and by the beneficiaries of the program.

In 1974 AID identified several countries in the world where the forti-

fication of wheat flour could be effected on a large scale.
After making a selection among forty countries, nine of them were visited by representatives of Kansas State University, among them Ecuador. The favorable report given to the AID offices in Washington by these representatives, with reference to the Ecuadorian situation, led to a second visit with the purpose of drawing up a document in the manner of "reference terms" leading to the fortification at a national level of all the wheat flour.

V. COST OF THE FLOUR FORTIFIED WITH SOYA

The need to establish the cost of production acquires even more importance in the case of the cultivation of wheat, a product in which the country is deficient and in which growing demand will increase pressure for imports in the face of tight international markets in the medium and long term, all of which will make for alarming price rises. On the other hand, the insufficiency of the national wheat production will reflect in the inflationary pressure which has started appearing in the principal foodstuffs, among which wheat products have an important position.

As a preface to the analysis of production costs of flour fortified with soya, it is indispensable to point out some notable facts.

The percentages of mixture indicated in Agreement N° 0585-MAG are similar for the two alternatives, only the decreasing or substitution of imported wheat by soya flour is carried out; this substitution is within the range of 12.0% of the total needs to produce one hundredweight of flour fortified with soya.

With reference to imported wheat, alternative I corresponds to the subsidized price, as it is established at present (US$ 137,74 the metric ton as reference price and US$ 94,04 per ton of subsidy). Alternative II considers a price for imported wheat of US$ 231,78 per metric ton eliminating the basic subsidy of US$ 94,04 per metric ton given in the month of July, 1974.

In the case of the Sierra, these prices have been increased by freight, handling and packing.

With reference to the price of the by-products, in the two alternatives a price of one hundred sucres per hundredweight is considered, because in several mills of the Sierra they have been sold at S/. 90 and S/. 100 per cwt. in spite of the dispositions of December of 1973 in which a price of S/. 60 per quintal was established.

Finally, a profit of S/. 13,42 per cwt. has been indicated for the two cases.

TABLE 6

Actual price of one quintal of wheat flour, average for the country - 1974

Blend %	
Imported	77.3
National	22.7
Requirements	132.62
Pounds of Imported wheat	102.52
Pounds of National wheat	30.10
Extraction %	75.41
Imported p/pound	1.6479
National p/pound	1.9443
Cost of raw material	227.56
Cost of imported wheat	168.94
Cost of national wheat	55.15
Cost of conditioners	0.10
Revenues for by-products	22.69
Net cost of raw material	201.50
Production costs	38.08
Profit margin	13.42
Sale price of 1 cwt. of flour	253.00

Source and presentation: Interinstitutional Commission 1974

TABLE 7

Alternatives, Cost and Price per Hundredweight of Wheat Flour Fortified with Soya, according to Regions

Items	Alternative N° 1		Alternative N° 2		Alternative N° 3	
	Sierra	Coast	Sierra	Coast	Sierra	Coast
Blend %						
Imported Wheat Flour	65.3	65.30	65.3	65.3	77.3	77.3
National Wheat Flour	22.7	22.70	22.7	22.70	22.7	22.7
Soy Flour*	12.00	12.00	12.00	12.00	-	-
Requirements	117.96	115.44	117.96	115.44	134.05	131.18
Imported Wheat lbs.	87.53	85.66	87.53	85.66	103.62	101.40
National Wheat lbs.	36.43	29.78	30.43	29.78	30.43	29.78
Soy Flour lbs.	12.00	12.00	12.00	12.00	-	-
Extraction %	74.60	76.23	74.60	76.23	74.6	76.23
Prices/lb.						
Imported Wheat	1.732	1.562	2.794	2.629	2.792	2.628
National Wheat	2.500	2.630	2.500	2.630	2.500	2.630
Soy*	4.545	4.545	4.545	4.545	-	-

*Soy Flour contains: thiamine, riboflavine, niacin, vit. A, calcium, iron, potassium bromate and SSL.

../.... Cont. TABLE 7

Items	Alternative N° 1		Alternative N° 2		Alternative N° 3	
	Sierra	Coast	Sierra	Coast	Sierra	Coast
Cost of raw material per 1 cwt. of flour fortified with soy	282.41	266.86	375.33	358.23	365.62	345.06
Cost of Imported Wheat	151.60	133.80	244.52	225.17	189.34	266.54
Cost of National Wheat	76.07	78.32	76.07	78.32	76.08	78.32
Cost of Soy*	54.54	54.54	54.54	54.54	-	-
Cost of Conditioners	0.20	.2	0.20	.2	.2	-

*Soy Flour contains: thiamine, riboflavine, niacin, vit. A, calcium, iron, potassium bromate and SSL.

Source and Presentation: Work Group

TABLE 8

Items	Sierra	Coast	Sierra	Coast	Sierra	Coast
Revenue for by-products	29.96	27.44	29.96	27.44	34.32	31.18
Net cost of raw mater.	252.45	239.42	345.37	330.29	331.30	313.88
Production Cost and Profit Margin	13.42	13.42	13.42	13.42	40.84	62.35
Sale Price	293.29	201.57	386.21	392.94		

Alternative N° 1: Price per cwt. of by-products S/. 100 Subsidy to imported wheat 100%.

Alternative N° 2: Price per cwt. of by-products S/. 100 without subsidy to imported wheat.

Alternative N° 3: Price per cwt. of by-products S/. 100 without subsidy, and no fortification.

Source and Presentation: Ministry of Agriculture and Livestock, Interinstitutional Commission for Wheat 1974, Work Group.

PRESENT COST SITUATION AND PRICE FOR ONE QUINTAL OF FLOUR, AVERAGE FOR THE COUNTRY			SITUATION PROJECTED WITH SOY FORTIFIED FLOUR		
Sale price flour S/	253.00 (1)	274.65 (2)	298.81 (3)	390.70 (4)	374.60 (5)

(1) Present situation, according to Wheat Commission, 1974 .

(2) Present situation, according to Mills. Using subsidized imported wheat.

(3) Future situation according to Soy Flour Plan average weight: 2/3 Coast - 1/3 Sierra.

(4) Future situation according to Soy Flour Plan - without subsidy of imported wheat average weight: 2/3 Coast - 1/3 Sierra.

(5) Future situation without subsidy of imported wheat and with no soy-fortified flour

* F.F.S. : With no Soy-fortified Flour

This last information indicates that the price of fortified flour would be increased by 8.8% with reference to the unfortified flour, in the case of subsidized wheat. For unsubsidized wheat, the price of the fortified flour would only increase 4.5% with reference to the unfortified flour.

This price increase of the fortified wheat would have a minimum effect on the cost of bread. The present price for the raw material (wheat flour) represents only 38.5% of the price of bread at retail level. Thus, if all the other factors are maintained constant, an increase in the cost of wheat flour in 8.8% would cause an increase in the retail price of bread of 3.4%.

Really the price of bread should not rise. Experience in many countries and with several varieties of bread, shows that the bakers have an increase in the yield of the fortified flour of approximately 6% over the unfortified. This increase in yield should more than compensate for a possible increase in the price of fortified flour.

Furthermore, it has been found that for the baking of a product of equal quality, the fortified flour permits the reduction of the quantity of raw material compared to unfortified flour. The typical formula for bread making in the Ecuadorean Sierra requires four pounds of lard for every hundred pounds of flour; it is expected that the proportion of lard can be reduced to two pounds for every hundred of fortified flour. The present price of lard is of 12 sucres per pound, and the price of subsidized wheat flour is of S/. 2.74 per pound. Thus the cost for a dough for these two raw materials would be (100 x 2.74) plus (4 x 12) = 322 sucres for 104 pounds; the cost of the mixture using fortified and subsidized wheat would be (100 x 2.99) plus (2 x 12) = 323 for 102 pounds.

VI. THE CONDITION OF THE MILLING INDUSTRY

There exist three mills on the Coast, two of them with a capacity which exceeds 5,000 cwts. per 24 hours each, and the third with a capacity of 330 cwts. for a total of 10,450 cwts. per day. In the Sierra there are 22 mills with daily capacities which fluctuate from 100 to 550 cwts. daily, and a total capacity of 7,800 cwts. per day. The nominal extraction rate is of 75%, although it is said that it occasionally rises to 80%. Normally, the flour with 76% extraction will have 0,6% ash.

At the present the millers use a mixture of 78% imported wheat and 22% national wheat. Seventy percent of the national wheat production is sold to the mills while 15% is consumed directly and 15% is used for seed.

Some mills have equipment to add malt and enzymes, or potassium bromate to the flour. Presently none of them have machinery to enrich with vitamins and minerals. For the initial stage of the project it will be necessary to import a pre-mix which will contain defatted and toasted soya flour, conditioner (SSL), vitamins and minerals, and potassium bromate. The mills would simply mix the two streams of flour and pre-mix to obtain the fortified and enriched flour. This operation would require little or no change in the operation or technology of the mill. Subsequently, for economic or technical reasons, micronutrient feeders could be installed in the mills, permitting the importation of separate ingredients to be mixed in each mill. The cost of the mentionedequipment is estimated at approximately US$ 20,000 per mill. The design and specifications for the machinery are available through the Kansas State University.

VII. THE CONDITION OF THE BAKING INDUSTRY

In Ecuador, bread is available in a large variety of forms, but the most important type is the round bun which contains approximately 4% shortening and 5% sugar and is baked using the sponge method. The french type breads represent a relatively small part of the production. There exists one large, totally mechanized bakery, ten intermediate sized bakeries which are semi-mechanized and many small bakeries which are mostly equipped with a mechanical mixer. There are two yeast factories. One of the mills in Guayaquil has available a mobile school of bread making.

The incorporation of flour fortified with soya in the breads of Ecuador will not require the purchase of new equipment by the bakers and there will be small variations in the method of bread making with soy-fortified flour which will permit the utilization of less shortening, a shorter time for mixing, and at the same time increases the dough yield. It would be desirable to give demonstration or short one day courses to the bakers concerning the changes in baking techniques which are required to obtain optimum results with the final product. At present some bakers in Ecuador have experience with soy-fortified flour which has been donated by the United States through CARE and CRS to the nutritional programs for schools and mother-child programs. More than five million pounds of this product were used during last year.

Apart from bread, other products may be made with the fortified flour, such as noodles, pastas and cookies. There exist at least ten pasta factories which produce a large variety of spaghetti or other products. A cookie factory also exists which produces up to eight tons per hour of the product and has a national distribution chain. A second large factory has just started production. It will be necessary to demonstrate the use of flour fortified with soya in the manufacture of pastas and cookies in the respective industries.

VIII. THE CONDITION OF THE PROTEIN FOODS INDUSTRY

The program for fortifying wheat flour with protein in Ecuador must be based on a defatted and lightly toasted soy flour which will contain a minimum of 50% of protein. The production of soya in Ecuador is being rapidly increased, which will supply the best and most abundant source of protein for fortification; an adequate technology at commercial level does not yet exist to produce proteins from cotton meal lupines and "quinoa".

The importation of the pre-mix may be replaced by the ingredients S.L., potassium bromate, vitamins and minerals, when the soy production and the industrial processing capacity of the soy flour are sufficient. Obviously the substitution of a national soy flour for the imported wheat will be an economic advantage for the country.

At the present time there exist seven edible oil refineries in Ecuador, with a total capacity of approximately 7,000 metric tons per year. The industry has processed relatively small quantities of soya in the last few years; nine tons in 1969; 20 tons in 1970; 126 tons in 1971, 112 tons in 1972. In accordance with documents of the Ministry of Industries, Commerce and Integration in 1972, approximately half the installed capacity for the production of edible oil was idle; nevertheless, we are informed that at least two extracting companies are at present increasing their capacity. It is necessary to carry out a study of the state or level of technology of this industry to determine the feasibility of adapting one or more of the plants to defatted, lightly toasted soy flour, which would satisfy the specifications, for incorporation in breads or, if it is necessary, to install a completely new factory to produce edible soy products.

IX. TECHNOLOGY OF COMPOSIT FLOURS

The Institute of Technological Investigation of the Politechnic School of Quito, in cooperation with the cereals laboratory of INIAP has carried out research on compositeflours using flours of maize, potato, yuca and rice. The personnel of these two institutions knows the basic technology of wheat flour fortification with soya. Additional investigation of the matter will not be necessary; nevertheless, we recommend the demonstration of the quality of breads made with the fortified flour presently available in the country.

After starting the program of flour fortification, the cereals laboratory of INIAP may serve as control laboratory to assure that the milling industry maintains the quality of fortified flour both in the analytical and bread-making aspects.

X. TENTATIVE PLAN OF ACTION *

1. Development of the "Terms of Reference" for presentation to JUNAPLA-PONAN and to the Ministry of Agriculture and Livestock.

2. Development of the action plan.

3. Approval of the project by the National Government and authorization to proceed to the development of the legislation and implementation.

4. Designation of responsibility and authority for the coordination of the project.

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* The numerical order as presented in this Plan of Action does not necessarily indicate the chronological order which must be followed for the completion of the activities contemplated.

5. Writing the draft of necessary legislation.
   a. Technical assistance
   b. Government counterpart

6. Drafting of the fortification law regulations.
   a. Technical assistance
   b. Government counterpart

   The regulations will include the specifications of the products: wheat flour; defatted soya flour; pre-mix of vitamins and minerals; dough conditioner; wheat flour fortified with soya.

7. Survey of the program to increase the production of soya.

8. Feasibility study for a soy flour plant.
   a. Technical assistance
   b. Government counterpart

9. Baking tests with national flour and material provided by the Kansas State University to the Institute of Technological Investigations and INIAP. Tests with bakers.

10. Develop the basis for a wheat and soy price policy and a plan which controls the importations and use of the pre-mixed soy flour.
    a. Technical assistance
    b. Government counterpart

11. Expediting of the Fortification Decree.
    a. Technical assistance
    b. Government counterpart

12. Prepare programs and budget for the administration, operation and control of the fortification of the flour.
    a. Technical assistance
    b. National counterpart

13. Evaluate the capacity and needs of the mills with reference to fortifications, to expedite orders for equipment and technical aid.
    a. Technical assistance
    b. National counterpart

14. Order pre-mix.
    a. National counterpart

15. Submission of the draft budget.

16. Develop nutrition education program.
    a. Technical assistance
    b. Government counterpart

17. Development of short courses and demonstrations for the bakers.
    a. Technical assistance
    b. National counterpart

18. Arrival of machinery and installation.
    a. Technical assistance
    b. Government counterpart

19. Arrival of the pre-mix and delivery to the mills.
    a. National counterpart

20. Test period. Voluntary participation of the bakers.
    a. Technical assistance
    b. National counterpart

21. Identification of problems at the initiation of the program.
    a. Technical assistance
    b. Government counterpart

22. Initiation of the program on a large scale.

23. Evaluation of the program.
    a. Consumption
    b. Nutritional effect
    c. Market, etc.

24. Construction of the soy flour plant.

25. Introduction of the national soy flour to the program.

PRELIMINARY EVALUATION OF SOY FORTIFIED WHEAT FLOUR FOR NUTRITIONAL IMPROVEMENT IN IRAN

BACKGROUND

Nutritionally improved bakery products have become technologically possible through research efforts performed at Kansas State University and further developed under a contract with the Office of Nutrition, Technical Assistance Bureau, United States Agency for International Development entitled "Nutritional Improvement of Cereal Based Foods."

Prior to these research efforts, the addition of soy flour to wheat flour in amounts sufficient to increase substantially the protein content of the resulting bakery products resulted in products with poor quality and, as a consequence, low consumer acceptability. The research efforts determined that the use of sodium stearoyl-2-lactylate (SSL) in the soy fortified flour allows the production of nutritionally improved products without loss in organoleptic quality.

As a practical result of this project, soy fortified flour (SFF), containing either 6% or 12% defatted toasted soy flour and enriched with Vitamin A, niacin, thiamine, riboflavin, calcium and iron, is being purchased through Food for Peace programs, P.L. 480 Title II, for use in institutional feeding programs sponsored by voluntary agencies or host governments in approximately 20 countries.

Mr. Ordoobadi, of the Iranian Embassy in Washington, D.C., visited the Kansas State University Food and Feed Grain Institute to evaluate the potential for soy fortified flour in Iran. As a result, it was suggested that Dr. William J. Hoover visit Iran to assist in assessing the possible role of soy fortified flour in the proposed school lunch in Iran. The visit was originally scheduled for July, but was delayed until September due to a disruption of Dr. Hoover's schedule by the Cyprus war which prevented travel from Turkey to Iran in late July.

New technologies for providing nutrients have been developed in the past and still newer ones will be developed in the future. In some cases more nutritious forms of agricultural raw materials (e.g., high lysine varieties of corn, manioc, sorghum) will be developed. In others more nutritious foods using already existing ingredients (e.g., SFF products) will be developed. The question that arises in regard to the use of a new technology is whether or not it is an efficient provider of nutrients. Before it is used, each new technology should be examined to determine if in fact it is an efficient way of providing nutrients. Many things are technically possible but not economically efficient.

No single technological improvement will solve all the nutrition problems of a society. But each technology that is adopted should be a component of an efficient system to provide nutrients.

Protein-calorie malnutrition has many causes. Low income levels and lack of concern about nutrition on the part of consumers can lead to a low demand for and inadequate intakes of protein and calories. Nutrients may be high priced due to low agricultural productivity and the unavailability of nutritious varieties of agricultural raw materials and nutritious forms of processed foods. These causes of malnutrition can be addressed by general increases in per capita income and nutrition education leading to increased demand for nutrients, and through technological improvements that lead to increased supplies of nutritious agricultural raw materials and more nutritious processed foods. Some of these approaches will work over the long-term (e.g., increases in per capita income) and some in the short-term (e.g., protein fortification of existing foods). Due to the complexity of the protein-calorie malnutrition problem, there is no single approach to its solution. Many approaches will be needed. It was not our purpose to compare wheat flour fortification with the other possible approaches.

EVALUATION

We have made a preliminary examination of the potential usefulness in Iran of wheat flour fortification. On the basis of this preliminary examination we think that protein fortification (and simultaneous vitamin and mineral enrichment) of wheat flour offers a useful approach that can be implemented in the short term.

Wheat flour based foods form a substantial and basic part of the diet of most Iranians. Wheat flour, more than any other basic food ingredient, lends itself to fortification or nutritional intervention particularly that which is processed in large mills.

The technology of soy flour fortification of wheat flour is now highly developed. The adaptation of Iranian flour mills for soy flour fortification and vitamin and mineral enrichment of wheat flour is thought to present little difficulty. The use of soy fortified flour is compatible with Iranian baking methods and will not significantly alter the quality of bakery products in Iran as was demonstrated in acceptability evaluations.

Some alternative levels of nutritional intervention with soy fortified wheat flour are:

a. Fortification and enrichment of all wheat flour produced by mills having a capacity of over 5,000 metric tons per year.

b. Fortification and enrichment of all wheat flour produced by large mills marketing to a specified geographic region with high nutritional need, i.e., the urban centers.

c. Fortification and enrichment of all wheat flour purchased by the Government of Iran for specific institutional programs, i.e.; school lunch program, hospitals, mother-child health centers, military personnel.

d. Fortification and enrichment of wheat flour for specific commercial users and customers.

e. Various combinations of b, c, and d above.

The wheat and breadstuffs industry in Iran is subject to much government regulation. It is clear that a high priority must be given by the Government of Iran to nutritional improvement before any of the above levels of intervention can be realized.

At the present time, there are no protein resource materials available in commercially significant quantities in Iran. Potential long-range resources may be chickpeas, sunflower seeds, cottonseed, fish protein concentrate or locally produced soy flour. All of these potential resources must await increased production levels, technological breakthroughs, or the development of a viable commercial industry before they become actually available.

Similarly, vitamins, minerals and sodium stearoyl-2-lactylate are not domestically produced in Iran.

The use of protein fortified and vitamin and mineral enriched wheat flour in Iran will probably evolve through several phases:

1. Importation of soy fortified wheat flour.
2. Importation of a premix (containing soy flour, SSL, vitamins and minerals) for mixing with Iranian wheat flour either at flour mills or at large bakeries such as operated by the Army.
3. Importation of SSL, vitamins and minerals for blending with Iranian wheat flour and domestically produced soy flour.
4. Potential use of other indigenous protein resources in place of soy flour in 3 above.

FIELD TRIALS

Through the efforts of Mr. Payan of the Institute of Nutrition and Miss Zand of the Imperial Organization for Social Services, soy fortified flour was provided to two bakeries and produced into Sangak and Barbari bread. No special instructions were given to the bakers. No difficulty was encountered in producing the bread.

This bread was then evaluated by the bakers themselves and by staff members of the Nutrition Institute and the Ministry of Education. The bread was completely acceptable and found to be not different from the regular bread produced by these bakeries.

Encouraged by these results a baking test was arranged through Mr. Sheibani at the Army Bakery. Mr. Al Cardenas of the ADM Milling Company, Overland Park, Kansas, who was in Iran at that time took an active part in this testing program. Bread in the form of flat bread as produced by the Army and as buns was produced.

Dr. Seyhoon of the Ministry of Education used the buns in acceptability tests with school children in Tehran. The buns were liked by all the children. The buns have 10.6 gms of protein and 217 calories when their baked weight is 100 gms or 14.3 gms of protein and 292 calories when their baked weight is 135 gms.

The baking formula was:

2,200 gms of 11.5% protein (75% extraction) Iranian wheat flour
300 gms of soyflour premix (containing SSL, vitamins and minerals)
2,500 gms
250 gms (10%) sugar
38 gms (1.5%) salt
50 gms (2%) yeast
1,800 gms (72%) water

If 3% i.e., 75 gms of vegetable oil are added to the formula, the protein and calories would be as follows:

	Protein (gm)	Calories
100 gm bun	10.4	227
135 gm bun	14.1	306

COST ANALYSIS

Cost analyses were made comparing buns fortified with 12% soy flour (containing SSL, vitamins and minerals) versus buns made with Iranian wheat flour without fortification.

Unfortified

100 kg of Iranian wheat flour of 75% extraction costs

1,000 rials or U.S. $15.00

1 kg costs --- U.S. $ 0.15

2,500 gms costs --- U.S. $ 0.375

The yeild was 37 buns of 100 gm each (baked)

1 bun costs U.S. $ 0.01013

Fortified

1 kg of soy flour premix containing SSL, vitamins & minerals (ADM's Emulsoya) costs C & F Abadan U.S. $ 0.4506

300 gm premix cost U.S. $ 0.1352

2,200 gm Iranian wheat flour cost U.S. $ 0.3300

cost of 2,500 gms mix U.S. $ 0.4652

The yield was 40 buns of 100 gm each (baked)

1 bun costs U.S. $ 0.01163

Conclusion: The extra cost per bun is so small (U.S. $ 0.0015) that it is negligible. Essentially it will cost virtually nothing extra to provide Iranian school children much better nutrition by fortifying bread than providing the unfortified product. It appears that soy fortified bread is the most logical and least expensive way to improve nutrition in Iran.

RECOMMENDATIONS

The breads supplied in school lunch and military rations in Iran should be based upon soy fortified wheat flour. In the foreseeable future, this represents the most efficient method of improving the nutritional status of these segments of the population. An action program should be developed for initiating the introduction of fortified bread into these feeding programs as soon as possible. Subsequently, consideration can be given on whether soy fortified flour usage should be extended to other population segments through normal commercial channels.

Based upon preliminary evaluations, soy fortified bread or buns represent the least cost way of providing specified nutrients in the school lunches and certainly will fall well within the budget allowances for feeding the children.

A combination of distribution programs will probably be required to permit fortified bread to be used in all school districts: in Tehran, bread can be baked on contract by the military bakeries and by commercial bakeries (soy fortified flour supplied by Government) and delivered to specified distribution points or schools; in the major cities and large villages, bakers can produce the bread on contract (soy fortified flour supplied by Government) for delivery to specified distribution points or schools; in small villages and rural areas, soy fortified flour will be distributed to schools and mothers will receive rations and prepare soy fortified bread in the home for the child to take to school.

SPECIFIC RECOMMENDATIONS FOR ACTION

1. Establish an office or position of specific authority and responsibility for evaluating the use of soy fortified wheat flour based breads in the school lunch program and for coordinating the inputs from the several concerned Ministries into an action purchasing, logistic and supply system.

a. Conduct an economic feasibility study.

b. Establish plan and determine role, relationships, and responsibilities of various governmental agencies.

c. Develop logistic support program including contractual arrangements for product supply.

d. Establish nutrient specifications and standards for school lunches. Long term nutritional studies should be avoided. Make decision on best available data.

2. Initiate pilot program involving the schools in Tehran this school year.

a. Arrange for importation of soy fortified flour (or premix).

b. Contract with Army bakery for preparation and delivery of fortified bread or buns.

c. Evaluate and use results as guide for a more extensive program in 1975.

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IMPRESSIONS ON THE POTENTIAL FOR SOY-FORTIFIED WHEAT FOODS IN PERU

POPULATION

Peru's population (1975) is about 16 million and is increasing at about 3 percent annually. If this rate continues Peru's population will double in the next 25 years. The rapid rate of growth has resulted in a youthful population. About one-third of the population is age 10 or younger; about two-thirds is age 25 or younger. This age distribution ensures a much larger total population in Peru in the future as these young people pass through the reproductive years. It is estimated that about 48 percent of the population lives in the Costa, 41 percent in the Sierra, and 11 percent in the Selva or Amazon area. At the present time urban areas contain about 55 percent of the population. The urban areas of the Coast have grown very rapidly in recent years due in large part to migration from rural areas in the Sierra. Lima's population is about 3 million, almost 20 percent of Peru's population.

GROSS PRODUCT AND INCOME

GNP for 1973 was about $6.2 billion (1968 constant prices; exchange rate 43.38 soles = 1 $). During the period 1970-1973 the growth rate of GNP declined from 7.6 percent to 5.3 percent. GNP per capita in 1973 was about $400. Income in Peru is very unequally distributed.

WHEAT CONSUMPTION

Annual wheat consumption was about 450,000 MT in the early 1960's and is now about 950,000 MT. Over the period total consumption roughly doubled while population increased roughly one-third. Therefore per capita consumption of wheat increased by roughly 50 percent over the period.

With population at about 16 million and wheat consumption at 950,000 MT, per capita wheat consumption is presently about 60 kg per year. Assuming 82 percent flour extraction rate, flour consumption is about 50 kg per year or 135 grams per day. Of course, flour is not consumed equally in the three regions or equally in urban and rural areas. Flour (equivalent) consumption in the urban areas is probably substantially above 135 grams per day.

Ministry of Agriculture figures for the years 1965-1969 show that wheat flour consumption increased at an average annual rate of 11 percent. Consumption of no other food except oranges increased so rapidly.

BREAD CONSUMPTION IN LIMA

The National Survey of Food Consumption (Ministry of Agriculture, Encuestra Nacional de Consumo de Alimentos, Lima, March 1974) provides information on bread consumption in Lima. Information was provided on per capita consumption for five different income levels. (It is not clear what proportion of Lima's total population is contained in each of the five income groups.) For the lowest income group (per capita income less than $186), per capita bread consumption was 31 kg per year (85 grams per day). For the other four income groups (in order of increasing income) daily bread consumption was 100 grams, 100 grams, 98 grams, and 105 grams. Clearly, bread consumption is important for all income levels in Lima, and it appears that per capita consumption is roughly the same for the four higher income groups.

The survey presented estimates of the calories and protein provided by bread in Lima. Bread provided 275 calories and 8.8 grams of protein

per capita per day to the lowest income group and about 325 calories and 10.3 grams of protein per capita per day for the four higher income groups. Because family size is largest in the lowest income group, and because this is probably due to a larger number of children, it appears that the average consumption for adults and average consumption for children is roughly the same across all income groups. Bread is clearly an important provider of calories and proteins in Lima. (The survey data show that low income groups also spend on pasta products one-half as much as they spend on bread. Therefore the total contribution of wheat products (bread plus pasta) to calorie and protein intake is even more important.)

The above-mentioned figures can be used to illustrate the impact on protein intake if all bread were to be made with soy-fortified wheat flour. Assume bread consumption is 100 grams per day. The bread would contribute 240 calories per day and 11.7 gms of protein with double the nutritional quality of regular bread protein. If the poorest group ate enough bread to the equivalent of 275 calories/day the improved protein level would be 12.8 grams compared with the present 8.8 gms.

WHEAT SUPPLY

Peru's wheat production has roughly stagnated for the past 15 years. Annual production has been and is currently about 150,000 MT. Peru's wheat is grown principally in the Sierra on small plots with very low yield. Only small amounts of domestic wheat enter commercial channels.

Peru's wheat imports were about 400,000 MT annually in the early 1960's, about 500,000 MT annually in the mid-1960's, and about 700,000 MT annually in the late 1960's. Imports exceeded 850,000 MT in 1972, fell to 780,000 MT in 1973, and probably exceeded 800,000 MT in 1974.

The approximate stagnation of production and the doubling of imports in the last decade have led to domestic production accounting for only about 15 percent of total supply.

NUTRITION STATUS

The report Peru: Situacion y Politica Alimentaria y Nutricional (Instituto Nacional de Planificacion, Lima, July, 1973) presents some information on the nutritional status in Peru. From figures on food "availability" for the years 1965-1969, it is estimated that average daily calorie intake was 2290 calories, about 10 percent below "requirement." Total protein intake averaged 55 grams, about 23 percent below requirement. Food consumption surveys over the period 1960-1970 in the Sierra showed an average calorie intake of 2,068, about 17 percent below requirement. Protein intake averaged 50.6 grams, 22 percent below requirement. The surveys in the "low income urban" areas of the Coast showed an average calorie intake of 1,958, 22 percent below requirement. Protein intakes averaged 50.4 grams, 22 percent below requirement. The same surveys revealed widespread deficiencies of calcium and vitamin A.

Taken in conjunction with the fact that Peru's income distribution is so unequal, these estimates of average intakes of nutrients that fall so far below "requirements" imply that a very large proportion of Peru's population received inadequate nutrients.

Surveys of food consumption of pre-school children (1-3 years) carried out in 1967 in three places (one rural area on the Coast, and two urban areas, one in the Sierra and one in the Selva) showed that very large proportions of these children were obtaining less than 75 percent of the "recommended quantities" of nutrients. The worst figures were from the Sierra and the Selva. In these areas more than three-fourths of the children were obtaining less than 75 percent of the recommended amounts of calories, proteins, calcium, iron, vitamin A, thiamine,

riboflavin, and vitamin C. The Coast survey showed almost as serious mineral and vitamin deficiencies, but less serious calorie and protein deficiencies.

COST OF SOY-FORTIFIED FLOUR

An attempt is here made to estimate (1) the cost to Peru of soy-fortified flour and (2) the cost to the Peruvian baker of producing one metric ton of bread.

The following assumptions are used:

1) Price of imported wheat, c.i.f. Peru $220/MT.
2) Price of soy-flour, vitamin and mineral enriched, including SSL, c.i.f. Peru $350/MT.
3) Extraction of wheat flour from wheat, 82 percent.
4) Current subsidized price of imported wheat to flour mills, $140/MT.
5) Millfeed sold from mills at $41.49/MT.
6) Flour sold from mills at $191.8/MT.

These assumptions make it possible to estimate a milling margin. At the present time, with subsidy, the flour mill buys wheat that costs $140/MT. From this the mill obtains .82 MT of flour and .18 MT of millfeed. At present the mill sells flour for $191.8/MT and millfeed for $41.49/MT. Therefore the mill obtains $164.74 for the product of one MT of wheat (= .82 x 191.8 + .18 x 41.49). The mill has a margin of about $24.74/MT of wheat milled (= 164.74 - 140). This figure is used in later computations.

The milling margin computed above can be used to estimate the cost of flour if wheat were not subsidized. Without subsidy, the flour mill will

buy imported wheat at $220/MT. One MT of wheat yields .82 MT of flour and .18 MT of millfeed. Assume millfeed still sells for $41.49/MT. The unsubsidized cost of one MT of flour to Peru can be determined as follows. It requires 1.2195 MT of wheat to yield 1 MT of flour (= 1.2195 x .82). This wheat costs Peru $268.29 (= 1.2195 x $220). It costs $30.17 to mill (= 1.2195 x $24.74). It yields .2195 MT of millfeed (= 1.2195 x .18) worth $9.11 (= .2195 x $41.49). One MT of wheat flour therefore costs Peru $289.35 (= $268.29 + $30.17 - $9.11).

One MT of soy-fortified flour consists of .88 MT of wheat flour and .12 MT of imported soy flour. It costs Ecuador $296.63/MT (= .88 x $289.35 + .12 x $350). On this basis, soy-fortified flour costs $7.28/MT more than wheat flour; SFF is 2.5 percent more costly per MT than wheatflour. This small increase in cost leads to a substantial improvement in protein content.

The cost of flour estimated above is the important figure from the point of view of society. It is also useful to estimate some costs from the point of view of the baker. A unit weight of SFF yields about 6 percent more bread than does a unit weight of wheatflour. If SFF costs only 2.5 percent more than wheatflour (as shown above) then the "flour" cost of bread will in all probability be no more than at present and will possibly be less.

PROTEIN RESOURCES

Consumption of animal products is increasing slowly in Peru, mainly as a result of the development of a viable commercial feeding industry (1974 = 800,000 MT of mixed feeds, 88% of which was for poultry). Relatively little fish is directly consumed in spite of the large fish catches by the

country as most of the catch is used for production of fish oil for domestic use and fish meal for export and for the mixed feed industry.

The total 1974 production of beans and other pulse crops was estimated at 81,350 MT, compared to 82,400 in 1973. The planted area was also down, reportedly due to dissatisfaction with controlled prices. Production, by types, in 1974 were: dried beans, 35,000 MT; broad beans, 20,000 MT; dried peas, 16,500; Quinoa, 6,500 MT; lima beans, 3,200 MT; chick peas, 2,650 MT; mung beans, 2,500 MT; Canahua, 1,850 MT; and Lentils, 1,500 MT. No imports were authorized in 1974 and exports consisted of 2,000 MT of mung beans. Wholesale prices in soles per kg were fixed at: dried beans, 16; Bayo, Cabailero and lima beans, 17; Black, Panamila beans, 16.50; Broad beans, 12; Chick peas, small, 14; Chick peas, large, 19.50; lentils, 31.00; and Canaria beans, 13.50. Typical retail prices are: Canaria beans, 30; lentils, 37; and quinoa, 53. As a point of reference, all-purpose flour retails at 15.6 soles per kg.

All locally produced vegetable protein resources are consumed in bean type dishes and it does not appear that a significant local source for wheat flour fortification will be available for at least several years. Little or no soybean production is available although agriculturists see no reason that a soybean production could not develop. Interest has been lacking, in the past, primarily because of the availability of fish meal and fish oil. There is interest in developing a protein concentrate source from quinoa flour. Current varieties must be processed to remove the normal saponins from the seed. A new variety which has a lower saponin content is being multiplied but it will be at least three years

before significant quantities are available. The future of quinoa as a flour additive is clouded at the present by the lack of technological development and economic evaluation.

STATUS OF THE MILLING INDUSTRY

The Peruvian milling industry consists of large modern sophisticated units ranging from 200 to 600 MT daily grind capacity. The largest company, Nicolini (600 MT), along with Excelsior (350 MT), Santa Rosa (450 MT) and Molinera Peru (300 MT) are located in Callao, the chief port of Peru, while Molitalia (125 MT) is located in Lima. In Arequipa, Nicolini is building a 200 MT mill and Sidsur is operating a 350 MT plant. Molinos INCA (200 MT) is located in Trujillo and Molinera Iquitos Guiulfo (180 MT) is in Iquitas. The industry operates primarily using imported grain as only 3,000 MT of domestic wheat was estimated milled in 1974.

The government has fixed the extraction rate at 82%, as well as the price of both wheat and flour, buys the millfeed, and allocates wheat to the mills. Persons in the industry feel that if the restriction on wheat imports were removed the level of imports would rise from 770,000 MT to 1,000,000 MT per year. At the present time, the milling industry is deemed in a good financial position primarily because the mills have been depreciated. Enrichment of flour with vitamins and minerals is not practiced.

STATUS OF THE BAKING INDUSTRY

The baking industry in commercial centers is at least partially modernized with, for example, fourteen semi-automated bakeries in Lima. However, there appears to be some resistance on the part of small bakers and their employers to new and modern techniques. In Lima, two industrial

bakeries, PNK and TODOS, produce and market loaf bread through supermarket outlets and estimate that loaf bread now accounts for 8 percent of the market with a 20 percent relative increase in 1974.

The common french roll (panacito) has been the most popular form of bread and the "pan labranza" differs only in that about 2-3% of vegetable shortening is used. An estimate of wheat products market in Peru showed that between 65-70% of the flour produced goes for bread, 20-25% for pasta and 10% for cookies and pastries. Pasta production is growing rapidly as it is a popular food and now less expensive than rice and beans which are a luxury. Large, modern biscuit and cracker plants are operating in Lima.

The economic plight of the Peruvian baking industry is very adequately described in a recent Great Plains Wheat report by Robert Drynon and thus is quoted here.

> "The baker has found himself in a squeeze with respect to the price controls on french rolls and his rising production costs. As in so many countries, bread prices have been fixed by the government as a function of wheat cost to the industry. Thus when the price of wheat to the miller was increased 71%, from US$ 70/MT to US$ 120/MT, bread flour was increased from US$ 5.53/cwt to US$ 8.48/cwt, about 53%, and the price of the french roll was increased from roughly .8 US cents to 1.1 US cents, (0.35 to 0.50 Soles), an increase of 43%. Whether the 53% increase in flour prices covered the effect of a 71% increase in the miller's wheat price, or a 43% increase in bread absorbed sufficiently a 53% increase in flour price is open to discussion, but bakers do insist that the increase in bread price was insufficient to cover the total increase in costs such as other ingredients and operating overheads. Recent contract negotiations for bakery laborers and new interpretations of the labor have definitely increased labor costs."
>
> "As a consequence of these cost-price pressures, bakers have been actively blending wheat flour substitutes into their products. Government controls do not include weight-quality standards, so as a result, both product size and quality have

suffered as much at the baker's instance as it has from increased extraction at the mill. Bakers are required by decree to have french rolls available on their counters at certain hours; 6 to 9 am, 11 am to 1 pm, and 4 to 6 pm. During these hours the customer finds french rolls, but between these hours only "pan labranza", the price of which has not been subject to government control, can be found in the bakeries."

The level of technology in the smaller bakeries is demonstrated by the typical use of slow speed mixers in a sponge dough system with a long fermentation time and no temperature regulation during fermentation. Generally, quality control is not very good on either raw material or finished goods. Two yeast companies serve the market and have sponsored baking short courses. There is an active Bakers Association in Lima which publishes a bi-monthly journal, "Panificacion".

Bakers have had absolutely no difficulty in making bread and rolls with soy-fortified flour for the school lunch program. In fact, many state they prefer it to their regular flour. Acceptability in the school program has been excellent.

STATUS OF PROTEIN INDUSTRY

Six to eight edible oil refining plants are operating. None of these plants are currently equipped for producing edible proteins. Interest is growing in soy importation and one company is currently importing 100 tons per month of TVP. Soy flour is not known to be available at the present time in Peru.

INSTITUTIONS FOR COMPOSITE FLOUR TECHNOLOGY

The Universidad de Agraria at La Molina is a recognized leader in composite flour technology with Dr. Antonio Bacigalupo showing an early

and continued active interest in this area. In the past, research support from FAO, OAS, and Rockefeller Foundation aided in this effort, and at present experimental facilities are adequate. A mill for preparing composite flours has been constructed but is not fully operative. A small commercial bakery produces bread daily containing either potato or sweet potato solids in addition to wheat flour.

Although it has less experience with composite flours, the Instituto de Investigaciones Agro Industriales is now equipped with an excellent pilot bakery and is interested in research in this area as well as in establishing a training program for bakers.

Little research effort has been made toward protein fortification of bakery products in Peru.

INTERNATIONAL NUTRITION PROGRAMS

Due to a time limitation, the extent of involvement of International agencies other than AID were not determined. In 1974, three voluntary agencies were serving 350,000 people in organized programs with 200,000 of these in a school lunch program. Because of projected limited commodity authorizations under Title II, PL 480, the number will probably be reduced to 240,000 in 1975 and a most uncertain future beyond that time. Soy-fortified flour (6%) is being successfully used to produce buns for the current feeding programs.

GOVERNMENT COMMITMENT TO NUTRITION

The economic and social policy which forms part of the Government of Peru Strategy and Guidelines for Development policy for 1973 and 1974 contains the Food and Nutrition Policy (FNP).

The GOP proposes as an objective to assure the normal supply of basic food products, applying the FNP to increase food intake and the nutritional value of food for Peruvians, especially mothers and children. The strategy includes: (a) promote production of agriculture, fish, and industrialized food products; (b) restructure the internal marketing system and make selective substitutions for imported agriculture products based on Peru's comparative advantages and basic internal consumption needs; (c) create a centralized Food Assistance System to justify the promotion and use of externally donated food commodities for marginal groups; and (d) direct the research and training for feeding and nutrition to satisfy the most urgent needs of the marginal groups.

To carry out these strategies a most impressive action program has been outlined but most of the effort is in only the beginning stages and results are yet to be seen. One significant new development is the creation of a Minister of Food with the breaking up of the former Agriculture Ministry. A new organization, Oficina National de Apoya Alimentario (ONAA), now has the responsibility for nutrition and feeding programs. It is too early to determine the extent of its authority and emphasis of its programs.

GOVERNMENT REGULATION

Pricing regulations on both the milling and baking industries have been previously mentioned. As subsidization of wheat has kept the price of bakery products low in relation to other foods, the industries have realized a stable and slowly expanding market. On the other hand, the government has limited the growth by restricting wheat importation and by prohibiting the baking industry from advertising or otherwise promoting

its products. Liberal laws permit the addition of dough improvers and other food additives by both the miller and baker and certainly flour enrichment would not be restrained legally.

SUMMARY

Available surveys indicate that average protein intake in Peru is below recommended amounts. It appears that the protein intake of a very large proportion of Peru's pre-school children is inadequate. Consumption of wheatflour products is widespread in Peru, probably especially so in urban areas. While the overlap between the persons having inadequate protein intake and the persons consuming wheatflour products cannot be quantified at this time, it is likely that a significant increase of the protein content of wheatflour products would lead to increased protein intake by persons now receiving inadequate protein.

The cost to Peru of increasing the protein content of wheatflour by switching to a 12% soy-fortified wheatflour is likely to be very small. In terms of the final product of wheatflour it is likely that there will be no increase in cost.

There are no real technological barriers to the introduction of soy-fortified flour and it could be accomplished with modest capital expenditures at the mills. As the government controls the milling and baking industries rather closely a government regulation requiring fortification and enrichment could be quickly and simply implimented. On the otherhand, without government action there is little likelihood of commercial intervention through bakery or pasta products.

RECOMMENDATIONS

1. Followup meetings with the Ministry of Food should be handled by Food for Development Office of the USAID Mission to Peru.
2. More extensive economic feasibility analysis should be undertaken if encouraged by the Peruvian Ministry of Food.
3. A series of conferences designed to explain the product, its nutritional value, and economics and to demonstrate the production of soy-fortified foods should be held for millers, bakers and government representatives.
4. A continuing program of technical assistance to millers and bakers should be offered by AID.
5. Assistance should be offered in the development of a regulation including pricing policy, import duties, etc. to control the marketing of soy-fortified flour based foodstuffs.
6. Long term technical assistance to aid in developing indigenous protein resource materials should be explored.

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IMPRESSIONS ON THE POTENTIAL FOR FORTIFIED WHEAT FOODS IN TURKEY

POPULATION

Turkey has a current population of approximately 38 million people with a growth rate of 2.7% per year. Nearly 70% of the population is rural and 42% is under 15 years of age.

GROSS NATIONAL PRODUCT

National average is $310 per year with much of the rural population essentially on a subsistance agriculture basis as far as their own food requirements are concerned.

NUTRITIONAL NEED

Food consumption statistics indicate adequate average caloric intakes in Turkey and reasonable levels of protein as well although cereal grains (80% wheat) represent about 80% of source of both calories and proteins. Infant mortality data, local nutritional status studies, and regional food consumption investigations have all indicated a wide deviation from the average exists within Turkey. Evidence indicates presence of malnutrition from protein-calorie lack as well as vitamin and mineral deficiencies. Well-documented evidence is not available, however, and a well-planned nutritional status survey was initiated in July, 1974, by the Ministry of Health with the cooperation of USAID, CARE, UNICEF and others.

WHEAT CONSUMPTION

Wheat is truly the mainstay in Turkey's diet with an average consumption of about 425 pounds per capita per year, or over 500 grams per capita per day. Nearly half of the wheat produced is consumed on the farm where grown. Wheat is consumed almost entirely in the form of bread, which accounts for 88% of usage. Bulgur accounts for 7% of wheat consumption, biscuits and pastries for 3% and pasta for 2%.

WHEAT SUPPLY

Turkey requires approximately 10 million tons of wheat each year. In 1971 and 1972, it was self-sufficient and even exported a small amount of wheat but short rainfalls the last two growing seasons have led to importation of about 750,000 metric tons in each of the last two years. The bulk of the wheat in Turkey is white winter wheat for breadmaking although some spring wheat is grown and durum wheat is grown for bulgur and pasta.

PROTEIN RESOURCES

As a national average, about 64% of current proteins are from wheat. Animal proteins represent about 20% of intake and are represented by lamb and poultry meats primarily. Potential protein resources for flour fortification are represented by a current annual production of about 800,000 tons of cottonseed, 500,000 tons of sunflower seed, 20,000 tons of sesame, 15,000 tons of peanuts, 4-10,000 tons of soybeans, and 200-800,000 tons of olives. Vegetable oil produced from these raw materials is in short supply and oil rather than raw material for crushing is imported. The growing feedstuffs industry is currently using all of the protein residue from the oil extraction industry.

PRICE RELATIONSHIPS, GOVERNMENTAL PRICE SUPPORTS AND PRICE CONTROLS

Wheat producers have the freedom to sell to a local merchant or miller either for immediate or future delivery or to sell to the State grain agency (TMO) at a fixed price announced just prior to the harvest season. TMO purchases 5-10% of total wheat production or 9-18% of that wheat which enters marketing channels and all of the imported wheat. TMO's two main objectives are to insure that the bread needs of consumers are met and to stabilize prices. The mayor of each major city or district establishes the price of bread and controls the milling extraction rate of flour millers. Millers are allocated production rates to insure 22 lbs/capita of bread

wheat per month. They purchase grain on the open market to the extent possible and buy their residual requirements from TMO. Free market price of wheat is now 220 kurus/kilo. TMO is paying producers 215 kurus/kilo and selling to millers at 125 kurus/kilo. The difference, representing a direct government subsidy to keep the price of bread down and the price of wheat to producers up, has become a major financial problem to the government in the last two years. Nevertheless, the present government is dedicated to a low price for bread. The retail price of wheat flour in Istanbul in December 1973 was 370 kurus/kilo. This price is used in the least-cost diet analysis reported below. At this price wheat flour is in the least-cost diet for both adults and children.

STATUS OF FLOUR MILLING INDUSTRY

There are approximately 275 roller mills in Turkey with an overall capacity for nearly 4 million metric tons of wheat per year. In addition, there are about 25,000 water powered stone mills in the villages with a capacity each year for grinding about 5 million metric tons of wheat (two-thirds for flour, one-third for bulgur). Many of the roller mills are quite old but in good repair and apparently operating well for production of 80-85% straight grade flour.

STATUS OF BAKING INDUSTRY

There are no large wholesale bakeries in Turkey although one rather large plant is under construction in Istanbul. Of the 6,000 bakeries in Turkey, 400 are considered semi-modern with some mechanized equipment. Thirty-five percent of bakeries use 1,400-2,000 kg of flour/day; 60% use 2,000-3,500 kg of flour; and 5% use 3,500-14,000 kg of flour daily. Practically all bread is a lean formula (no fat, no sugar) french bread which is sold over the counter (unwrapped) each day to neighborhood customers. Only about 400 bakeries are now using compressed yeast and about 800 are using ascorbic acid as a dough improver. Two modern biscuit factories distribute cracker and cookie products throughout the country.

STATUS OF PROTEIN INDUSTRY

A soybean mill at Ordu has recently been equipped by UNICEF to produce defatted toasted soy flour for a weaning food "Sekmama." Although the soy flour currently produced was not up to U.S. baking quality, discussions with management and evaluation of the product make us confident that this plant can produce adequate quantities of good quality soy flour for a bread fortification program in Turkey provided an adequate supply of domestically produced or imported soybeans are obtained. No indication was found of interest in producing edible protein flours from sunflower seed or cottonseed.

INTERNATIONAL NUTRITION PROGRAMS

The World Food Program is supplying commodities for 100,000 students in educational boarding institutions and for Work-for-Food developmental projects, but the program is to be reduced and phased out in the future. UNICEF is conducting a project to produce a low-cost protein-rich weaning food. WHO is assisting UNICEF by conducting acceptability and marketing studies with the product. USAID through CARE is supplying 23 million pounds of soy fortified flour for a supplemental feeding program for 1 million school children during the 1974-75 school year. This support is scheduled to end in June 1975.

GOVERNMENT COMMITMENT TO NUTRITION

The government of Turkey budgeted $9.8 million to the Ministry of Education's Nutrition Division in 1973 including $715,000 for purchase of commodities which was 10 times the amount budgeted the previous year. For 1974, $1.45 million has been budgeted to distribute to school districts for direct purchase of local food. For the 1975 school year, it is hoped that $7.5 million will be budgeted for commodities as apparently the USAID Food-for-Peace contribution will be discontinued. The goal is to feed 1.2 million children in 1975 and eventually extend the coverage to 2.5 million. The current year costs for soy fortified flour will be close to $3 million. Unfortunately, at this time definite plans and budgets do not exist for beyond the current year. Both the Ministry of Health and the Ministry of Education are interested in soy fortified wheat flour for institutional feeding programs in the future.

GOVERNMENT REGULATIONS

The composition of flour and bread is rigidly controlled in Turkey. At present no additives are permitted to be added to flour and only yeast and ascorbic acid are allowed additives by the bakers. The regulations would have to be amended or special exemptions allowed for the production of soy fortified flour to enable millers to blend wheat flour and soy flour and then to add vitamins, minerals, SSL, and potassium bromate. Officials have indicated that an open-minded review would be given at the appropriate time.

SUMMARY

Wheat in the form of bread is the foundation of the diet in Turkey. For significant improvement in the nutritional status by enrichment and fortification with certain nutrients, centrally milled wheat flour is the obvious carrier of choice. Wheat and bread are not only the most important crop and food in Turkey but also are extremely important to the general economic status of the people. Any program of nutritional improvement involving bread on a massive scale would necessarily need to be carefully examined from social, political, and economic viewpoints.

The State Planning Office is interested in studying the improvement of bread for all the people. To that end, a plan for a pilot project to market soy fortified flour and bread in the Ankara area for a one-year period is being drafted. This would tentatively involve the entire production of one flour mill (150 tons/day) for a year with subsequent evaluation of the acceptability and accompanying marketing program before determining whether to extend the program to other geographic areas.

Unfortunately, it is currently unclear how long and to what extent USAID will have a technical assistance program operating in Turkey.

RECOMMENDATIONS

1. Encouragement should be given to the early development of the pilot fortification project proposal.(expected about Oct. 1, 1974).

2. USAID through the Mission and TAB/N have the capability to respond to many of the needs that will probably be expressed in the proposal.
   a. Supply of some ingredients (SSL, vitamins, minerals, etc.)
   b. Training and demonstrations for bakers
   c. Mixer and micronutrient feeder technology
   d. Training advertising or propaganda personnel
   e. Evaluation of results

   Early action on the proposal will be needed to assure continuation of interest and enthusiasm.
3. A bread fortification project strictly through the private sector does not seem advisable at this time because of the status of the baking industry and the close governmental price controls and rigid composition regulations.

A LINEAR-PROGRAMMING TEST OF THE ECONOMIC EFFICIENCY OF SOY-FORTIFIED WHEAT FLOUR IN TURKEY

SUMMARY

Based on requirements for protein-calorie intake, and prices and nutrient composition of food items available in Istanbul, a linear-programming least-cost diet analysis was performed. The purpose of the analysis was to determine if SFF would enter the least-cost diet as an economically efficient source of protein and calories. The results indicate that SFF would probably not be an efficient source of nutrients for adults, and probably would be an efficient source of nutrients for growing children.

INTRODUCTION

Linear programming can be used to determine least-cost human diets. Using information of food prices, food nutrient composition, and human nutrient requirements, linear-programming can determine the least-cost combination of foods that provides the nutrient requirement.

Of the three types of information required for linear programming--food prices, food nutrient composition, and human nutrient requirement--the latter two are relatively well-known, when the population group (adult, children, or infant) for whom the diet is to be determined is identified, the nutrient requirement can be specified within a usable degree of accuracy. When the list of food items available to be included in the diet is known, the nutrient composition of the items can be specified within a usable degree of accuracy. Food price information for linear programming work raises some problems. To the extent that (relative) food prices differ among regions of a country, or from one season to another, the least-cost human diet will probably differ according to region and season. Separate analyses will be needed for each set of relative food prices.

Because actual human diets are determined by many considerations in addition to nutrient requirements, it is necessary to take account of these other considerations

in order to make the least-cost diet realistic. That is, we determine least-cost diets subject not only to meeting minimum nutrient requirements, but also to various specified conditions. For example, we can set upper limits on the amounts in the diet of low cost "efficient" sources of nutrients in order to take account of consumer unwillingness or inability to consume large amounts, or of simple unavailability of large amounts. On the other hand, we can force minimum amounts of high cost "inefficient" sources of nutrients (e.g., beef) into the diet in order to satisfy cultural preferences. It seems wise to begin analysis with no restrictions of this sort and then to add them one at a time in order to move the diet toward realism.

The purpose of the analysis reported here is to determine the conditions required for a food not presently available to enter the least-cost diet. Specifically, under what conditions would soy-fortified wheat flour (88 parts wheat flour and 12 parts soy flour), hereafter abbreviated SFF, enter a least-cost diet as an efficient provider of nutrients? The analysis examines two kinds of conditions: the price of SFF relative to the price of wheatflour, and quantitative upper limits on the quantity of flour (SFF plus wheatflour) in the diet. There is some price of SFF low enough to allow it to be included in a least-cost diet; there is some price of SFF high enough to prevent it from being included in a least-cost diet. The analysis will identify these lower and upper SFF prices. There may be upper limits on the amount of flour that people can consume or are willing to consume. It will be seen that quantitative upper limits on flour consumption may determine if SFF is in or out of the least-cost diet. The analysis will identify the quantitative limits that have such influence.

The analysis is carried out using the foods available in the retail markets of Istanbul, Turkey, in December 1973. Relative prices for December 1973 are used. Further work is needed to determine if the results presented here are valid for other places in Turkey and at other times of the year.

Seventeen food items from Istanbul are used. Nutrient composition data are based on USDA, Handbook No. 8 (Washington, 1963) and FAO, Amino-Acid Content of Foods (Rome, 1970). Prices were obtained in State Institute of Statistics (Turkey), Monthly Bulletin of Statistics, Dec. 1973 (Ankara). An eighteenth food item, SFF, is also included. Its nutrient composition data was obtained from the ADM Milling Co. (The calorie value for SFF was set at exactly the same value as that of wheatflour. While not strictly correct, the small adjustment (about 2%) drastically simplifies Diagrams 1 and 2 below and the related discussion.) The nutrient composition and price data for the eighteen food items are presented in the appendix.

Note that wheatflour (80-90% extraction) is used instead of bread in order to facilitate the comparison with SFF. There are two reasons to make the comparison in terms of flours, rather than in terms of breads. First, the flours can be used for many kinds of foods (breads, pasta, weaning foods, etc.) so the flour comparison leads to broader conclusions. Second, the nutrient composition and prices can be more accurately determined for flours than for breads.

The analysis is carried out first for adults, and then for children (age 10-12).

Adult Least-Cost Diet Diets

The daily nutrient requirement assumes the representative adult to be a 70 kg. (154 lb.) male. The calorie, protein, and amino-acid requirements are based on FAO/WHO, Energy and Protein Requirements (Rome, 1973). The assumed daily requirements are:

Calories	3200 kcal.
Protein	40 gr.
Lysine	880 mg.
Methionine-Cystine	960 mg.
Threonine	520 mg.
Tryptophan	260 mg.

The analysis is limited to calorie and protein (and amino-acid) requirements. When the (U.S.) National Research Council, RDA figures for minerals (calcium and

iron) and vitamins (vitamin A, niacin, thiamin, riboflavin, and ascorbic acid) were included as nutrient requirements, and when only the seventeen "natural" ("unenriched") Istanbul foods were available, the Istanbul least-cost diet was three times more costly than when mineral and vitamin requirements were not included. It is clearly very costly to use the seventeen available "natural" foods to obtain the RDA levels of vitamin A, niacin, and ascorbic acid. (A highly probable implication of this is that if RDA levels of these and other minerals and vitamins are desired, vitamin and mineral fortification may be an efficient way of providing them.) A food that is fortified with vitamins and minerals stands a good chance of being included in a least-cost diet in Istanbul solely because of such fortification. Therefore, in order not to confuse the issue of vitamin and mineral fortification with protein fortification, the vitamin and mineral requirements were not included in the analysis.

Even before linear programming is used two very important implications can be drawn from the nutrient composition data about wheatflour (see appendix) and the adult nutrient requirement just presented.

First, wheatflour of 80-90% extraction has a higher ratio of each of the essential amino-acids to total protein than the adult requirement. The implication of this is that high extraction wheatflour, by itself, is of adequate protein quality to satisfy the adult requirement. An adult who consumes enough 80-90% extraction wheatflour to obtain the required 40 grams of protein will simultaneously obtain more than adequate amounts of each of the essential amino acids.

Second, the ratio of protein to calorie in wheatflour (1 gram protein:30 calories) is above the adult requirement (1 gram protein:80 calories). This fact, together with the first implication above mentioned, means that an adult eating only wheatflour will satisfy the protein (and each essential amino-acid) requirement with

a smaller wheatflour intake than needed to satisfy the calorie requirement. Put another way, if wheatflour alone is used to satisfy the calorie requirement, it will more than satisfy the protein (and amino-acid) requirements. (In our particular case, if wheatflour is used to provide 3,200 calories, it will simultaneously provide 105 grams of protein, far above the requirement of 40 grams, and far more than the required amounts of the essential amino acids. The upshot of this is that in this case increasing the protein and amino acid content of flour is not useful.)

In order to determine if SFF is an efficient provider of nutrients, it is necessary first to identify the conditions required for SFF to enter a least-cost diet. It is then necessary to decide if the requisite conditions actually occur in a particular place and time.

The "conditions" examined here are the price of SFF relative to the price of wheatflour, and upper-limit restrictions on the amount of flour (SFF plus wheatflour) that can be in the diet. For the problem at hand these are the interesting parameters. It must be kept in mind that all other prices, absolute and relative, remain constant. Changes in prices of other foods lead to a different pattern of results. For example, a decrease (increase) in the price of chickpeas, an important competing source of protein, results in a decrease (increase) in the range of SFF prices over which SFF is an efficient source of nutrients. (In terms of the diagram discussed below, changes in other prices have the effect of changing the location of the horizontal price-line boundaries between regions 5 and 4, and between regions 3 and 4. The sensitivity of this price boundary to changes in the prices of competing protein sources is very important and is discussed later.) Note that the price of wheatflour must also remain constant. Different relative prices of SFF and wheatflour are brought about solely through changes in the price of SFF.

Although the focus of this analysis is on the conditions required for SFF to enter a least-cost diet, it 's useful before examining these conditions to indicate

the type of diet that results from the relative prices and constraints used in the model when no SFF is available. With the prices extant in Istanbul in December 1973 wheatflour is the cheapest source of calories, even when all the value of wheatflour is imputed to calories. (The Istanbul December 1973 wheatflour price that gives this result is not unusual. An examination of wheatflour prices over the period 1965-1973 for four cities in Turkey indicates that wheatflour consistently provided the cheapest calories. Therefore, the discussion in the following paragraph is probably widely applicable.)

If wheatflour provides the cheapest calories, and if there are no quantitative limits on the consumption of wheatflour, then wheatflour is the only food in the least-cost diet. Wheatflour will be consumed in amounts (877 grams) adequate to satisfy the calorie requirement (3,200 calories). When this happens, as pointed out earlier, the protein (and amino-acid) requirement is exceeded. Other foods will enter the least-cost diet only if wheatflour consumption is limited by assumption. If wheatflour consumption is limited below 877 grams, the next cheapest source of calories--sugar, in Istanbul in December 1973,--enters the diet. If sugar in turn is limited by assumption, then the next cheapest source of calories--vegetable oil--enters the least-cost diet, and so on. If wheatflour consumption is limited to an amount below that needed to meet the protein requirement (333 grams), then other sources of protein will enter the diet. In the no-SFF-available-case, the next cheapest source of protein is chickpea, followed by beans. In summary, with no quantitative limits on wheatflour consumption, wheatflour alone is in the least-cost diet. When limits below 877 grams are imposed other sources of calories enter the diet, and if limits below 333 grams are imposed other sources of protein enter the diet.

When SFF is available, it will replace or supplement wheatflour under certain conditions. It is to these conditions that we now turn.

Diagram 1 shows all possible combinations of relative prices of SFF (to wheatflour), and quantitative upper limit restrictions on the amount of flour in the diet, and shows if SFF enters the least-cost diet. The technical characteristics of the five regions of the diagram are explained as follows:

Region 1. Flour limit greater than 250 grams; SFF price less than wheatflour price.

SFF is in the least-cost diet. The quantity of SFF is determined by the flour limit. SFF is in the diet in place of wheatflour because calories provided by SFF cost less than calories provided by wheatflour. In region 1 only calories are scarce. SFF consumption greater than 250 grams more than meets the protein and various amino-acid requirements.

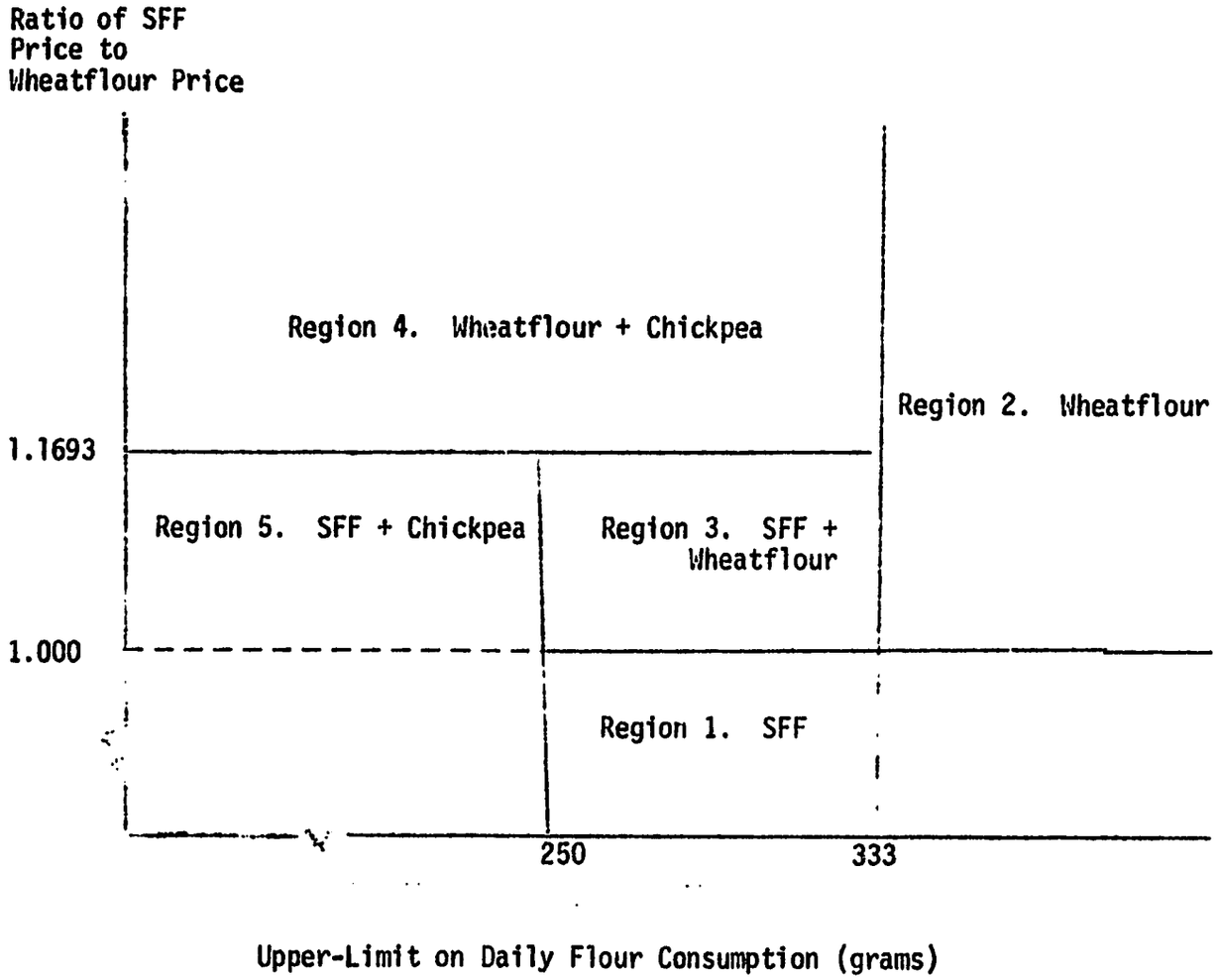
Region 2. Flour limit greater than 333 grams; SFF price greater than wheatflour price.

SFF is not in the least-cost diet. Wheatflour is cheaper source of calories and is in the diet. In region 2 only calories are scarce. Wheatflour consumption greater than 333 grams more than satisfies the protein and various amino-acid requirements.

Region 3. Flour limit greater than 250 grams but less than 333 grams; SFF price above wheatflour price but less than 16.9% above wheatflour price.

SFF is in the least-cost diet along with wheatflour. SFF quantity determined jointly with wheatflour quantity to satisfy the flour limit and the protein requirement. The SFF proportion increases as the flour limit decreases toward 250 grams; the SFF quantity reaches 250 grams (100% of the flour limit) at flour limit of 250 grams. Wheatflour proportion increases as flour quantity limit increases toward 333 grams; wheatflour quantity reaches 333 grams (100% of the flour limit) at flour limit of 333 grams. In region 3 both calories and protein are scarce.

DIAGRAM 1. SOURCE OF PROTEIN IN ADULT LEAST-COST DIETS: ISTANBUL, DECEMBER 1973



Region 4. Flour limit less than 333 grams; SFF price more than 16.9% above the wheatflour price.

SFF is not in the least-cost diet. Protein in the diet is provided by wheatflour (quantity of wheatflour is determined by the flour limit) and by chickpeas.

Region 5. Flour limit less than 250 grams; SFF price less than 16.9% above wheatflour price.

SFF is in the least-cost diet. The quantity of SFF is determined by the flour limit. Protein in the diet is provided by SFF and chickpeas. The chickpea quantity is greater the lower the flour limit.

Diagram 1 can be summarized as follows:

--If SFF is priced below wheatflour, SFF always enters the least-cost diet, completely replacing wheatflour. SFF quantity is determined by the flour limit, if any.

--If SFF is priced more than 16.9% above wheatflour, SFF never enters the least-cost diet. Wheatflour is always in the diet, its quantity determined by the flour limit, if any.

--If SFF is priced above the price of wheatflour but less than 16.9% above the price of wheatflour, <u>and</u> if there is a flour limit below 333 grams, SFF enters the diet. As the flour limit is reduced from 333 grams toward 250 grams, the proportion of SFF in the total flour quantity increases. At all flour limits of 250 grams and lower, the entire flour limit is filled by SFF.

Having determined the crucial boundaries (for the Istanbul, Turkey, December 1973, pattern of relative food prices), what conclusion regarding the efficiency of SFF is appropriate? One must decide which region of the diagram encompasses Istanbul's conditions. This is a matter of judgment in the absence of detailed empirical evidence about possible SFF prices and flour consumption. It appears that Istanbul would be in region 2 of the diagram because the price of SFF is likely to be above the price of wheatflour, and because there appears to be no good reason to assume an upper limit on flour consumption of less than 333 grams in Istanbul. If this is so, SFF is <u>not</u> a component of a least-cost diet for adults. That is to say, SFF is <u>not</u> an efficient source of nutrients for adults, given the Istanbul, December 1973, pattern of relative prices.

Children Least-Cost Diets

The daily nutrient requirement assumes the representative child to be a 36.9 kg. (81 lb.) adolescent male, 10-12 years old. The calorie and total protein requirements are based on FAO/WHO, Energy and Protein Requirements (Rome, 1973). The amino-acid pattern is from (U.S.) National REsearch Council, Recommended Dietary Allowances, Eighth Edition 1973 (Washington, 1974). The assumed daily requirements are:

Calories	2600 kcal.
Protein	30 gr.
Lysine	1624 mg.
Methionine-Cystine	812 mg.
Threonine	1033 mg.
Tryptophan	148 mg.

In the case of children, unlike the case of adults, wheatflour by itself does not contain adequate protein quality to meet the requirement. That is, wheatflour will satisfy the total protein requirement (30 grams) before it satisfies the lysine requirement (1624 mg.). If sufficient wheatflour (498 grams) is consumed to satisfy the lysine requirement, total protein intake exceeds 30 grams. Note that SFF alone also contains inadequate lysine to satisfy the lysine requirement before it satisfies the protein requirement. If sufficient SFF (333 grams) is consumed to satisfy the lysine requirement, total protein intake exceeds 30 grams. In other words, for children, the ratio of required lysine to required total protein (1624 mg./30 gr.) is greater than the ratio of lysine to protein in wheatflour (326 mg./12 gr.) and in SFF (488 mg./16 gr.). If either or both of these flours are used to satisfy the lysine requirement, the protein requirement will be exceeded, that is, protein will not be scarce. In short, in the case of children, the scarce nutrients are calories and lysine in regions 3, 4 and 5 of diagram 2, and only calories in regions 1 and 2.

Diagram 2 shows all possible combinations of relative prices of SFF, and quantitative restrictions on the amount of flour in the diet. The diagram shows the important price and quantity boundaries.

Region 1. Flour limit greater than 333 grams; SFF price less than wheatflour price.

SFF is in the least-cost diet. SFF quantity is determined by the flour limit. In region 1 only calories are scarce, because any SFF consumption above 333 grams exceeds protein (and lysine) requirements.

Region 2. Flour limit greater than 498 grams; SFF price greater than wheatflour price.

SFF is not in the least-cost diet. Wheatflour is in because it is a cheaper source of calories. In region 2 only calories are scarce, because any wheatflour consumption above 498 grams exceeds protein (and lysine) requirements.

Region 3. Flour limit greater than 333 grams but less than 498 grams; SFF price above wheatflour price but less than 10.2% above wheatflour price.

SFF is in the least-cost diet along with wheatflour. The SFF proportion of total flour is greatest at low flour limit; the wheatflour proportion is greatest at high flour limits. In this region both calories and lysine are scarce.

Region 4. Flour limit less than 498 grams; SFF price more than 10.2% above wheatflour price.

SFF is not in the least-cost diet. Lysine in the diet is provided by wheatflour and chickpeas. In this region both calories and lysine are scarce.

Region 5. Flour limit less than 333 grams; SFF price less than 10.2% above wheatflour price.

SFF is in the least-cost diet. Lysine in the diet is provided by SFF and chickpeas.

Diagram 2. SOURCE OF LYSINE IN CHILDREN LEAST-COST DIETS: ISTANBUL, December 1973

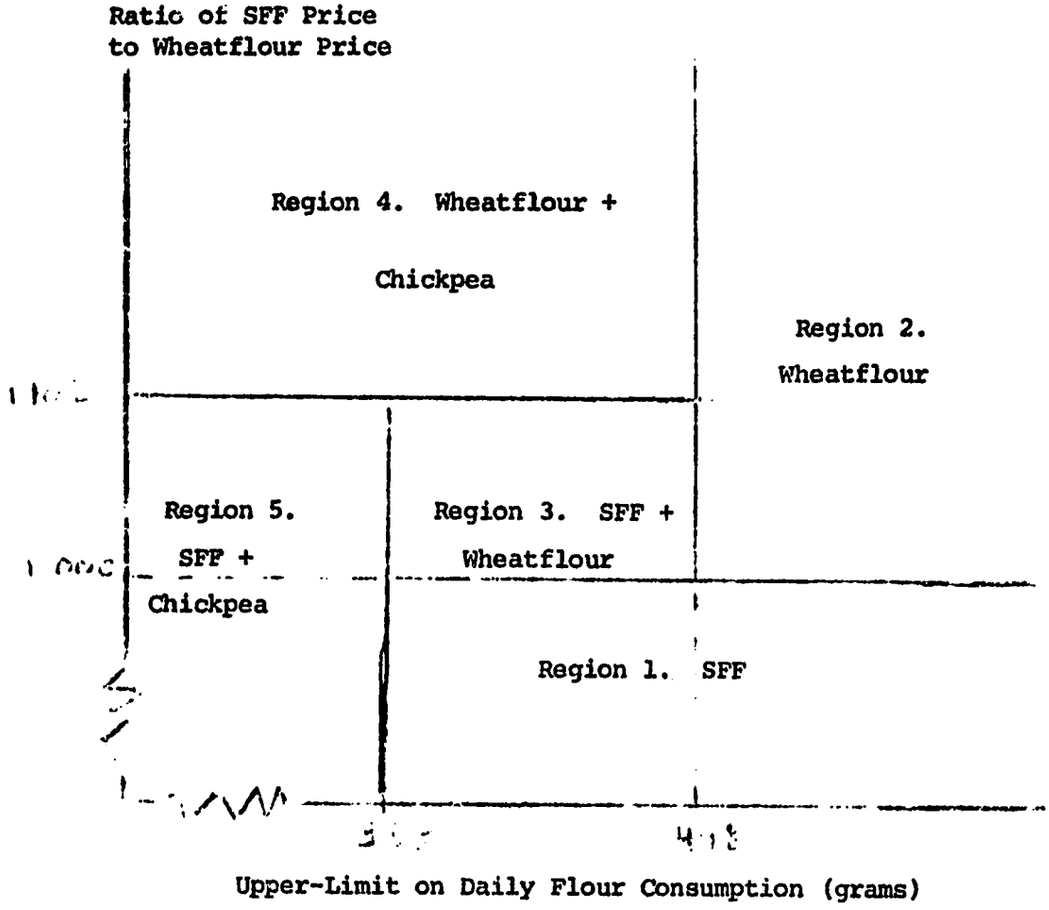


Diagram 2 can be summarized as follows.

-- If SFF is priced below wheatflour, SFF always enters the least-cost diet, completely replacing wheatflour.

-- If SFF is priced more than 10.2% above wheatflour, SFF never enters the least-cost diet.

-- If SFF is priced above wheatflour but less than 10.2% above the price of wheatflour, <u>and</u> if there is a flour limit below 498 grams, SFF enters the diet. As

the flour limit is reduced from 498 grams toward 333 grams, the proportion of SFF in total flour increases. At all flour limits of 333 grams and lower, the entire flour limit is filled by SFF.

Having determined the crucial boundaries (for the Istanbul, Turkey, pattern of relative prices), what conclusion regarding the efficiency of SFF is appropriate? We need to determine which region of the diagram encompasses Istanbul's conditions. It is unlikely that flour intake by 10-12 year olds could be as high as 498 grams. It is also unlikely that SFF would be priced below wheatflour. Thus, regions 1 and 2 are unlikely to be relevant. For SFF to be priced more than 10% above wheatflour would require that straight soy-flour be priced more than 83% above wheatflour (recall that SFF is 88 parts wheatflour and 12 parts soy flour). This seems unlikely to be the case. Thus, region 4 is unlikely to be relevant. It appears that regions 3 and 5 are realistic. If this is so, it means that SFF enters the least-cost diet for 10-12 year olds. It appears that SFF <u>is</u> an efficient source of nutrients for 10-12 year olds, given the Istanbul December 1973 circumstances.

<u>Extending the Least-cost Diet Analyses to the Entire Society</u>

The results reported above show how adults and children can obtain required nutrients at least cost. These results depend on the assumed pattern of prices. If only a small proportion of persons in the market reallocated food expenditures toward the foods that compose the least-cost diet, there is unlikely to be enough price change to alter the composition of the least-cost diet. But if the entire population reallocated expenditure toward the foods in the least-cost diet, perhaps as the result of a successful nutrition-education program, the resulting shift in demand could alter prices enough to change the composition of the least-cost diet. The greater the difference between the actual diet before the shift and the least-

cost diet the bigger the shift in the demand pattern and the greater the probability that prices will change enough to alter the least-cost diet.

The objective of this paper is to determine the efficiency for society of SFF. We need to know if the results reported above that are strictly applicable to "individual" adults and children can be used to make such a determination.

The least-cost analyses showed the crucial importance of the role of chickpeas. Chickpeas are an important competing source of protein (in the adult case) and lysine (in the children case). The chickpea price is a crucial determinant of the efficiency of SFF. The amount by which the price of SFF can exceed the price of wheatflour is determined by the price of chickpeas: the higher the price of chickpeas the higher the price of SFF can be before SFF no longer is in the least-cost diet.

Let us examine the case for children. Assume the price of SFF is 15% above the price of wheatflour. The analysis showed that SFF is not a component of the least-cost diet for children at that price. Assume also that wheatflour cannot be consumed by children in amounts sufficient to provide the required amount of lysine. Given these assumptions, chickpeas are in the least-cost diet to provide lysine. But if chickpeas are used to provide lysine the consumption of chickpeas will increase substantially.*

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*In 1972 chickpea production was about 13 grams per person per day (1972 chickpea production was 178,000 MT, and 1972 population was 37.1 million). One-half of the population is in the age-group 1-19 years. Even if all the chickpeas were consumed by this group, daily intake with current production would be only about 26 grams. If we make the rough assumption that half of the lysine of this group was to be provided by wheatflour, and the other half by chickpeas, and that the average body weight of persons 1-19 years of age is 34 kg., chickpeas would have to provide 748 mg. of lysine per person per day. Chickpea intake would have to be about 54 grams per day. Therefore, even under these conservative assumptions, with all chickpeas going to children, chickpea production would have to double.

Chickpeas are not now a major part of the diet. A significant increase in demand for chickpeas is likely to result in a rise in price of chickpeas. If the rise is sufficient it will turn out that SFF priced at 15% above the price of wheatflour will enter the least-cost diet as an efficient source of lysine. (The next section shows the sensitivity of our conclusions to the chickpea price.)

To answer the question of the efficiency of SFF for society we need to perform the linear programming analysis using prices that would exist if society were in fact purchasing the least-cost diet. In our particular problem we need to know the chickpea price that would exist if society was to purchase chickpeas in amounts sufficient to fill the part of the lysine requirement not filled by wheatflour.

This paper makes no attempt to estimate what the long run price of chickpeas would be. But we can determine how various increases in the price of chickpeas would influence the results of our analysis.

The Effect of Higher Chickpea Prices on the Efficiency of SFF

This section shows the sensitivity of the conclusions about the efficiency of SFF when chickpea prices increase by 10-40%. The two tables show the upper-limit prices of SFF (expressed as % above the wheatflour price). These upper-limit prices of SFF are the horizontal boundary lines below region 4 in both diagrams 1 and 2. If the SFF price exceeds the wheatflour price by more than the amounts shown in the tables, SFF does not enter the least-cost diets. (Note that upper limits on flour quantities must also be taken into account in reading the tables.) The tables clearly show that if the chickpea price increases as a result of an increased demand for chickpeas, the range of prices over which SFF would enter the diet increases.

Table 1. Adult Case

Per cent increase in Chickpea Price	The Amount by which the SFF Price can exceed Wheatflour Price
0	16.9
10	20.6
20	24.3
30	28.0
40	31.7

Table 2. Children Case

Per cent increase in Chickpea Price	The Amount by which the SFF Price can exceed Wheatflour Price
0	10.2
10	12.4
20	14.7
30	16.9
40	19.1

The Relation of SFF Price, Wheatflour Price, and Soyflour Price

One of the important "conditions" determining the efficiency of SFF is the price of SFF relative to the price of wheatflour. We have seen in the adult case and in the children case the borderline price ratios (determined when the prices of all foods are given and constant) that determine if SFF is in or out of the least-cost diet.

SFF consists of 88 parts wheatflour and 12 parts soy flour. (This analysis deals only with 12% SFF but other formulations are possible. In addition, it ignores the one-half part of the emulsifier SSL.) Because the wheatflour portion is so large, the price of wheatflour is by far the major determinant of the price

of SFF. A simple formula shows this. The price of SFF is equal to 0.88 times the price of wheatflour plus 0.12 times the price of soy flour. If the price of soy flour is the same as the price of wheatflour, the price of SFF is the same as the price of wheatflour. If soy flour is twice the price of wheatflour, SFF will be 12% higher priced than wheatflour (the ratio of SFF price to wheatflour price is 1.12, in terms of the diagrams). If soy flour is triple the price of wheatflour, SFF will be 24% higher priced than wheatflour.

A precise determination of the SFF price depends on knowing the prices of wheatflour and soy flour. But even in the absence of this information, the above relationship allows us to put a rough upper-limit on plausible SFF prices. Because it seems unlikely (in Turkey or elsewhere) that the price of soy flour will be as much as three times the price of wheatflour, it seems unlikely that the price of SFF will exceed the price of wheatflour by as much as 24%.

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WHFLOUR	LYSINE	528.00000	METHCYS	459.00000
WHFLOUR	THREON	394.00000	TRYPTO	139.00000
WHFLOUR	BREADMAX	1.00000	COST	37.00000
SFF	CALORIE	365.00000	PROTEIN	16.00000
SFF	LYSINE	488.00000	METHCYS	596.00000
SFF	THREON	520.00000	TRYPTO	170.00000
SFF	BREADMAX	1.00000	COST	39.00000
RICE	CALORIE	363.00000	PROTEIN	6.70000
RICE	LYSINE	255.00000	METHCYS	259.00000
RICE	THREON	234.00000	TRYPTO	95.00000
RICE	COST	100.00000		
POTATOES	CALORIE	76.00000	PROTEIN	2.10000
POTATOES	LYSINE	96.00000	METHCYS	38.00000
POTATOES	THREON	75.00000	TRYPTO	33.00000
POTATOES	COST	21.50000		
BEANS	CALORIE	338.00000	PROTEIN	25.10000
BEANS	LYSINE	1513.00000	METHCYS	359.00000
BEANS	THREON	786.00000	TRYPTO	202.00000
BEANS	COST	95.90000		
CHICKPEA	CALORIE	360.00000	PROTEIN	20.50000
CHICKPEA	LYSINE	1376.00000	METHCYS	447.00000
CHICKPEA	THREON	756.00000	TRYPTO	174.00000
CHICKPEA	COST	70.10000		
ONION	CALORIE	38.00000	PROTEIN	1.50000
ONION	LYSINE	63.00000	METHCYS	16.00000
ONION	THREON	20.00000	TRYPTO	20.00000
ONION	COST	26.30000		
SUGAR	CALORIE	385.00000	SUGARMAX	1.00000
SUGAR	COST	39.50000		
MUTTON	CALORIE	247.00000	PROTEIN	16.80000
MUTTON	LYSINE	1247.00000	METHCYS	583.00000
MUTTON	THREON	733.00000	TRYPTO	198.00000
MUTTON	COST	283.00000		
BEEF	CALORIE	323.00000	PROTEIN	16.50000
BEEF	LYSINE	1573.00000	METHCYS	704.00000
BEEF	THREON	812.00000	TRYPTO	198.00000
BEEF	COST	266.00000		
POULTRY	CALORIE	298.00000	PROTEIN	17.40000
POULTRY	LYSINE	1590.00000	METHCYS	764.00000
POULTRY	THREON	794.00000	TRYPTO	205.00000
POULTRY	COST	211.00000		
EGGS	CALORIE	163.00000	PROTEIN	12.90000
EGGS	LYSINE	1091.00000	METHCYS	301.00000
EGGS	THREON	1224.00000	TRYPTO	184.00000
EGGS	COST	238.00000		
OIL	CALORIE	884.00000	COST	93.30000
MILK	CALORIE	65.00000	PROTEIN	3.50000
MILK	LYSINE	248.00000	METHCYS	86.00000
MILK	THREON	153.00000	TRYPTO	50.00000
MILK	COST	50.00000		
CHEESE	CALORIE	370.00000	PROTEIN	22.20000
CHEESE	LYSINE	1559.00000	METHCYS	606.00000
CHEESE	THREON	725.00000	TRYPTO	217.00000
CHEESE	COST	197.00000		
YOGHURT	CALORIE	62.00000	PROTEIN	3.00000
YOGHURT	LYSINE	248.00000	METHCYS	86.00000
YOGHURT	THREON	153.00000	TRYPTO	50.00000
YOGHURT	COST	67.80000		
APPLE	CALORIE	56.00000	PROTEIN	.20000
APPLE	LYSINE	22.00000	METHCYS	8.00000
APPLE	THREON	14.00000	TRYPTO	3.00000
APPLE	COST	42.10000		
CABBAGE	CALORIE	24.00000	PROTEIN	1.30000
CABBAGE	LYSINE	50.00000	METHCYS	35.00000
CABBAGE	THREON	61.00000	TRYPTO	17.00000
CABBAGE	COST	24.00000		