FOOD ENGINEERING AND THE THIRD WORLD: TECHNOLOGY TRANSFER - LESSONS AND CHALLENGES.

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Food Engineering and the Third World: Technology Transfer - Lessons and Challenges.

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Food Engineering covers the areas of specialization within the field of Food Science and Technology, concerned with design of food processes. Many of its concepts deal with the industrial and commercial aspects of the processing of food. It is appropriate that at this meeting, some time should be taken to review the contribution of food engineering to the development of food processing and of increased supplies of stable, popular foods in Third World countries.

This paper focuses particularly on the issues of Transfer of Technology, with some comments on the current status of economic and food conditions in developing countries and the lessons learned in technology transfer, as well as the challenges with which food technologists are confronted, to contribute to improvement of food availability in these countries.

Economic and Food Conditions

World Bank statistics now classify developing countries in three categories according to annual GNP per capita (Table 1). Thirty-four countries in the least-developed group have GNP less than USD$400 (1982), average USD$250 and annual growth rate of 1.1% (China and India fall into this group but are excluded from averages). Many of these countries have negative growth rates. The lower middle income group comprises 37 countries with GNP per capita from USD$440 to 1.610, with an average of USD$840 and an average growth rate of 3.2 percent. The upper middle income group of 21 countries have GNP per capita from USD$1.680 to 6.840, with the highest 8 greater than USD$4.000, comprising countries such as Venezuela and Singapore. The average is USD$2.490, with an average growth rate of 4.1 percent. Some of this last group surpass the GNP and growth rate figures for some developed countries in the industrial market economies group which range from USD$5.150 to 17.010, with averages of USD$11.070 for GNP per capita and 3.3 percent for growth rate. These figures illustrate that, despite all the development activities and international aid programs, the gap between the rich and poor countries continues, and may even be widening in the poorest of countries, and that a few countries of the 94 have developed economically at least to European levels.

The economic resources of developing countries have to be spread over an ever increasing population, to provide for specific needs, such as food. There are indications that many countries, specifically China, have been successful in reducing birth and population growth rates, but this has coincided with the shift of the population and its growth rate to urban areas (Table 2). With a greater population requiring food and employment in

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the cities, the demands on the food supply system are exploding, precisely when the number of rural people and farmers is decreasing. Fortunately, major achievements in the adoption of high yielding varieties of cereals in farming systems have kept pace with this change in some areas, but more and more countries have become dependent on imports of cereals and other foods, mainly to supply urban consumers (Table 3). For Africa and the Far East, food supplies have not been able to meet gross calorie requirements as measured by FAO (Table 4). African food production has, in fact, declined by 10% in this decade. (2)

Of course, these averages only illustrate the overall status of food supply; it is not countries, but individuals who suffer from a shortage of food - not because of fluctuations in national supplies, but because of high food prices which they cannot afford, or because of inadequate marketing systems. In Latin America one in three families is unable to afford to buy basic food requirements, the measure of poverty (Table 5). Their diet will only improve when their general economic state does. For the increasing populations of the cities, this depends on the availability of income from employment. Recent estimates suggest under and unemployment in urban areas of Latin America at 30% of work force, while in rural areas this rises to 65%. (4) In Africa, the situation will be worse. But a recent World Bank report suggests that both urban and rural populations will increase rapidly into the next century in the low-income countries of Asia and Africa. Thus, while general concern with the provision of productive employment for urban dwellers is well-founded, many countries will face the task of absorbing considerably more workers into the rural economy (1). It is here where food processing industry has a role to play, providing employment in both rural and urban areas.

In terms of employment, the food processing industry in developing countries is one of the major employers in the manufacturing sector, with around 20-30% workforce, particularly in poorer countries (Table 6). This industry sector is also important in terms of the output and the number of establishments. There is also faster growth in the food sector in comparison with industrial growth as a whole in the developing countries (Table 7. More detailed information for the Andean countries also identifies the major products in the food sector (Table 8). These are typical of most developing countries - large plants for the primary processing of products for export - fish, oils and fats and sugar, in this case; or large urban based plants for the production of beer, spirits and products for higher income groups, such as dairy foods and processed fruits and vegetables. Typically, the milling and cereal sector is important, but again these plants are centralised often in the capital city and/or the main port. All of these are important sources of employment, but with the exception of the milling sector, make little impact on food supplies for the low-income majority of the population.

This description of the food processing sector of developing countries has not taken account of the thousands of cottage and small-scale plants scattered throughout rural and urban areas of Asia and Latin America, in particular. These plants are not usually registered in official government records so are not included in the statistics. They are typically

family-operated businesses, utilising local raw materials which provide local employment, often informally, in the production of popular processed foods which are marketed in the immediate area or the nearest city, usually at prices affordable to the majority of the population. Thus are satisfied the millions of customers for soysauce, noodles, fish pastes, steamed baked goods, confectionery and snacks in Asia and tortillas, bakery products, cheeses, fermented cereal beverages, snacks and confectionery in Latin America. Equivalent local enterprises exist in African countries, but not to the same extent. This is not to say that these foods are only provided by these small plants, for there usually exists a local, larger scale plant which produces some of these popular products, but again these are often targeted at the more affluent consumer who will pay for the percieved higher quality, and the more expensive packaging and marketing associated with these companies.

Some countries have recently initiated programmes to support the development of small-scale businesses, having realised their importance in their economies. Thus some more detailed information is becoming available on their importance as low-capital intensive, high labour intensive industries capable of supplying domestic and, in some cases, export markets, not only, of course, in food processing. However, food plants are generally dominant in the small enterprise sector and over 80% of food plants in developing countries are small-scale (Table 9). (7)

Technological Development of the Food Industry.

At this time, most developing countries have a wide range of technologies and degrees of technological sophistication in the food industry existing alongside each other. The large number of small enterprises have evolved from scaling up kitchen level processes: for a large proportion, technology means using larger cooking vessels, perhaps firewood or bottled gas as the heat source and finishing with sun-drying on racks outdoors, for example, fish cracker industry in Malaysia; for others, attempts have been made over the years by the owners to adapt equipment or to develop ingenious designs to cope with difficult operations in the process, eg. tortilla forming and baking in Mexico; and for many, their processes represent a mixture of traditional operations with more modern processing options, eg. in mung bean noodle manufacture in Thailand, centrifuges operate alongside starch tables for the separation of starch and traditional dough kneading and extrusion alongside blast freezers in the noodle-making section. Technological developments, if they have occurred in this sector, have depended on the initiative and imagination of the entrepreneur.

What is generally represented as the food processing industry in developing countries are the large scale plants. These have been established either in colonial times for the primary processing of raw materials with imported technology, such as sugar, fats and oils, for shipment to European industry; or since the end of the last war, where decision-makers in Third World countries, who had been trained in the West, understandably implemented large-scale, capital-intensive projects dependent on the importation of

equipment, technology and know-how from companies and countries of the developed world where these technologies and products had proven successful. (10) Thus were established the flour milling complexes, the massive export canneries for pineapples, the prawn freezing plants, the breweries and soft-drinks plants, to name a few. The foods produced were again mainly for export or for the urban high-income consumer. Employment has been generated to some extent, although mainly in agricultural sector. These developments have usually been with multinational companies, who provide all the management and technical know-how. In more recent times, there has been considerable persuasion and success in using a joint venture approach, where local developing country finance and personnel is shared with contributions, usually involving technology transfer from the developed country partner, perhaps in a licensing agreement. These again provide mainly developed country products for the local high income sector or for export markets. Thus, in some developing country capitals, one is able to obtain any type of processed food, if one has sufficient income. Few of these newer developments create significant new employment in proportion to the capital invested. The contribution to food availability for the low-income majority is insignificant, if not negative, due to the heavy advertising based on health and status factors which motivates these consumers to spend some of their limited cash on products such as dried milk, fruit drink mixes and the like, thus depriving them of the opportunity to purchase cheaper products, typically in the fresh and more perishable state.

It can be concluded that developing countries, in the main, have relied on the transfer of food processing technologies from developed countries to establish a completely new food industry, separate and divorced from the traditional food industry which continues to survive. There has been little, if no, internal transfer of technology to the traditional sector.

One of the major reasons for this situation is that all the training in the food-related sciences has taken place in developed countries, up until the seventies, when food science degree and technological research institutes became established in many developing countries. It is fair comment to state that these new facilities in developing countries are again heavily based on developed country models and curricula. Research Directors, senior researchers and professors have almost all been trained in major universities of the developed countries. It is then no surprise that local research topics and locally trained food science graduates are more orientated to sophisticated processes or large-scale industry and that locally trained graduates are attracted to jobs in production or quality control in these large-scale plants, due to higher salaries. There is little, if no consciousness of the potential of indigenous food processing enterprises. It is also a question of numbers. No figures were accessible for food-related fields, but figures for the number of graduates finishing in all developing countries in the science and engineering fields barely match those for a developed country, such as Canada, with the notable exception of the large increase in the number of engineers graduating recently in Asia (Table 10). This data illustrates the still wide imbalance in educational resources available in developing countries. If it were possible to isolate the food science and technology graduates from these

figures, it would be evident that developed countries continue to dominate in this field and, therefore, orientate research direction, as well as criteria for publications on food issues inevitably towards areas of interest in developed countries.

This is the overall picture, but it is clear that younger staff in food technology departments and in research institutes in many developing countries, as they become leaders, are changing the orientation to reflect more concern over issues of more local and immediate interest. Thus, more and more work is concerned with, for example, characterisation of local raw materials as possible substitutes for imported materials, examination of indigenous energy resources to replace imported oil, developing new processes for traditional products, etc. This is a trend which has to be encouraged further and extended to collaboration on socio-economic and political research so that the limited human resources available are oriented to local needs and towards local development opportunities, in this case, to increase employment and food availability through the food industry. Fortunately, this is occurring more and more as developing countries strive for some degree of self-reliance.

The status of the food industry will vary, of course, in each particular continent, country and even within countries. Thus, the particular food production patterns, quantities, population pressures, cultural aspects concerning food preparation and processed foods, as well as the availability of remunerative employment and income will determine food and income availability and the market for processed foods. The degree to which local technological know-how and research skills will influence technological choice for improvement or development of local food industry will depend on the size of the trained resource base, its orientation to local or imported conditions and credibility with local entrepreneurs and government officials. The availability of finance (local or from abroad, through aid agreements) and the pressure of time to generate results among others, will also be significant. Thus, local constraints and conditions will determine whether technology transfer is really necessary or how it can contribute. An orientation towards developed country solutions is understandable given the preponderance of research expenditures in developed countries - 96% world Rand D expenditure. (11)

It can be appreciated that the constraints in African countries are quite distinct due to insufficient food supply, a much larger rural population, few trained scientists, and limited economic resources when compared to Latin America where overall there are sufficient food supplies, but major constraints occur in effective marketing and distribution to the huge urban populations, as well as to relatively isolated rural communities, while a larger scientific community exists and extreme national cash flow problems persist. Therefore, appropriate technological development options will of necessity be different. The challenges lie for technologists and engineers to become aware of the total mix of constraints and conditions for a particular technological development to deliver the benefits desired and adapt their approach and ideas to suit. The importance of thorough problem analysis, assessment of needs and field testing of possible solutions is now essential. One does not begin now by identifying "what technology?", but

rather "technology for what?". (12)

Technology Transfer

The term "technology transfer" has a variety of meanings such as the movement of technological development along the path from basic discovery to commercial application or the transfer of technology from one social/economic/cultural political context to a different one, eg. from developed to developing countries. In this discussion the focus is mainly on the latter.

Lessons from past experiences

1. In spite of successful technological transfers in certain sectors in developing countries, eg. fresh milk distribution, widespread poverty persists. (12)

2. Developing countries must specify the scope and thrust of technology to be transferred in such a way that the domestic economy is left with a strengthened and viable technological capability. (13)

3. Commercial technology transfers have tended to be inequitable and expensive for developing countries, frequently providing technology inappropriate to their needs, inhibiting development of their own capabilities and reinforcing their dependence on outside sources (12) - eg. transnational export plants for canned fruit, oils and fats, sugar, frozen fish, canned tuna, etc.

4. Imported processes or technologies developed where labour costs are high and capital costs are low, have led to displacement of labour in some developing country situations. (10) eg. factory fishing ships in India.

5. Imported plants typically run at excess capacity, and hence are more expensive to operate in developing countries for a variety of reasons, due to lack of raw material, irregular delivery, inadequate supplies of spare parts, poor availability of skilled labour and management, unreliable energy sources and utilities, overestimation of the market, poor knowledge of local quality standards. (10) eg. tomato paste plant in Nigeria.

6. Much technology, that has been applied for many years in more highly developed economies has tended to appear to be the most effective for many situations, but developing countries sometimes feel that a loss of face is involved in using such older technology - they insist on only the most modern technology available with the higher costs and risks often implied. (13) On the other hand, older, sometimes obsolete plant, has been sold to developing countries which, after some time, begins to breakdown without access to parts and servicing.

7. Technology transfer can take place through transfer of complete processing units (turnkey projects) or through the purchase or licensing of technology and hiring of managers or consultants.. Suppliers may make some adaptations which are usually limited to scaling down to make the operations economically feasible or perhaps modifications to suit raw material and consumer needs. (10) Much more adaptation is required in collaboration with developing country partners and target groups to take account of a wider range of factors.

8. There is need for development of improved capability on the part of developing countries to negotiate the aquisition of foreign technology so as to increase prospects for effective, stable agreements for all parties. (12) This implies the development of fair patent procedures and code of conduct for technology transfer. This will be enhanced by increased investment in local research and development by developing countries targeted at technological problems defined by their social needs. Thus more technically and socially informed local specialists can participate in negotiations.

9. In assessment of feasibility, standard economic criteria and considerations receive more attention than the social, political, economic and cultural aspects where the technology is to function. These economic feasibility calculations are not usually reliable, but may be very useful in highlighting critical factors. (10)

10. Decisions on feasibility are often made by consulting or contracting agencies in developed countries, whose experiences may only lie with their local situations and tends toward sophisticated capital intensive technology, since rarely have they experience of smaller scale or more labour intensive approaches. (10) In fact, there is relatively little technology available of this type that could be taken into consideration. Developing country and developed country research should focus on the development of new options of this type, including improvement of existing indigenous technologies. (7, 10, 12)

11. The real needs for the particular food situation in a developing country often differ from those assessed by extension workers or government officials who have not had sufficient contact or made a comprehensive enough study of the target situation or target groups to make a precise statement of the problem. (10) There needs to be liaison between those developing the technological improvement and its potential users, not only within the target groups, but also between this group and the more powerful sections of the society which will impact on, or be impacted upon, by the implementation of the change.

A summary statement at an UNIDO meeting in 1978 still represents the current status on technology selection under widely divergent conditions in developing countries; "no single pattern of technology or technologies could be considered as being appropriate, and a broad spectrum of technologies should be examined and applies... The selection and application of appropriate technologies would, therefore, imply the use of both large-scale

technologies and low-cost small-scale technologies, dependent on the objectives in a given set of circumstances. (14)

Implications for Food Technologists

From this discussion, the overall conclusion is that the transfer of developed country technology in general has had limited impact. In the food area, some benefits have accrued, mainly from the exportation of processed food products and raw materials and provision of a range of processed foods for the relatively small high-income sector of the population, despite the demands required for continued importation of ingredients, packaging and machinery and parts and the export of a portion of the profits to the developed country, mother company or partner. Little impact on the alleviation of rural and urban poverty can be cited.

As mentioned, a mix of approaches is required. There is a need to consider the design of improvement for the particular target situation which implies a 'market' definition activity, rather than install technology designed for the much more organised and standardised environments of developed countries.

Account must be taken of the constraints and conditions that function beyond solely specific unit operations or plant limits. Thus, design engineers must broaden their activity in collaboration with other relevant specialists to take account of the particular food system in operation, considering, for example, source, scheduling, characteristics of potential raw materials; the social and economic conditions under which they could be made available for processing on a regular basis; social-cultural barriers to particular processing operations, job specifications, entrepreneurship and management of local community members; energy and utility constraints and cost fluctuations; marketing and sales practices, servicing and maintenance facilities, etc. But this must also be done within a context of understanding the aims of the particular technological development - who is to benefit and how. Thus, there must be an awareness of national or local goals or objectives and efforts must be made to understand how the benefits can be generated. These 'local' factors should be researched preferably by developing country specialists in socio-economic, political and cultural fields so as to identify the constraints and provide 'feedback' as the design and development evolves. This social science input should analyse the existing socio-cultural and economic situation because each new technology has to compete with already existing practices and to fit in with existing socio-cultural values. This involves encouraging participation of beneficiaries input to define aspirations and constraints.

With this framework, food engineers/technologists can identify a range of possible technological solutions, some of which, without doubt, will already exist in developed country situations. Transfer of such technology must include a re-evaluation of its likely impact given the new pattern of constraints or environment. It is likely that some modifications will have to be made, not only in scale; but perhaps reducing the level of automation, to provide for more labour activities in the new situation; or perhaps

adaptation to a solar energy source; or reduction in stainless steel content, to lower costs or allow for manufacture in local metalworking shops, or even increase in stainless steel content due to risks of excesive rusting given new climatic conditions. Thus, the technological principles may be appropriate for transfer, but the new environmental specifications will indicate the need for adaptation or complete change in the design. Where possible, developing country engineers should be involved to guide the adaptive work and particularly to carry out local tests and provide feedback to design team. The International Development Research Centre (IDRC) has been supporting this approach in the development of grain dehullers in Africa and more recently fish deboner for small-scale situations in Thailand and Chile. In the relatively few cases where no technological solution is available, completely new research work will be required. The relatively greater experience of developed country design engineers can effectively contribute to such new research by developing country technologists, provided again there is sufficient awareness of the problem situation and constraints.

Thus, a shared approach between experienced developed country technologists and developing country engineers, technologists and social scientists will improve the success and relevance of transfer of technology - a concept expanded beyond merely selection, sales and installing of developed country hardware at a developing country site.

This approach suggests a reorientation of training of food engineers and technologists is required, particularly to broaden skills in the definition of constraints to a problem and development of an adaptive approach to application of known technological principles to less organised environments. For example, the principles of food drying already result in a variety of processing options in developed countries - spray drying, bed drying, cabinet drying, etc. Can these options be extended effectively for situations in developing countries, based on the known principles for new raw materials (with unknown heat and mass transfer coefficients); extreme climatic conditions of temperature and humidity; taking advantage of solar heat; and maintenance of product quality in storage and distribution, all of which have to be tailored to the particular local social, cultural, marketing, political, economic conditions?

As indicated earlier, much potential exists in providing employment and popular foods through improving food processing operations in the small and medium scale sector in developing countries, where operational and marketing know-how already exists. Yet, how little is known of the principles of their traditional processes and the technological options for improvement in terms of process control and small-scale equipment. This must become a priority area for food engineering. IDRC is also supporting research groups in a number of developing countries in this area. Training should be adapted to provide for development of a group of engineers with orientation to traditional processes and/or small-scale process and process equipment development. The lack of competitive, i.e. low-cost, low-energy small-scale options in food processing, is one of the factors which has led to poor image and ineffectiveness of technology transfer to date. This approach will also be of benefit for developed countries.

Conclusions

The opportunities and challenges for food engineering/technology in improvement of food systems in developing countries may require at least:

a) An understanding of the particular food systems operating in the developing country situation.

b) A greater perception and analysis of the country/clients needs and constraints - a market led approach.

c) An orientation in training to include adaptive research based on existing principles, particularly for small-scale industrial conditions.

This will be achieved through a greater sharing of technological research and adaptation between developing country and developed country scientists in concert with colleagues with socio-economic skills. The emphasis must be in encouragement of research led by developing countries themselves.

The views expressed in this paper are those of the author and not necessarily of the International Development Research Centre.

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TECHNOLOGY TRANSFER LESSONS

1. DESPITE TT, POVERTY PERSISTS.
2. DC MUST SPECIFY SCOPE AND THRUST OF TT NEEDS.
3. TT OFTEN INAPPROPRIATE AND CREATING DEPENDENCE.
4. IMPORTED, CAPITAL INTENSIVE TECHNOLOGY, HAS CAUSED UNEMPLOYMENT.
5. IMPORTED PLANTS RUN AT EXCESS CAPACITY, EXPENSIVE.
6. OLDER TECHNOLOGY OFTEN APPROPRIATE, NOT ACCEPTABLE TO DC.
7. MORE ADAPTION OF TT REQUIRED TO LOCAL CONDITIONS.
8. IMPROVED NEGOTIATION SKILLS BY DCS REQUIRED IN TT.
9. ECONOMIC CRITERIA OF LIMITED VALUE IN ASSESSING FEASIBILITY.
10. LITTLE EXPERIENCE AVAILABLE OF SMALL-SCALE, LABOUR INTENSIVE TECHNOLOGIES FOR IT.
11. DC GOVERNMENT OFFICIALS NOT ALWAYS AWARE OF REAL NEEDS OF TARGET SITUATION.

"... NO SINGLE PATTERS OF TECHNOLOGY OR TECHNOLOGIES COULD BE CONSIDERED AS BEING APPROPRIATE, AND A BROAD SPECTRUM OF TECHNOLOGIES SHOULD BE EXAMINED AND APPLIED... THE SELECTION AND APPLICATION OF APPROPRIATE TECHNOLOGIES WOULD, THEREFORE, IMPLY THE USE OF BOTH LARGE-SCALE TECHNOLOGIES AND LOW-COST, SMALL-SCALE TECHNOLOGIES, DEPENDENT ON THE OBJECTIVES IN A GIVEN SET OF CIRCUMSTANCES."

CONCLUSIONS

A) AN UNDERSTANDING OF THE PARTICULAR FOOD SYSTEMS OPERATING IN THE DEVELOPING COUNTRY SITUATION.

B) A GREATER PERCEPTION AND ANALYSIS OF THE COUNTRY/CLIENTS NEEDS AND CONSTRAINTS - A MARKET LED APPROACH.

C) AN ORIENTATION IN TRAINING TO INCLUDE ADAPTIVE RESEARCH BASED ON EXISTING PRINCIPLES, PARTICULARLY FOR SMALL-SCALE INDUSTRIAL CONDITIONS.

TABLE 1. ECONOMIC INDICATORS

	TOTAL POPULATION (MILLIONS) MID-1982	WEIGHTED AVERAGE GNP PER CAPITA DOLLARS 1982	AVERAGE ANNUAL GROWTH RATE (PERCENT) 1960-82
DEVELOPING COUNTRIES			
LOW-INCOME (34 COUNTRIES)	2,266.5	280	3.0
CHINA AND INDIA	1,725.2	290	3.5
OTHER LOW-INCOME	541.3	250	1.1
LOWER MIDDLE-INCOME (37 COUNTRIES)	669.6	840	3.2
UPPER MIDDLE-INCOME (21 COUNTRIES)	488.7	2,490	4.1
DEVELOPED COUNTRIES			
INDUSTRIAL MARKET ECONOMIES (18 COUNTRIES)	722.9	11,070	3.3

REF. ABSTRACTED FROM WORLD BANK (1) COUNTRIES WITH POPULATION GREATER THAN 1 MILLION.

TABLE 2. URBAN POPULATION GROWTH

	PERCENTAGE URBAN POPULATION		
	1950	1980	2000
ALL DEVELOPING COUNTRIES	18.9	28.7	--
EXCLUDING CHINA	22.2	35.4	43.3
LOW-INCOME			
ASIA	10.7	19.5	31.3
CHINA	11.2	13.2	--
INDIA	16.8	23.3	35.5
AFRICA	5.7	19.2	34.9
MIDDLE-INCOME			
EAST ASIA AND PACIFIC	19.6	31.9	41.9
MIDDLE EAST AND NORTH AFRICA	27.7	46.8	59.9
SUB-SAHARAN AFARICA	33.7	49.4	55.2
LATIN AMERICA AND CARIBBEAN	41.4	65.3	75.4
SOUTHERN EUROPE	24.7	47.1	62.3
INDUSTRIAL COUNTRIES	61.3	77.0	83.7

REF. WORLD BANK, 1984 (1).

TABLE 3. CEREAL IMPORTS

	1974	1982
	(THOUSANDS OF METRIC TONS)	
DEVELOPING COUNTRIES		
LOW-INCOME ECONOMIES (TOTAL 34 COUNTRIES)	22,774	29,260
LOW-INCOME (EXCEPT CHINA AND INDIA)	8,337	6,493
CHINA	9,176	20,365
LOWER MIDDLE-INCOME (TOTAL 37 COUNTRIES)	16,901	27,423
EGYPT	3,877	6,703
PHILIPPINES	817	1,287
NIGERIA	389	2,280
PERU	637	1,524
UPPER MIDDLE-INCOME (TOTAL 21 COUNTRIES)	24,517	38,880
KOREA	2,679	5,538
BRASIL	2,485	4,492
DEVELOPED COUNTRIES		
HIGH-INCOME OIL EXPORTERS (TOTAL 5 COUNTRIES)	1,379	7,371
INDUSTRIAL MARKET ECONOMIES (TOTAL 18 COUNTRIES)	65,494	66,103

REF. ABSTRACTED FROM WORLD BANK, 1984 (1).

TABLE 4. CALORIE CUPPLY

	1969-71	1978-80
	PERCENT DAILY REQUIREMENTS	
DEVELOPING MARKET ECONOMIES	95.5	99.2
AFRICA	93.5	93.7
FAR EAST	92.8	95.7
LATIN AMERICA	105.8	108.9
NEAR EAST	97.2	111.0
OTHER	100.0	105.7
ASIAN CENTRALLY PLANNED ECONOMIES	90.7	104.3
TOTAL DEVELOPING COUNTRIES	93.9	100.9
LEAST DEVELOPED COUNTRIES	88.3	84.1
TOTAL DEVELOPED COUNTRIES	128.4	133.1
WORLD	104.8	109.8

REF. FAO, 1982 (2)

TABLE 5. PERCENTAGE POPULATION IN POVERTY IN LATIN AMERICA

	1970	1981
ARGENTINA	8	8
BRASIL	49	43
COLOMBIA	45	43
COSTA RICA	24	22
CHILE	17	16
HONDURAS	65	64
MEXICO	34	29
PANAMA	39	37
PERU	50	49
VENEZUELA	25	24
LATIN AMERICA (10 COUNTRIES)	39	35

POPULATION WITH FAMILY INCOME LESS THAN TWICE BASIC FOOD BASKET COST. REF. UN-ECLA. 1982 (3)

TABLE 6. CONTRIBUTION OF FOOD SECTOR TO TOTAL MANUFACTURING INDUSTRY (MOST RECENT YEAR, PERCENTAGE)

	NO. OF EMPLOYEES	NO. OF ESTABLISHMENTS	GROSS OUTPUT
DEVELOPING COUNTRIES			
LOW-INCOME (11 COUNTRIES)-AVERAGE	17	22	20
INDIA	18	19	17
KENYA	25	21	32
HAITI	24	31	-
ETHIOPIA	20	30	26
LOWER MIDDLE-INCOME (18 COUNTRIES)-AVERGAE	22	23	26
PHILIPPINES	21	35	24
GUATEMALA	27	26	34
ZIMBABWE	15	NA	23
ECUADOR	28	23	37
UPPER MIDDLE-INCOME (9 COUNTRIES)-AVERAGE	16	19	20
CHILE	19	21	18
SINGAPORE	4	8	5
SYRIA	18	19	25
PANAMA			
DEVELOPED COUNTRIES			
CANADA	11	12	15

REF. DERIVED FROM UN, 1983 (5)

TABLE 7. INDEX CHANGES IN OUTPUT AND EMPLOYMENT IN FOOD INDUSTRY (1975 = 100)

	FOOD/BEVERAGE/TOBACCO		ALL INDUSTRIAL SECTORS	
	1971	1981	1971	1981
OUTPUT				
DEVELOPING COUNTRIES	83	145	82	122
LATIN AMERICA AND CARIBBEAN	83	140	79	132
ASIA	84	148	82	113
DEVELOPED COUNTRIES - EEC	92	115	94	115
WORLD	86	122	86	125
EMPLOYMENT				
DEVELOPING COUNTRIES	77	125	77	121
LATIN AMERICA AND CARIBBEAN	77	114	76	114
ASIA	77	129	77	124
DEVELOPED COUNTRIES - EEC	105	98	105	91
WORLD	89	113	92	108

REF. ABSTRACTED FROM UN, 1983 (5)

TABLE 8. CONTRIBUTION OF FOOD SECTOR TO TOTAL MANUFACTURING INDUSTRY IN ANDEAN PACT COUNTRIES (1981, IN PERCENT)

	NO. OF EMPLOYEES	NO. OF ESTABLISHMENTS	GROSS OUTPUT	MAJOR PRODUCT GROUPS
BOLIVIA	23	17	35	SUGAR MILLING BREWING
COLOMBIA	15	13	31	MILLING SUGAR BREWING
ECUADOR	26	29	35	FISH MILLING SUGAR DISTILLING
PERU	21	13	29	FISH OILS AND FATS BREWING DISTILLING
VENEZUELA	13	7	23	BREWING DAIRY FRUITS/VEG.

REF. DERIVED FROM ANDEAN PACT STUDY, 1984 (6)

TABLE 9. SCALE OF FOOD INDUSTRY IN SELECTED DEVELOPING COUNTRIES

	PERCENTAGE NUMBER OF ESTABLISHMENTS IN EACH SIZE CATEGORY			
	COTTAGE	SMALL	MEDIUM	LARGE
MEXICO (A)	66.9	31.1	1.6	0.4
COSTA RICA (A)	45.7	37.8	11.3	5.2
NUMBER OF EMPLOYEES	(1-4)	(5-25)	(26-100)	(100+)
CHILE (B)	50.5	44.8	4.6	
BAKERY PRODUCTS	(25.6)	(27.4)	(0.5)	
NUMBER OF EMPLOYEES	(1-4)	(5-49)	(49+)	
PHILIPPINES (B)	79.0	18.8	1.5	0.6
NUMBER OF EMPLOYEES	(1-4)	(5-19)	(20-99)	(100+)

MALAYSIA (PENINSULAR) (B) PERCENTAGE NUMBER OF EMPLOYEES IN EACH INDUSTRY TYPE	(5-49 EMPLOYEES)	(50+ EMPLOYEES)
RICE MILLS (117 PLANTS)	81.0%	17.6
COCONUT OIL (69 PLANTS)	80.0%	17.5
PALM KERNEL OIL (97 PLANTS)	61.5%	38.5
BAKERY PRODUCTS (126 PLANTS)	85.2%	14.8

(A) CITA (8)
(B) ADAPTED FROM IDRC, 1984 (7)

TABLE 10. GRADUATES PER MILLION POPULATION OF SELECTED DEVELOPING COUNTRIES

		ARTS/SOCIAL SCIENCES	NATURAL SCIENCES	ENGINEERING	AGR./FOR./ FISHERIES
SOUTH EAST ASIA	69/70	650	181	218	91
(4 COUNTRIES)	79/80	1.400	267	723	141
SOUTH ASIA	69/70	489	156	28	15
(4 COUNTRIES)	79/80	1.101	238	36	17
EAST AFRICA	69/70	32	8	4	4
(9 COUNTRIES)	79/80	62	16	6	16
WEST AFRICA	69/70	56	14	5	5
(9 COUNTRIES)	79/80	170	38	11	11
MIDDLE EAST	69/70	343	104	85	43
(9 COUNTRIES)	69/80	691	174	125	76
LATIN AMERICA	69/70	164	77	63	21
(15 COUNTRIES)	79/80	672	227	176	71
CANADA	69/70	2.456	414	245	188
	79/80	3.069	493	355	261

REF. ADAPTED FROM HULSE, 1984 (9)