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In this issue

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AIMS AND SCOPE OF *INDUSTRY AND DEVELOPMENT*

Industry and Development attempts to provide a link between practitioners and theorists working on economic and related aspects of industrialization. The focus of the journal is on applied economics, particularly in areas emphasized in the Lima Declaration and Plan of Action on Industrial Development and Co-operation.

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The Supervisory Panel of *Industry and Development* welcomes readers' opinions and comments, and will be glad to consider for possible publication articles relevant to the aims and scope of the journal (see "information for contributors").

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Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

In tables:

Totals may not add precisely because of rounding.

A hyphen indicates that the item is not applicable.

An em dash (—) indicates that the amount is nil or negligible.

Two dots (..) indicate that data are not available or are not separately listed.

The following abbreviations are used in this publication:

AFIS	agro-food industrial system
APR	accounting price ratio
EEC	European Economic Community
FAO	Food and Agriculture Organization of the United Nations
GCC	Gulf Co-operation Council
GDP	gross domestic product
HDPE	high-density polyethelene
LDPE	low-density polyethelene
MEPS	methodology for assessing and programming industrial systems
MWR	market wage rate
OECD	Organisation for Economic Co-operation and Development
PVC	polyvinyl chloride
SABIC	Saudi Basic Industries Corporation
SACU	Southern African Customs Union
SIO	semi-input-output
SWR	shadow wage rate
TISTR	Thailand Institute of Scientific and Technological Research

AGRO-FOOD INDUSTRY IN LATIN AMERICA

Teresa Salazar de Buckle, William Holaday and Guillermo Castella*

Introduction

The Latin American agro-food industry represents 3.7 per cent of total gross domestic product (GDP) and 14.8 per cent of the GDP generated by the manufacturing sector, making agro-food industries in 1987 the most important single manufacturing branch in terms of value added. Between 1984 and 1987 the average growth rate for agro-industry in Latin America was 3.7 per cent per year, while that for the manufacturing sector as a whole was 3.3 per cent.**

Agro-food industries have the potential of playing an important role in the transformation of agriculture in developing countries, a role equivalent to the one they have played in developed countries, where agro-food industries have promoted increases in productivity, diversification and standardization of agriculture and increasing integration between agriculture and industry. They can also play important roles in exports and in meeting the demand for higher value-added products as a response to economic growth [1].

In this paper, the concept of an "agro-food industrial system" (AFIS) is used as a basis for the discussion of Latin American agro-food activities. AFIS is defined as a system comprising agricultural, industrial, trade and consumption components and the linkages between them, as well as the institutions and policies that affect the operation of the system. The system concept is best illustrated by figure VII of this paper, which shows the production and consumption components of an agro-industrial system.

Implicit in the system approach is the concept of integrated development, which recognizes that any change in one component of the system tends to modify the entire system, in different ways and magnitudes. Therefore, the development of the system should be approached in an integrated manner, that is, as a whole and not only as individual components.

The food security concept used throughout the paper refers to an "extended food security concept", defined as the combination of

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*United Nations Industrial Development Organization. The authors would like to express their thanks to Karl Gödert for his critical review of and valuable suggestions for this article.

**Based on UNIDO consolidated industrial statistics data, using average values between 1984 and 1987 for 17 countries in Latin America and the Caribbean.

actions permitting the protection of countries against risks of food shortages and enabling them to satisfy the food and nutritional requirements of the population by improvements in production, productivity, technology, establishment of reserves, marketing and food consumption. Thus five interrelated aspects are included: supply, demand, risk, nutritional goals and orientation toward the poorest population groups.

The analysis of the Latin American agro-food industrial system includes a discussion of the agriculture, processing industry, demand and trade components of the system. The mechanisms available for transfer of technology are also discussed, together with the role played by the transnational corporations in technology transfer and in the development of the system.

The results of the analysis indicate a low level of integration between agricultural production, food processing and internal demand, a predominance of primary processing for domestic mass markets that is not linked with the secondary and tertiary processing for export and high-income markets, and a high degree of geographical concentration of the food manufacturing industry in three countries of the region (Argentina, Brazil and Mexico). Further findings show the heterogeneity in size of enterprises in the processing sector and a high participation of transnational corporations in different components of the system (for example, 80 per cent of the subsidiaries of United States transnational corporations in the sector are concentrated in Latin America). Further development of AFIS is restricted by the present international food trade crisis and by the lack of effective demand by large segments of the population, where malnutrition and poverty prevail.

The paper proposes a study of the feasibility of promoting an agricultural-employment-technology development strategy, which could simultaneously create effective internal demand and promote trade diversification through South-South co-operation both within and outside the region. Technology needs for AFIS and the types of foods to be promoted should be determined on the basis of an analysis of demand within an extended food security concept.

Two issues that are not explicitly discussed in this paper, but which are relevant to the problem of ensuring food security, are land distribution and tenure practices and rural development, such development being essential to slow migration from the countryside to urban areas. The assessment of AFIS and the programming of development within the strategy proposed would also have to take those issues into account.

A. The Latin American agro-food industrial system

1. Agricultural production

An analysis of the Latin American agro-food industrial system, in which the food-processing industries operate, has shown that there is often a relatively low degree of integration between agricultural production and processing in the countries of the region.

In countries such as Colombia and other members of the Andean Pact,* the agro-food industries, with the exception of the sugar and oil-palm industries, have been developed in urban areas, with only an indirect contact with the agricultural production sector through conventional marketing mechanisms (internal and external) [2]. In this and other subregions of Latin America, most staple food production has not been transformed by modern agricultural technology. This is reflected in an increased dependence on imported raw materials for food-processing, as has been observed in the Andean Pact countries, Central America, Brazil and Mexico. The coefficient of dependency on imported cereals for those countries increased during the period from 1959 to 1986, as illustrated in table 1. The striking increase in dependency coefficients observed during the 1980s coincides with very high production and export growth rates in the countries of the Organisation for Economic Co-operation and Development (OECD), leading to lower international prices. Those prices among other factors discourage the introduction of technical change in the agricultural sector of the Latin American countries.

Table 1. Coefficients of cereal dependency in Latin American countries a/
(Percentage)

Country or area	1959-1961	1969-1971	1978-1980	1984	1985	1986
Brazil	11.8	8.6	18.0	61.8	57.4	61.6
Mexico	0.1	2.3	19.9	71.1	72.9	53.1
Andean Pact and other South American countries b/	22.1	28.3	36.4	84.0	83.5	81.5
Central America c/	12.6	13.3	19.5	69.6	69.3	71.7

Source: Data base of the Food and Agriculture Organization of the United Nations.

a/ Coefficients show the percentage of imported cereals in total consumption (internal production plus imported cereals).

b/ Including Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru and Venezuela.

c/ Including Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama.

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*The five Andean Pact countries are Bolivia, Colombia, Ecuador, Peru and Venezuela.

It is misleading to consider all of Latin America as a homogeneous region with respect to the agricultural component of AFIS, since there are large disparities in growth among the three main subregions,* as shown in table 2.

Central and Lower South America showed healthy growth indices in both decades. Upper South America suffered stagnation in yields and, as a result, greater reliance on the expansion of cultivated areas for its increases in food output ([3], [4]).

According to estimates of the Food and Agriculture Organization of the United Nations, the projected growth rate in agricultural production for the entire region from 1985 to 2000 will be 2.6 per cent per year, which is lower than the rate for the past 15 years. This is due to a variety of factors, including, among others, slower rates of population growth (down from 2.4 to 2 per cent), persistence of unfavourable economic conditions, greater dependency on growth of domestic demand and slow growth of agricultural exports [5].

2. Food processing

The industrial processing component of AFIS is heterogeneous in terms of size of enterprises, levels of processing and markets served. Large firms coexist with small- and medium-scale enterprises. There is a predominance of primary processing for the domestic low-income markets, and of secondary and tertiary processing for export and high-income markets.**

The most important characteristic of this component at the regional level is the high degree of concentration of industrial food processing in Latin America. In 1985, over 70 per cent of the gross value of production was provided by three countries, namely Argentina, Brazil and Mexico.*** Moreover, high indices of

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*In table 2, Central America also includes Mexico and the Caribbean countries, that is, it comprises Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama and Trinidad and Tobago. Upper South America comprises Bolivia, Brazil, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname and Venezuela. Lower South America comprises Argentina, Chile and Uruguay.

**Primary processing includes milk, meat, sugar, flour, oils and fats, and corn and oil products for animal feeding. Secondary processing includes bread, pastas, meat products, animal feedstuff, chocolate and sugar confectionery, dairy products, fruit and vegetable juices and preserves. Tertiary processing includes frozen products, biscuits, snacks, highly processed dairy products, baby foods, pet foods, soups, breakfast cereals, soft drinks, powdered coffee, beer and food ingredients (see [6]).

***Those three countries also have the highest shares of total value added in the region. Their population represents 38 per cent of the total population of Latin America.

Table 2. Average annual growth rates in Latin America as compared with all developing countries
(Percentage per annum)

Region or country grouping	1962-1972 growth rates			1972-1982 growth rates		
	Production	Area harvested	Output per hectare	Production	Area harvested	Output per hectare
Developing countries	2.97	1.29	1.66	2.88	0.84	2.03
Latin America	4.18	2.64	1.50	2.85	1.04	1.78
Central America	5.23	1.70	3.48	4.05	0.14	3.91
Upper South America	4.40	3.66	0.71	2.19	1.80	0.38
Lower South America	2.95	1.73	1.20	2.91	0.28	2.62

Source: L. A. Paulino and J. W. Mellor, "The food situation in developing countries - two decades in review", Food Policy, vol. 9, No. 4 (November 1984), pp. 291-303.

concentration are also seen in some individual countries of the region, as shown for Mexico in table 3. In Mexico, high indices of concentration coincide with high levels of participation by transnational corporations in food processing (for example, cereal flours, milk, chocolate and sugar confectionery). For Colombia, a country that is representative of the Andean Pact subregion, the relative importance of the different processing activities is given in terms of percentages of the total number of enterprises and contribution to value added. In that country, as reflected in table 4, a relatively high degree of concentration is found in primary processing (cereals, fats and oils and sugar) and in milk and bakery and biscuits [2].

Table 3. Selected indices of the food-processing industries in Mexico, 1975

Industry	Participation of transnational corporations (percentage)	Concentration index a/
Cereal flours (1)	70	85
Fats and oils (1)	14	22
Sugar (1)	..	..
Milk and milk products (1) and (2)	97 - 23	63
Animal feedstuff (2)	52	23
Meat and meat products (1) and (2)	..	..
Bakery and biscuits (2) and (3)	25	61
Chocolate and sugar confectionery (2)	63	86
Fruits and vegetable preserves (2)	31	05

Source: R. Ramirez, De la Improvisación al Fracaso - La Política de la Inversión Extranjera en Mexico (Mexico City, Centro de Ecodesarrollo, 1983).

Note: (1), (2) and (3) refer to primary, secondary and tertiary levels of processing, as defined in a footnote to the text of this article.

a/ Defined as the proportion of the total production supplied by the four largest enterprises.

Table 3. Selected indices of the food-processing industries in Colombia, 1983

Industry	Number of enterprises	Value added of the food-processing industries (percentage)
Cereal flours (1)	27	17
Fats and oils (1)	3	15
Sugar (1)	4	18
Milk and milk products (1) and (2)	8	9
Animal feedstuff (2)	5	5
Meat and meat products (1) and (2)	6	6
Bakery and biscuits (2) and (3)	28	11
Chocolate and sugar confectionery (2)	4	7
Fruits and vegetable preserves (2)	1	2
Others		10
Total		100

Source: A. Machado, El Problema Alimentario de Colombia (Bogota, Universidad Nacional de Colombia, 1986).

Note: (1), (2) and (3) refer to primary, secondary and tertiary levels of processing, as defined in a footnote to the text of this article.

The distribution seen in Colombia is representative of the food-processing activity of middle-income countries in Latin America. In those countries, the small- and medium-scale food-processing industries expanded during the 1970s and seem to have been more dynamic than large-scale industry. Rapid growth of demand has been identified as a prerequisite of dynamism in small- and medium-scale industries, as well as policies that provided access to credit imports, vocational training and technical assistance [7].

Among the upper-middle-income countries such as Brazil and Mexico, a structural dualism is found in the processing components of the AFIS. Two different types of production coexist: food for the high-income markets (with a high degree of processing) and food for the low-income markets (with emphasis on local staples). As a result, although the food industries in those countries have been able to expand in all stages of transformation in a fashion similar to the model provided by the developed Western countries [6], they have not been able to solve the problems of malnutrition and food security for the majority of the population.

Brazil, for example, from a traditional exporter of cocoa, coffee and sugar, has become one of the leading world exporters of soya beans and soya bean oil, meat, poultry and orange juice. However, Brazil is still a country with food problems, with famines in the North-East and an undernourished urban population. The reasons for this paradoxical situation are not easily identified. It is not only the presence of transnational corporations in the areas of agro-industrial production, processing and marketing. It is also a question of unequal distribution of and access to income, land and food [8].

3. Demand

It has been recognized that the slow growth of effective economic demand will be the main constraint to development of the world food system [9]. The validity of this statement in the Latin American context is illustrated in the following analysis.

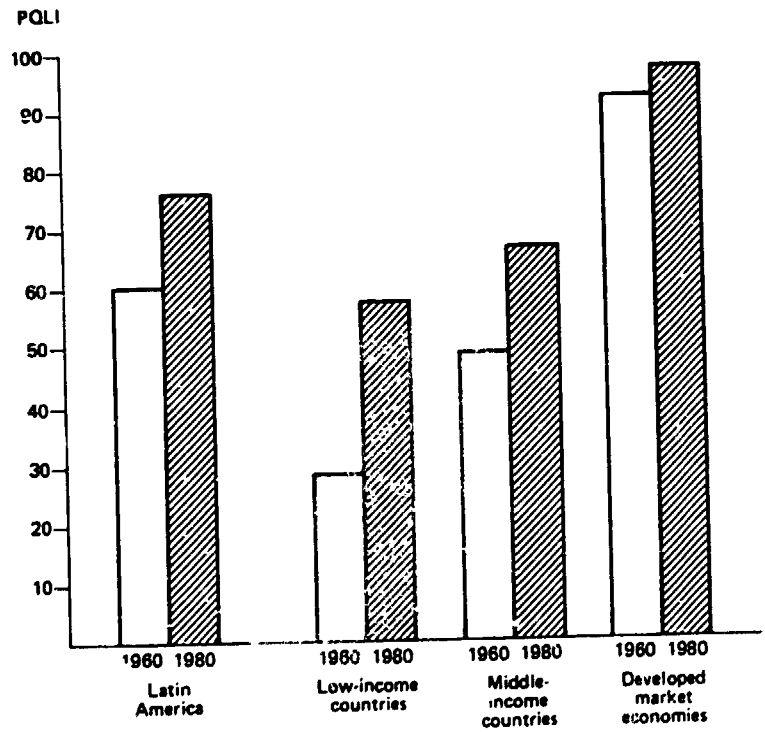
Inadequate mass market purchasing power (poverty) has been identified as the main factor restricting the growth of effective demand for food in Latin America and the maintenance of adequate nutritional levels in the population [5]. FAO has estimated a rate of growth in demand for food of 0.7 per cent per year between 1985 and 2000, equal to the one recorded between 1961 and 1985. That rate of growth, which is much less than the population growth rate, is far too low in view of the large segment of the population with low nutritional levels in the region [5].

Figure I shows how Latin America maintained levels of well-being much higher than those typical of other middle-income developing countries during the period from 1960 to 1980 [10]. However, despite the fact that substantial gains in meeting basic needs for physical well-being had been obtained in Latin America during that period, 13 per cent of the population still had a diet that did not provide enough calories for an active working life in 1980 [11]. Deteriorating economic conditions prevailing in the early 1980s may have increased the malnourished proportion of the population from 1980 to 1985.

Traditional approaches to food security, which have focussed on ensuring adequate supplies of food, have not succeeded in eliminating malnutrition, which must be seen as primarily a problem of lack of effective demand, or purchasing power, among the affected (low-income) population groups.

The impact of a positive evolution of income distribution on the improvement of energy consumption (calories per capita per day) in the different socio-economic groups is illustrated by the case of Colombia between 1972 and 1981. Figure II illustrates the changes that occurred in income distribution during the period and table 4 shows the parallel improvement in per capita energy consumption throughout the population. The analysis of this case showed that food insecurity decreased at the national level during

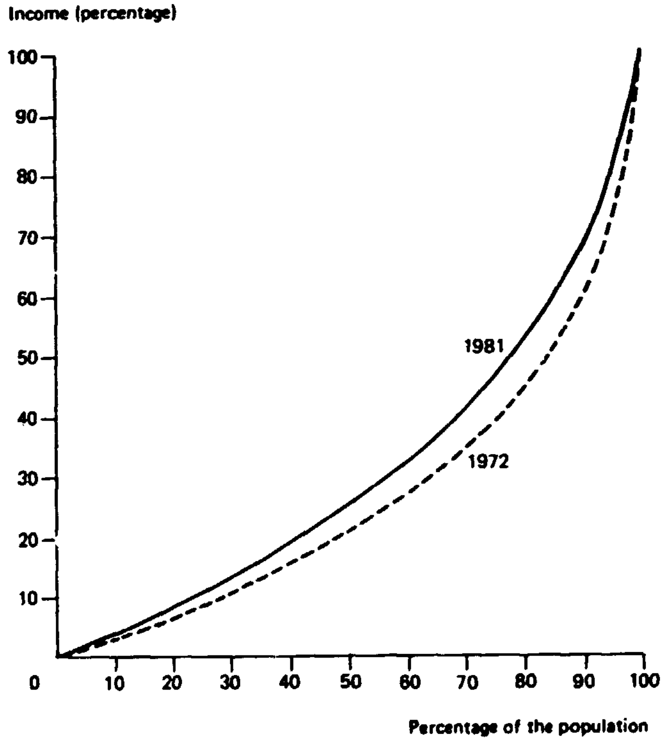
Figure 1. Physical quality of life index, 1960 and 1980: Latin America and other country groups



<u>Source</u>: W. J. Dixon, "Progress in the provision of basic human needs. Latin America, 1960-1980", <u>The Journal of Developing Areas</u>, vol. 21, No. 2 (January 1987), pp. 129-140.

<u>Note</u>: PQLI is an unweighted composite of the following social indicators, which are described by the Overseas Development Council in its Communiqué No. 4 (Washington, D.C., 1979): infant mortality; life expectancy at age one; and literacy.

Figure II. Income distribution in Colombia, 1972 and 1981



Source: T. Uribe Mosquera, "Revaluación de la inseguridad alimentaria en Colombia", Coyuntura económica, vol. XVII, No. 1 (April 1987), p. 161.

that period. While in 1972, 40 per cent of the population with the lowest income had been affected by food insecurity, in 1981 the figure was only 20 per cent. The analysis also revealed that food insecurity had become concentrated in the urban rather than in the rural population; in 1981, 60 per cent of food insecurity was found in urban areas, while in 1972 it had been only 30 per cent [12].

Table 4. Calorie consumption and income distribution in Colombia, 1972 and 1981

Income group by population decile	1972		1981	
	Annual per capita income (10^3 1970 pesos)	Calories per capita per day	Annual per capita income (10^3 1970 pesos)	Calories per capita per day
X	42.2	3 325	50.3	3 128
IX	20.0	3 045	28.9	3 076
VIII	13.8	2 810	17.9	2 888
VII	9.3	2 577	14.2	2 806
VI	7.1	2 441	12.9	2 775
V	5.3	2 292	8.8	2 629
IV	3.8	2 116	7.6	2 502
III	2.9	1 974	5.7	2 304
II	2.0	1 796	3.8	2 046
I	1.3	1 530	2.6	1 747

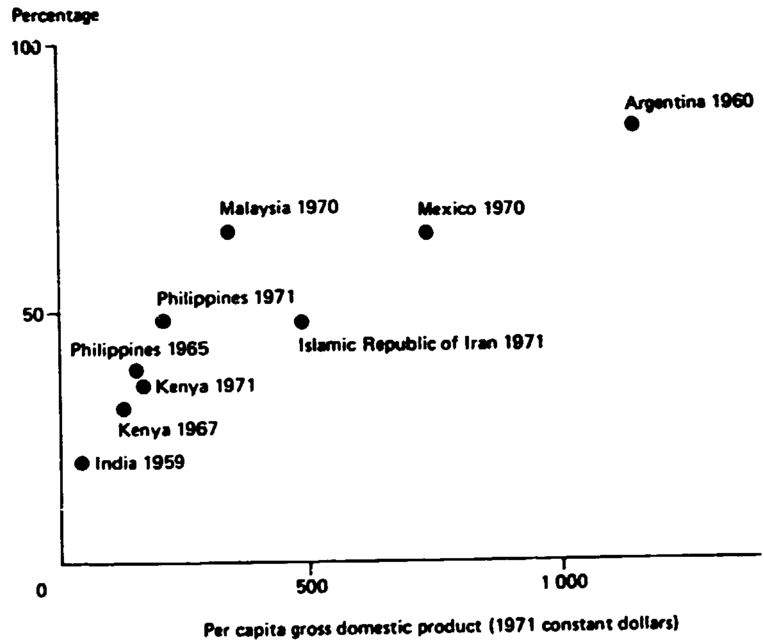
Source: T. Uribe, "Revaluación de la seguridad alimentaria en Colombia", Coyuntura Económica, vol. XVII, No. 1 (April 1987), pp. 157-193.

The study also showed that the resources needed to fill the food energy gap in 1981 would be equivalent to 386,000 tonnes of cereals, and stressed the importance of investments in technology to maintain adequate levels of food availability and prices and to secure adequate levels of food security [12]. The Colombian developments recorded between 1972 and 1981 may be taken as a reflection of developments in other Latin American countries as well as guidelines for national policy-making.

The urban poor, as non-food producers, depend more than the rural poor on the distribution through time of earnings, on the one hand, and on food availability and prices, on the other, to secure acceptable levels of food consumption [13]. Hence, the urgent need to reduce food insecurity among the growing Latin American urban population, which in the year 2000 is expected to represent more than 420 million or 76.6 per cent of the total population of Latin America [5].

Another important factor to consider in improving food security is the potential role of processed foods. The consumption of

Figure III. Percentage of processed food in total food consumption



<u>Sources</u>: "Technological choice and transfer in food processing in developing countries: an overview", in C. Baron, <u>Technology, Employment and Basic Needs in Food Processing in Developing Countries</u> (Oxford, Pergamon Press, 1980), p. 19; GDP figures come from the <u>Yearbook of National Accounts Statistics 1973</u>, vol. III (United Nations publication, Sales No. E.75.XVII.2).

processed foods with respect to total food consumption varies with income, as illustrated by figure III, in which two of the three important food-processing countries in Latin America are included, Argentina and Mexico.*

Table 5 presents a summary of demand forecasts made for three economic regions of the world in the 1980s [4]. In developed countries demand is levelling off because of low rates of population growth and apparent saturation of demand, while in developing countries income growth and urbanization will increase the demand for food in general and for processed food products at the primary stages of industrialization in particular. Rising productivity of time spent on food preparation and nurturing activities would also increase the demand for adequate processed foods in low-income households.

Table 5. Patterns of consumption forecast for three economic groupings in the 1980s

OECD countries a/	CMEA countries a/	Developing countries b/
Income no longer a constraint to calorie consumption Increase in consumption of meat products and alcohol Quality of food derived from convenience, variety, novelty and nutritional value Food products to cater to specific customer requirements without price restrictions and increased consumption in restaurants	Overall per capita decrease in consumption of cereal and potatoes No increase in sugar consumption Replacement of fat by vegetable oil in the diet Increased consumption of improved quality meat and milk products, eggs, fruit and vegetables Increased consumption of processed food products	Income growth and urbanization resulting in increasing shares of total processing of agro-food staples (3 per cent per year), vegetable oils, fruits and sugar (5 per cent per year) The higher the productivity in food production and nurturing activities, the higher the demand for processed food in low-income households c/ In low-income countries ($250 per year) sales of processed foods to remain at possibly one tenth the level of

continued

*Although no more recent data is available to the authors, the figure is used to illustrate the relationship between higher income and greater consumption of processed foods, which is assumed to be similar throughout Latin America to the other developing countries shown.

Table 5 (continued)

OECD countries a/	CMEA countries a/	Developing countries b/
Growing interest in the diet, reduction in fat intake from dairy products (25-50 per cent) and production of leaner carcasses e/		middle-income countries ($1,000 per year) d/

a/ Forecasts for OECD countries and countries belonging to the Council for Mutual Economic Assistance (CMEA) in "Agro-food industrial development in Latin America", Sectoral Studies Series No. 25 (UNIDO/IS.623), p. 24.

b/ Forecasts for developing countries in "Marketing issues for food processing in LDCs", Food Policy, vol. 6, No. 4 (November 1981), pp. 270-274.

c/ D. L. Franklin and M. W. Harrell, "Resource allocation decisions in low-income rural households", Food Policy, vol. 10, No. 2 (May 1985), pp. 100-108.

d/ Industry in a changing world (UNIDO publication, Sales No. E.83.II.B.6), chap. I.

e/ P. S. Gray, "New technology and the food and drink industries and its interaction with agricultural policies", paper presented to the Second National Conference and Exhibition of the Food and Drink Industries, Bristol, England, 26-28 November 1984.

It is important to note that the forecasts for OECD countries are also applicable to high-income groups in Latin American countries, as a result of the trend towards "westernization" of food consumption patterns.

4. Food aid

The long-term solution to the problems of malnutrition must be found in the creation of effective demand, and not only in food aid programmes. Many analyses of these programmes have concluded that food aid programmes based on donated foods, outside their very important role in famine and disaster, have deleterious effects on local agricultural development, are economically too expensive for the recipient countries and in the long term are an obstacle to the creation of a self-supporting agrarian sector [10].

Moreover, food aid programmes can act as an instrument for opening up markets in developing countries for the surplus agricultural production of developed countries, and, as a consequence, contribute to increasing levels of food dependence in developing countries. The effect of introducing United States grain in the form of food aid on the creation of markets for such grain in two Latin American and two Asian developing countries is illustrated in figure IV.

Food distribution programmes, however, may be required in the first stages of implementation of food security schemes. In those programmes the potential replacement of donated foods by food produced and distributed by the local agro-food processing industry exists, as shown for one Andean Pact country in table 6, below.

Table 6. Comparison of total costs to the Government per unit of food delivered for two food distribution programmes in Colombia, 1979

Item	Conventional food aid programme a/	National coupon programme b/
Food cost (dollars per tonne)	636.6	603.6
Cost of calories (dollars per thousand)	0.18	0.18
Cost of protein (dollars per kilogram)	3.58	3.63

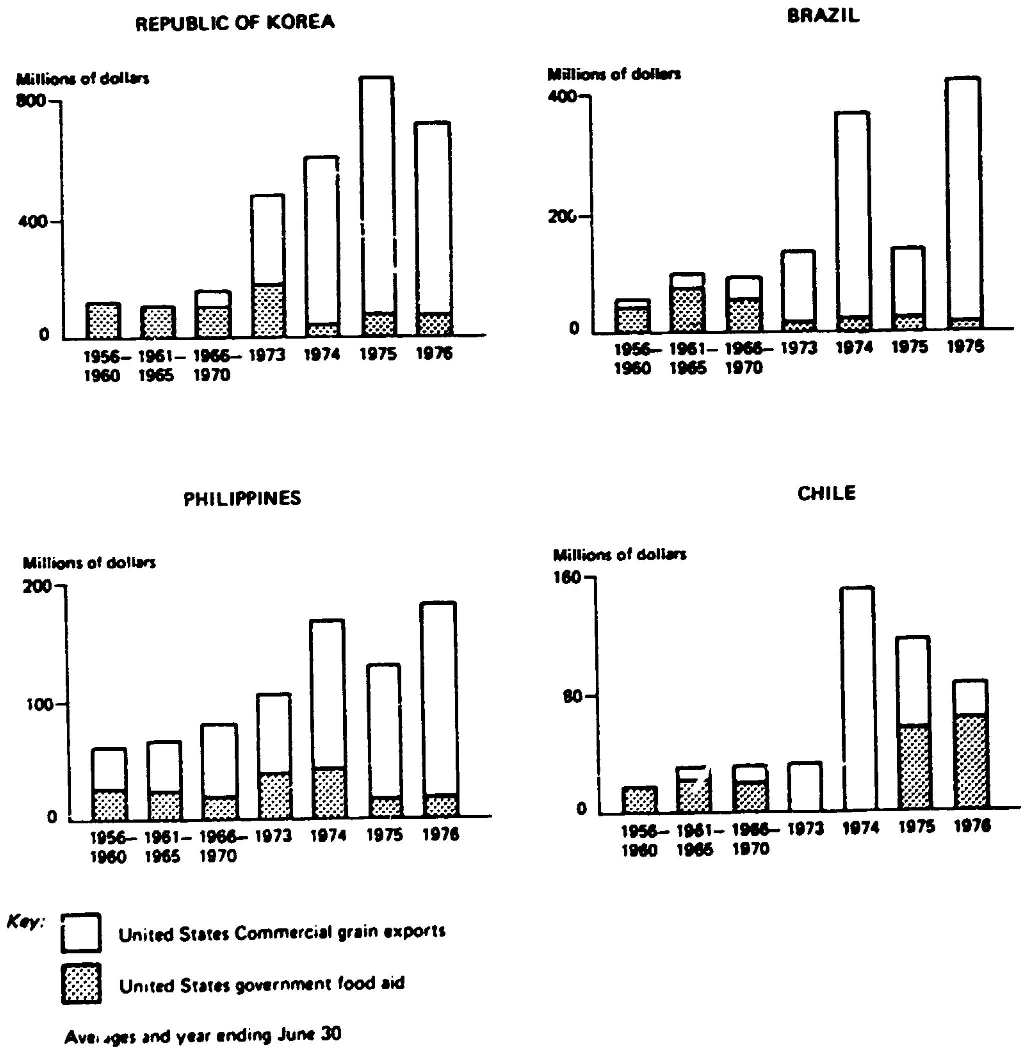
Source: "Análasis comparativo de los programas de complementación alimentaria al grupo materno infantil en la subregión andina", in Memorias del Primer Seminario Taller sobre Programas de Complementación Alimentaria del Grupo Materno Infantil de la Subregión Andina, Bogota, Colombia, 1-5 December 1980 (Lima, Junta del Acuerdo de Cartagena, 1981), pp. 170-172.

a/ Planned cost.

b/ Actual cost.

The costs to the Government of the developing country of delivering foods to the beneficiaries of the two food distribution programmes compared were very similar, in spite of the fact that in the conventional food aid programme the foods had been donated and the cost components of that programme were only administrative, storage, handling and distribution costs. In the coupon programme the cost components were the cost of the coupons (a direct subsidy to the consumer by the Government), equivalont to 60 per cent of the purchasing price of the foods, and some minor programme administrative costs. Moreover, the foods were produced and distributed

Figure IV. United States food aid and commercial grain exports to selected developing countries, 1956-1976



Source: P. Rieder and U. Eggar, "International agricultural markets and malnutrition in the third world", Food Reviews International, vol. 3, Nos. 1 and 2 (1987).

by the local industry without subsidies and using locally produced raw materials. This example illustrates not only the possibility of gradually replacing donated foods by locally produced ones, but that it is possible to integrate food distribution programmes into the local agro-food industrial system. This experimental evidence seems to contradict a widespread belief that nutritionally oriented food distribution programmes will always have to depend on donated foods because of the much higher costs of local foods.

5. Trade

World trade in agricultural and agro-industrial products has become a weaker and more uncertain growth factor. For Latin American countries the implications of such a trend are serious, since trade in agricultural and agro-industrial products represents an important proportion of total Latin American exports, and high rates of agricultural growth have often been associated with export growth. In 1985 the volume of world agricultural trade was only 8 per cent greater than that of 1980, while it had increased by 30 per cent between 1975 and 1980. Those figures are a reflection of the agricultural crisis that affects developed countries, characterized by surplus production at previously unknown levels. The surpluses have further depressed international prices, already affected by the international economic recession [5]. Table 7 illustrates the decrease in real prices of primary products between 1976 and 1986.* Such a situation results from the high levels of agricultural protection prevailing in both the United States and the countries of the European Economic Community (EEC).

Table 7. Real prices of primary products, 1976-1986

Product	1976	1980	1984	1986
Food	100	116	70	56
Tropical beverages	125	98	107	100
Vegetable oil-seeds and oils	101	91	130	75
All food	112	105	93	75

Source: United Nations Conference on Trade and Development, *Monthly Commodity Price Bulletin*, various issues.

One of the main reasons for excess agricultural production has been the continuous increase in yields, a result of technological progress in developed countries, while in developing countries the "green revolution" with its impressive results was followed by a

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*Among the main categories, prices of tropical beverages suffered the least, although they were below their 1976 peak.

transfer of technological innovations developed elsewhere. Mellor suggests that one reason for this was that the dynamics of agricultural growth, calling for gradual diversification from cereals to pulses and perishable crops, were not sufficiently understood, and research and extension in new crops did not receive enough impetus [14].

Insufficient intra-regional trade is another characteristic of Latin America. FAO has estimated that self-sufficiency could be established in the region if regional exporters would cover regional deficits. This can be illustrated by the case of wheat: net importers annually receive 12 million tonnes, and other countries in the region export 9 million tonnes to markets outside the region [5].

The promotion of agricultural and agro-industrial regional trade should be facilitated by existing agreements and trade mechanisms of the Asociación Latinoamericana de Integración, the subregional common markets and the recent commercial agreement between Argentina and Brazil with the participation of Uruguay. Simulations made by UNIDO and the Andean Pact secretariat have shown the advantages for the North and the South that increasing South-South trade would produce ([15], [16]).

6. Technology

The transfer of technology to the Latin American agro-food industrial system has been promoted both by the activities of transnational corporations and by indigenous efforts. For the last 20 years, regional technological research and development co-operative efforts have been made under the sponsorship of EEC, the International Development Research Centre, the Organization of American States and other agencies. Through those efforts, addressed at improving processing techniques and product quality, a large number of technical personnel has been trained for industries and for research institutes, centres of excellence have been promoted in many countries of the region and horizontal co-operation has been greatly developed. It could be said that for cereals and vegetable proteins, as well as in the processing of tropical fruits, a regional approach to problem-solving has been established. An interesting subregional co-operative effort oriented to the transfer of technology and the development of food industries to serve low-income mass markets was co-sponsored by the EEC and the Andean Pact countries under the co-ordination of the Andean Pact secretariat between 1979 and 1983. As a result of that effort, technology has been adapted, sometimes developed, and in most cases transferred to the local industry [17].

However, a large part of the transfer of technology in the region takes place through the activities of transnational corporations, which are more active in Latin America than in any developing region of the World (80 per cent of the subsidiaries of United States transnational corporations in agro-food industries are located in Latin America) [18].

Although in the past transnational corporations have been active in the production and commercialization of raw materials, there is a trend for transnational corporations to concentrate in activities with high value added. In processing activities that trend is translated into a concentration of production for high-income markets and very little investment in products for the mass markets [18]. Nevertheless, the introduction of the marketing and product diversification techniques of transnational corporations has contributed to changes in consumption patterns at all socio-economic levels. Furthermore, the transnational corporations have transferred very effective systems of quality control and monitoring throughout the production and marketing process.

Agro-food processing industries employ a relatively low level of technological intensity when measured by the share of scientists and engineers in total employment and by the proportion of investment in research and development with respect to total assets, as illustrated in table 8, which shows those relations for several industrial branches in the United States.

Table 8. Technology-related characteristics of different manufacturing industries in the United States

Manufacturing industry	Scientists and engineers as percentage of total employment	Investment in research and development as percentage of total investment
Food	3	0.8
Electronics	8	..
Chemicals	12	3.0
Machinery and equipment	..	4.1

Source: R. Ramirez, De la Improvisación al Fracaso - la Política de la Inversión Extranjera en México (Mexico City, Centro de Ecodesarrollo, 1983), p. 138.

Transnational corporations in the agro-food processing sector have from 6 to 10 per cent of their total assets invested in publicity and marketing techniques, because they have based their leadership on brand names, marketing and product differentiation techniques. Hence, a large proportion of the technology transferred by the transnational corporations to the food systems of developing countries is related to marketing, advertising and promotion strategies* [18].

Until recently, a specific role has never been assigned to the food-processing industry in food security programmes. Within the Andean Pact food security scheme, however, agro-food industries have been considered a mechanism to satisfy the basic consumption requirements of the population. The establishment of transnational agro-food industries linking subregional and foreign capital has also been considered.

A large potential mass market for the food-processing industries exists within the framework of already established food security and related schemes because food-processing permits the formulation of high-nutrition low-cost foods, can decrease the effective cost, correct protein-energy imbalances and cater to traditional food habits.

To reach mass markets, food-processing enterprises should cover urban and often rural markets, make use of idle installed industrial capacities whenever possible, and utilize entrepreneurial strategies that favour the production and distribution of processed food at prices within the reach of mediumand low-income populations. As shown in figure V, the strategy utilized by the local company in one Latin American country would be more appropriate for mass markets and food security schemes than that of the foreign company. The latter is characteristic of larger international food-processing firms operating in developing countries at low levels of production, using product differentiation and having high production, financial, advertising and retailing costs [19].

7. Policies

An analysis of the policies applied in Latin America over the last 30 years indicates the prevalance in the 1960s and early 1970s

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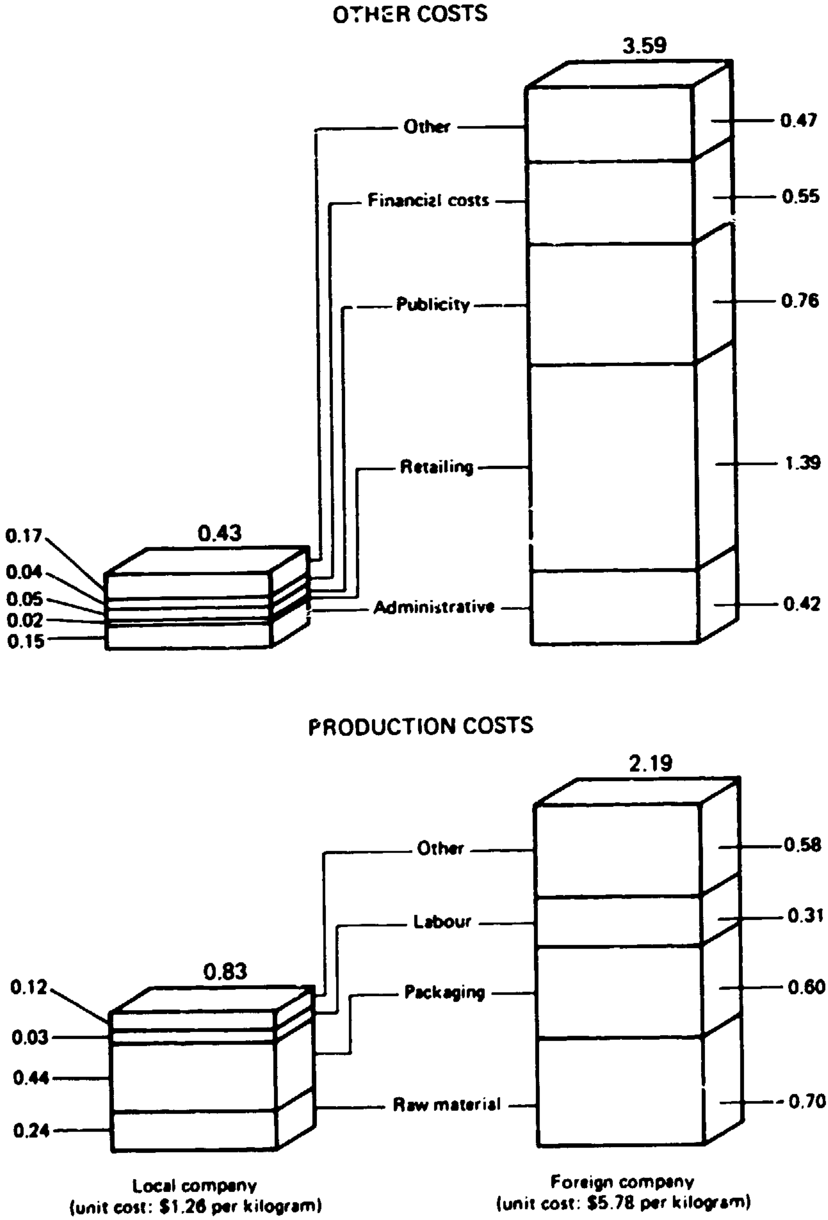
*An interesting example of technology transfer to different components of the food system is provided by the animal-protein food model and its introduction into Latin America and other developing countries. The transfer was based on the confluence of multiple elements, including: the promotion of transnational corporations supported by aid and agricultural policies in the country of origin; international demonstration effects in the middle- and high-income population groups; and food policies designed by local governments to keep food prices low for the urban population in the face of agricultural constraints and easily available imported agricultural raw materials. The introduction of that model often promoted increased dependence on imported grains and other raw materials. Transnational corporations played a key role in countries like Brazil in initiating first-stage processing with imported or local inputs. They have since been replaced by local firms in processing and staple food production. The imports of basic staples required by that food model are increasing [6].

Figure V. Comparison of component cost of infant cereal: local and foreign companies, Venezuela, 1980 (Dollars per kilogram)



Source: Junta del Acuerdo de Cartagena, "El sector de alimentos infantiles en la subregión Andina" (Lima, 1983), p. 69.

of import-substitution policies, which discriminated against the agricultural sector in favour of the manufacturing sector. The basic needs strategies, which came into fashion during the mid-1970s, recognized the importance of agriculture, but were not sufficiently linked with commercial agriculture and with the industrial sector. The impact on basic needs was positive, owing to the integrated approach followed, which was aimed at simultaneously improving health, sanitation, education and nutrition. That strategy was not continued, however, perhaps because the economic development that would have been required for the strategy to be self-supporting was not achieved. The export-led policies introduced in the early 1980s do not discriminate against the agricultural sector as a whole; however, as they are oriented towards the conventional external markets in the North that are currently experiencing a crisis, it does not appear that they can be economically successful for most countries.

The shortcomings of an export-led strategy, which was considered the most appropriate strategy for promoting economic growth in the early 1980s, are well illustrated by the present agricultural and agro-industrial crisis in Brazil. The overwhelming emphasis placed on agricultural and agro-industrial production for export markets greatly reduced the production of food for internal markets, thus drastically lowering the levels of food security and at the same time creating a tremendous external dependency for inputs. The situation is further exacerbated by the current low prices for agricultural and agro-industrial products on the world market [20].

B. Need for an alternative development strategy

In the light of the above summary description of the Latin America AFIS, what is required is an alternative strategy that would approach the development of the system in an integrated manner and take account of all the following needs:

(a) To satisfy a growing demand for food in the internal mass markets;

(b) To find alternatives to the depressed conventional international market in most traditional branches;

(c) To overcome the shortcomings of the present dual system in agricultural production, comprising a modern sector producing for export markets beside a depressed traditional agricultural sector;

(d) To incorporate the rural population into agricultural production;

(e) To provide adequate levels of nutrition to low-income groups in rural and urban areas.

1. A proposed strategy

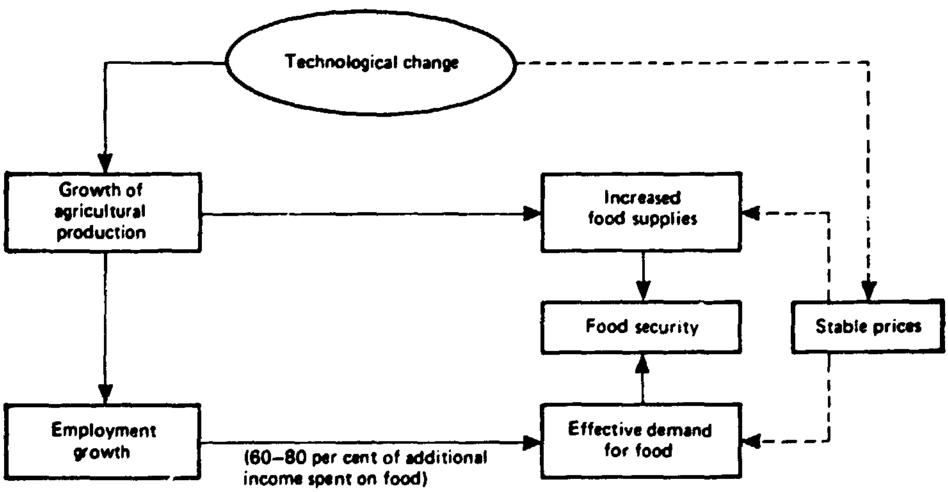
A possible strategy to meet the above-mentioned needs, a strategy that should be further analysed for its potential applicability to Latin America, is known as the "agricultural-employment-technology development strategy", which was originally proposed by J. W. Mellor* [14]. The two main characteristics of the strategy are the following:

(a) Accelerating the pace of agricultural growth despite the constraint imposed by a fixed area of land, a constraint that should be overcome by technological change;

(b) Accelerating the growth of employment through the direct and indirect effects of agricultural growth, which in turn will lead to expanded domestic demand for agricultural output.

For the strategy to be effective, both supplies of and demand for food must be increased, as explained below and schematically illustrated in figure VI.

Figure VI. Agriculture-employment-technology strategy components



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*Mellor entitled his strategy "agricultural-employment". Given the important role to be played by technology in the strategy, the new title is proposed here.

Accelerated growth in employment must be accompanied by accelerated growth in food supplies, since increased employment provides the working population with added income, 60 to 80 per cent of which is spent on food. The result will be a reduction in levels of malnutrition achieved by reducing poverty. Thus, two factors are necessary: increased supplies of less expensive food and increased demand through increased incomes generated by increased employment. Stable food prices are necessary to maintain the equilibrium; they can be secured by technological change in the presence of effective demand.

The technology to be introduced must be carefully selected as the most appropriate for the specific crops and region. In many cases, a combination of advanced and intermediate technology may be indicated, as it is evident that the indiscriminate introduction of capital-intensive agricultural production methods would not be conducive to employment growth.

For such a strategy to succeed, appropriate policies must be devised in the areas of industry (including small- and medium-scale), finance, trade, infrastructure, research and development and training, among others. For the agricultural sector, appropriate policies must take into consideration such factors as land distribution and land tenure, pricing and other producer incentives, availability of inputs, as well as overall rural development.

Although the strategy proposed by Mellor provides a conceptual framework that points out priorities and essential interrelationships, as well as some of the mechanisms for an alternative development strategy, it is clear that before attempting to apply such a strategy, it must be further refined, adjusted to the specific AFIS development patterns of the countries in the region, and tested, using the available tools. The whole process should be based on previous Latin American experience, existing guidelines and indications provided by research and development work already carried out in the region in the fields of agriculture, agro-industry and food security ([21], [22]).

An analysis of the proposed strategy must be made at the country, subregional and regional levels. If the strategy is to be implemented in the context of an extended food-security concept, the first step would be an analysis of demand. That should be followed by the selection of the foods to be produced on the basis of the results of the analysis of demand, an assessment of technology needs and an analysis of the role of the food and related industries.

2. Tools for refining and testing the proposed strategy

Testing and refining the proposed strategy would require the application of an integrated systems approach to the analysis of the structure of AFIS in each country of the region and to the programming of its development. The systems approach provides a much broader view of the sector than traditional approaches because it recognizes the interdependence of economic and social components within and outside the system and helps to provide the conceptual framework to analyse and evaluate those interrelationships [23]. The approach makes possible the analysis of the feasibility of an integrated development of the system, by considering the development of all the components of the system simultaneously. The tools to be used for such an approach should permit the identification of all the different components comprising the system, the linkages between production and demand components, the interaction between subsystems, as well as bottlenecks and constraints to the development of the system. The proposed analysis could be carried out on two different levels.

On the first level, Latin American countries could be grouped according to similarities in the patterns of development of AFIS in each country. Common development strategies could be designed for the countries of each group within the framework of the proposed "agriculture-employment-technology" development strategy. An additional goal would be to identify complementarities between the strategies of each group in order to promote co-operation within the entire region.

A grouping of countries following this method has been carried out by UNIDO in co-operation with FAO on the fisheries industrial systems of 64 developing countries. Strategies were derived for 10 groups of countries corresponding to the 10 different patterns of development identified [24]. The methodology used is available at UNIDO and could be a useful tool for refining and testing the proposed strategy at the group level.

A second level of analysis would be required for individual countries. The main output of such an exercise would be a programme* for the integrated development of AFIS, aimed at attaining a set of objectives, including food security, as identified by the Government. The analysis of the characteristics of the pattern of development to which the country belongs and the group-specific development strategy designed during the first level of analysis would facilitate and accelerate the assessment and programming of AFIS at the country level.

The "methodology for assessing and programming industrial systems" (MEPS) is a tool that would be well suited for the assessment and programming of AFIS at the country level. The methodology was originally developed by the Junta del Acuerdo de Cartagena and further expanded in co-operation with UNIDO [23]. Within the MEPS framework, an AFIS could be illustrated in a very aggregated and generic fashion by the base diagram included in figure VII. The diagram identifies the boundaries of the system, its different production and consumption components and the linkages between components, as well as the policies that affect the components, their linkages and the system as a whole. MEPS permits the quantitative

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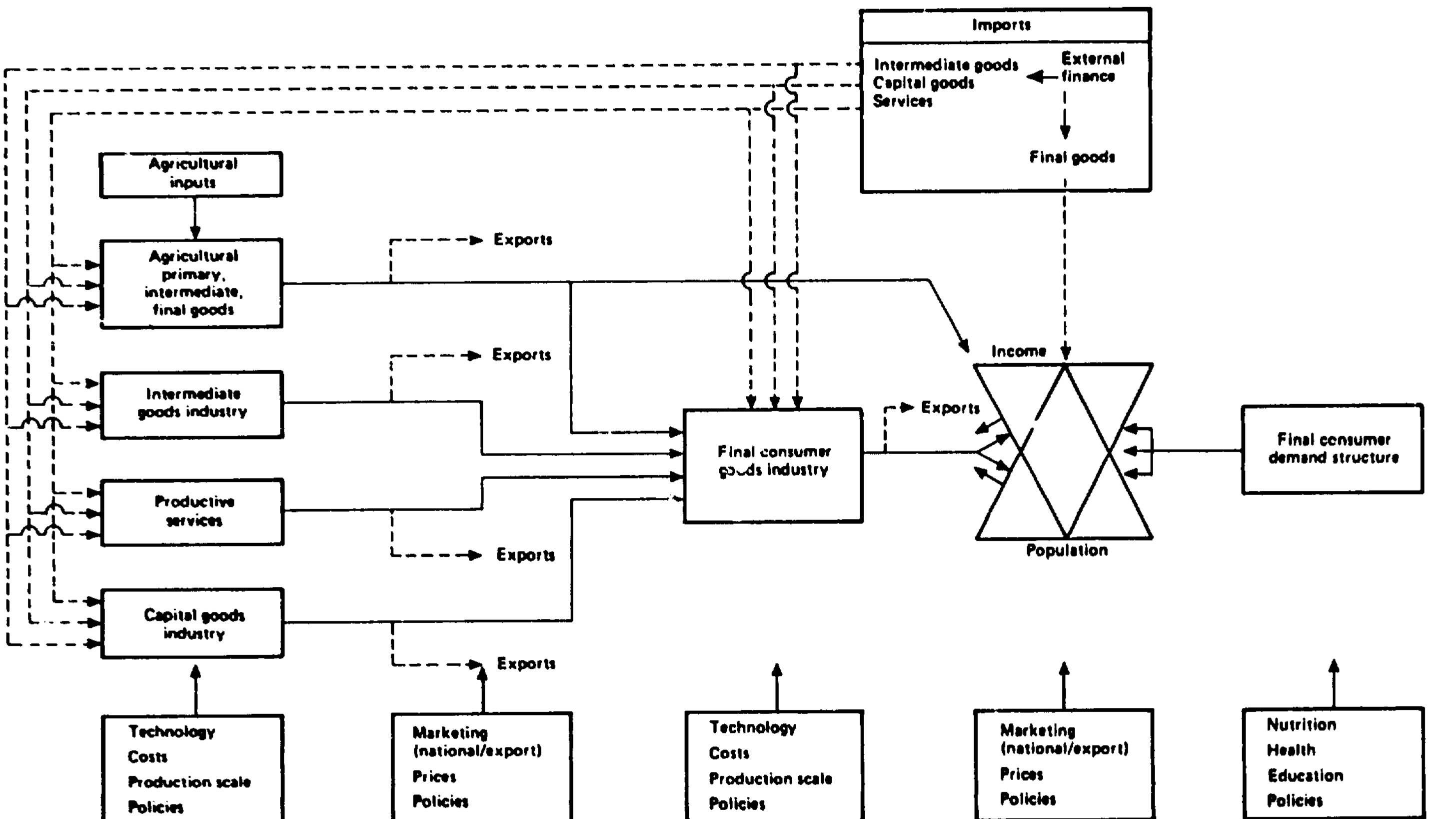
*A programme consists of a set of policies, technical assistance projects and the investments required to attain a set of goals within the integrated development of a given system [22].

Figure VII. Production and consumption system



description of the different subsystems interacting in a given AFIS, and within them, the identification of bottlenecks and constraints. The methodology provides the basis for identifying various technical and economic options to eliminate constraints to development, and permits the computer simulation of those options and the measurement of their effects on the system. On the basis of the most appropriate options, development strategies can be designed and their micro- and macro-effects on the development of the system simulated and measured. The optimum strategy for the attainment of a given set of objectives can thus be selected, and on that basis, a programme for developing an improved alternative system can be designed [25].

The application of MEPS for the programming of agro-food industrial systems within the context of food security is being promoted by the Junta del Acuerdo de Cartagena in the five Andean Pact countries. UNIDO has been co-operating in that effort since 1985.

More recently, a model for analyzing the demand component in MEPS, for use in designing AFIS development programmes within the food security concept, has been produced by UNIDO [19], together with a set of guidelines for food security assessment. That is a follow-up to the analysis made in 1985 at UNIDO by Uribe and Zinnes [26], in which a methodological basis was given for the determination of demand for processed foods within the food security scheme being implemented in the Andean Pact countries.

The demand model was developed with several objectives in mind, in particular to provide a more accurate method for analyzing the demand behaviour of the target population groups, especially with respect to issues related to ability to pay, and to provide a way of measuring the risk factor associated with the various components of the system and for the target population groups. The model initially designed for the Andean Pact countries could be applicable to a large number of developing countries [27].

The linking of MEPS and the demand model to a general equilibrium model is a further task that could be undertaken in order to account for the general equilibrium implications of proposed policies for other sectors, as well as for the macro-economic interactions between AFIS and the rest of the economy.

References

1. United Nations Conference on Trade and Development, "Protectionism and structural adjustment" (TD/B/1086).

2. A. Machado, El problema alimentario en Colombia (Bogota, Universidad Nacional de Colombia, 1986).

3. L. A. Paulino and J. W. Mellor, "The food situation in developing countries - two decades in review", Food Policy, vol. 9, No. 4 (November 1984), pp. 291-303.

4. "Agro-food industrial development in Latin America", Sectoral Studies Series No. 25 (UNIDO/IS.623).

5. Food and Agriculture Organiz ion of the United Nations, Agriculture: Toward 2000 (Rome, 1987).

6. J. P. Peemans, "Agro-food industries: a comparative typology of performances and prospects", unpublished study undertaken for UNIDO (January 1985).

7. M. Cortes, A. Berry and A. Ishaq, Success in Small- and Medium-scale Enterprises, the Evidence from Colombia (New York, Oxford University Press, 1987).

8. J. P. Bertrand, "Brésil, modernisation agricole et restructuration alimentaire dans la crise internationale", Revue Tiers Monde, vol. XXVI, No. 104 (October-December 1985).

9. F. H. Sanderson, "World food prospects to the year 2000", Food Policy, vol. 9, No. 4 (November 1984), pp. 363-373.

10. W. J. Dixon, "Progress in the provision of basic human needs: Latin America 1960-1980", The Journal of Developing Areas, vol. 21, No. 2 (January 1987), pp. 129-140.

11. P. Rieder and U. Eggar, "International agricultural markets and malnutrition in the third world", Food Reviews International, vol. 3, Nos. 1 and 2 (1987).

12. T. Uribe, "Revaluación de la seguridad alimentaria en Colombia", Coyuntura Económica, vol. XVII, No. 1 (April 1987), pp. 157-193.

13. P. Spitz, "The right to food in historical perspective", Food Policy, vol. 10, No. 4 (November 1985), pp. 306-316.

14. J. W. Mellor, "Agriculture on the road to industrialization", International Food Policy Research Institute Reprint No. 83, in Development Strategies Reconsidered, United States - Third World Policy Perspectives No. 5 (New Brunswick, New Jersey, Transaction Books, 1986).

15. Junta del Acuerdo de Cartagena, Economía Andina. Informe Trimestral de Coyuntura No. 13 (Lima, 1987).

16. Industry and Development: Global Report 1985 (United Nations publication, Sales No. E.85.II.B.1).

17. T. S. Buckle and H. Riveros, "Los proyectos andinos de desarrollo technológico en el area de alimentos, su origen, contribución a la solución del problema alimentario de la subregion andina", Ciencia y Technología de Alimentos, vol. 4, No. 3 (September-December 1983).

18. C. Oman and R. Rama, "Las nuevas formas de la inversión internacional en la agroindustria latinoamericana", Comercio Exterior, vol. 36, No. 10 (October 1986), pp. 878-894.

19. "Potential contribution of the agro-food industry to food security systems: the case of a Latin American subregion" (UNIDO/IS.587).

20. M. Burztyn, "Endettement et crise du modèle agricole brasilien", Revue Tiers Monde, vol. XXV, No. 99 (July-September 1984).

21. T. Uribe Mosquera, "Anotaciónes criticas sobre la seguridad alimentaria", report prepared for the Government of Colombia (Bogota, 1987).

22. J. Garcia, The Effects of Exchange Rates and Commercial Policy on Agricultural Incentives in Colombia: 1953-1978, Research Report No. 24 (Washington, D.C., International Food Policy Research Institute, 1981).

23. "Methodology for the assessment, programming and management of production and consumption systems", abridged version, Sectoral Studies Series No. 27 (UNIDO/IS.643).

24. "Industrial development strategies for fishery systems in developing countries", vol. 1, Sectoral Studies Series No. 32 (UNIDO/PPD.30).

25. "Methodology for the assessment, programming and management of production and consumption systems", user's guide, Sectoral Studies Series No. 33 (UNIDO/PPD.33).

26. "La seguridad alimentaria y los alimentos procesados: bases metodológicas para la determinación de su demanda", Sectoral Studies Branch, study undertaken by UNIDO (February 1988).

27. A. Barajas, "A model for food demand in developing countries - guidelines for food security assessment", Sectoral Studies Branch, study undertaken for UNIDO (January 1988).

THE ECONOMIC CASE FOR THE EMERGENCE OF NEW PRODUCERS OF PETROCHEMICALS IN THE HYDROCARBON-RICH DEVELOPING COUNTRIES

P. Abou-Ezze,* D. W. Butterfield** and A. A. Kubursi**

Introduction

Industrialization is a critical part of the third world development process. Domestic industrial production provides a reliable and secure source of supply to satisfy domestic needs. The factory is often as valuable as the school in developing expertise, upgrading skills, instilling work discipline and fostering collective practices and team-work. It is a transformer of habits, attitudes and outlook. Industrialization is also a source of income: it raises the value-added component of domestic production and increases the rent on domestic resources. Moreover, industry plays an important role as a carrier of technology. It can make possible the development of products, machines and processes that are better suited to local circumstances, and it enhances the ability to adapt to and control changing world economic conditions.

It is within such a perspective that current and future third world petrochemical production must be evaluated. Production and investment figures are, however, less important and meaningful than the broader issues of the overall strategy of development at large and the developing of the South's petrochemical industry in particular.

In a sense, hydrocarbon-rich developing countries are in a race against time. It is now all too clear that the gestation period for reaching self-sustaining growth in those countries may be longer than the life of most of their resources, particularly that of oil.

A. Moving downstream

Were oil and gas resources everlasting or renewable, the citizens of the oil-producing states would be entitled to a perpetual rent accruing from those resources, and economic diversification would not be a critical consideration. However, oil and gas supplies are finite and non-renewable. At recent rates of utilization, oil will run out in many of the oil-producing developing countries in the lifetime of the present generation, or in a few cases in that of its children or its grandchildren. Before 1973, exploration,

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production and utilization of oil were determined by major consumer countries in the developed world. The price of oil was low and the pattern of ownership was such that little capital was generated to effect industrial restructuring and further processing of the hydrocarbon resources.

The accumulation of large financial surpluses in the early 1970s, however, preceded any deliberate plan for their domestic absorption or investment abroad. There was no historical experience on which to base predictions of future growth in domestic absorption, and therefore no reason to question the economic rationality of a surplus of the magnitude realized. However, oil producers are no longer oblivious to the risk of accumulating fixed-income-yielding assets in an inflationary and uncertain world. They are, therefore, no longer satisfied with their role as residual suppliers of the world oil requirements. They are actually moving "downstream" to create an advanced and integrated industrial base and to expand their sphere of control over the transportation, refining, liquefaction, processing and marketing of their hydrocarbon resources and derivatives. Although building an industrial establishment based on oil and gas resources does not strictly diversify oil producers' economies, the increase in value-added derived from the dwindling supplies of these resources, and the industrial experience gained from capitalizing on comparative advantage will have beneficial implications and will convey definite advantages to other activities and sectors. It must be realized that despite dramatic increases in the national incomes of the oil-producing countries as oil prices increased, the non-oil sectors of most of those economies remained relatively undeveloped. Standards of living in those countries have certainly risen, but essentially and primarily through a form of capital consumption, namely the depletion of oil and gas reserves.

B. Why petrochemicals?

Petroleum and gas have traditionally been used primarily for energy and that situation is not likely to change in the near or medium term. Therefore, it is to be expected that hydrocarbon resource prices will reflect primarily energy developments. Petrochemical manufacture, which absorbs about 5 per cent of the world's oil supplies, is nonetheless a very important source of demand for hydrocarbon resources for many reasons, as outlined below.

1. Financial considerations

Whereas oil was selling for a little less than $0.10 a pound,* petrochemicals and products derived from petrochemicals were selling for $0.24 to $0.66 cents or more a pound in 1981.** Furthermore,

*1 pound = 0.4536 kilogram.

**The price ratio of ethylene to oil in 1970 was as high as 5.3-6.8; by 1978, the ratio had fallen to 2.8-3.7. For high-density polyethylene the ratio was as high as 21.8-27.8 in 1970 and about 5.8-6.9 in 1978. See [1], p. 87.

the high value of sales of petrochemicals, exceeding $150 billion in 1980, is indicative, albeit indirectly, of a lucrative industry with a significant rate of return on investment.* In the context of some oil-producing developing countries, it represents a decidedly productive use of financial surpluses.

2. Production sequences

Movement along the production chains to achieve economies of scale and to benefit from technical linkages are important industrial considerations for countries concerned with deepening processing activities in their economies. The petrochemical industry is typical of industries with clearly demarcated production chains and processes. Although it is difficult to devise a simple system of classification to include all petrochemicals, it is customary to use three broad categories to identify the products, namely, basic, intermediate and final products.

The main petrochemical basic products are the olefins (ethylene, propylene, butadiene), aromatics (benzene, toulene, xylenes) and methanol. Two primary processes are used in their production: steam cracking of naphta for the olefins and catalytic reforming for the aromatics. A third process - steam reforming - is also used to synthesize ammonia and methanol. Those products form the building blocks from which final petrochemical products are made. The dominant production chains from basic to final products include ethylene and propylene as the main inputs in the making of plastics, aromatics in the making of synthetic fibres, butadiene and benzene in the production of rubber, and methanol (converted into formaldehyde) in the manufacture of adhesives.

The increased processing activity in the petrochemical industry raises automatically the value-added component derived from hydrocarbon resources. The larger the use of domestic resources in the processing activity, the higher are the returns to those factors and therefore the higher the domestic value-added contribution of the activity.

3. Diversification considerations

Petrochemical manufacture is based on hydrocarbon resources, and it is difficult to see that it contributes to a diversified economic base in oil-based economies. The geographic pattern of markets for petrochemical products is, however, substantially different from those for oil and gas. The markets for oil and gas are highly concentrated in countries of the Organisation for Economic Co-operation and Development (OECD). However, that is not likely to be the case for petrochemical products. Thus, an increase in the share of petrochemical products in the exports of oil-rich countries carries with it the possibility of diversification of

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*Rates of return on investments in petrochemical production in the Arabian Gulf region are estimated to be about 28 per cent evaluated in 1979 prices. See [2], p. 13.

exports in terms of products and markets. Such diversification is important in reducing vulnerability to Western demand fluctuations and to variations in product cycles.

4. Comparative advantage and learning by doing

The world petrochemical industry is characteristically migratory, technological, capital-intensive, resource-intensive, energy-intensive, scale-sensitive and dominated by transnational corporations.

Petrochemical production is scattered over roughly one thousand facilities throughout the world. The United States, Western Europe and Japan produce over 66 per cent of world petrochemical products; some years ago the figure was substantially higher. In the future it is expected to become substantially lower. The shift in regional output shares is a direct result of the nature of the product cycles that characterize petrochemical demand and of the substantial change in the relative prices of the inputs used to produce petrochemicals. On both counts - the phase of the product cycle and the change of the relative prices of inputs - oil-based economies are in a privileged position to produce petrochemicals.

The product-cycle theory of product demand is based on the premise that as a product matures, consumption increases rapidly after the initial introductory period and then grows more slowly during product maturity. Concurrently, the number of producers increases rapidly and then also slows; the price also declines, rapidly at first, but finally tending to level off in the mature stage. The price declines are due partly to the combination of decreased costs as a result of both economies of scale and operating experience, and to increased competition. It is to be noted that whereas consumption grows smoothly, capacity can only be augmented in large steps. During the early stages of the product life cycle, one country is the only producer, for example, the United States, and hence fills both local and foreign demand. While such exports often are attributed either to a "technological gap" or "managerial gap", in many cases they are simply explained by the time lag in commencing production in the importing country owing primarily to a limited domestic market or to the inability of the importing country to capitalize on its domestic opportunities.

In 1963, United States exports of styrene to the Federal Republic of Germany were negligible, but during 1964 and 1965 averaged $10 million yearly. After that time they dropped back to a negligible quantity as new capacity came onstream in the Federal Republic of Germany. The whole history of the world petrochemical industry is rife with examples of production migrating from one region to another, primarily in response to development of domestic production capabilities or to changes in cost structures. The recent change in the importance of feedstock prices relative to capital costs of petrochemical production suggests that migration of the industry towards the resources is a natural and logical outcome of the workings of economic laws of production and location.

Oil- and gas-based petrochemicals accounted for about 50 to 70 per cent of total world petrochemical production in industrial developed economies in the 1970s. In 1972, 92 per cent of organic chemicals in the European OECD countries, 95 per cent in the United States and 96 per cent in Japan were produced from oil and gas ([3], p. 27). Such heavy dependence on oil and gas was basically in response to significant declines in the real prices of those inputs until the 1970s.

With the upward adjustment of oil prices in 1973, the decline of chemical prices in the 1960s was arrested and reversed. In 1974, the prices of internationally traded basic petrochemicals were three to four times higher than their levels of 1970 to 1972, and by 1979 to 1980, new peaks were achieved. The major result of the dramatic rise in feedstock prices was the rise in the proportion of raw material costs in total production costs of petrochemicals. In the late 1970s, feedstock prices as a percentage of total production costs accounted for 60 to 80 per cent in fertilizer production, 45 to 75 per cent in plastics and more than 50 per cent in synthetic fibres ([1], p. 88). Raw material requirements are highest in the initial stages of manufacturing - the production of intermediate products and monomers requires from 2 to 4 tonnes of hydrocarbon raw material for every tonne of production; in the final production phase, monomer consumption is no more than from 1 to 1.5 tonnes per tonne of plastic ([1], p. 89).

Alternatively, the expansion of large-scale production and the higher capacities of individual production facilities have resulted in a substantial lowering of current and capital expenditures per unit of production, in addition to lowering unit operating and management costs. For instance, in the 1960s, the increase in the capacity of ethylene plants from 50,000 to 450,000 tonnes a year had the effect of reducing average capital costs from $220 to $90 per tonne ([1], p. 78). Similarly, the increase in the size of an ammonia-producing plant from 36,000 to 130,000 tonnes a year lowered unit capital costs by over 35 per cent ([1], p. 78). Such examples abound.

The combination of a rise in feedstock prices and a decline in unit capital costs increased the incentives to locate petrochemical plants near hydrocarbon resources. In addition to those factors, the energy-intensive nature of cracking and reforming imply for oil-based countries substantial comparative advantage in producing petrochemicals. Table 1 presents comparative cost conditions in the production of petrochemicals.

A number of pitfalls remain and require careful attention. Recall that, as a general principle, as a product matures, competition grows keener and the quality of the product becomes more standardized, so that the ability to sell it becomes very sensitive to price. Under those circumstances one would expect that any country with intrinsically lower production costs would become a major exporter. That has happened in electronics: South-East Asian countries with lower labour costs have become major exporters to developed countries. There is a decisive

Table 1. Comparative advantage of the Arab Gulf region in petrochemical products, 1980
(Production cost analysis)

	Methanol: 320,000 tonnes per annum from natural gas		Ethylene: 450,000 tonnes per annum from ethane		Ammonia: 430,000 tonnes per annum from natural gas	
	United States	Arab Gulf region	United States	Arab Gulf region	United States	Arab Gulf region
Fuel/MMBTU	$4.00	$0.25	$4.00	$0.25	$4.00	$0.25
Location factor	1.00	1.25	1.00	1.50	1.00	1.25
Production cost (cents/kg)						
Raw materials	8.52	0.67	22.20	1.59	7.60	0.58
Utilities	7.16	1.14	9.98	1.91	5.50	1.63
Other direct costs	0.55	0.98	2.97	4.36	0.93	1.06
Overheads and taxes	0.62	0.76	2.02	3.29	0.84	1.06
Depreciation	1.68	2.09	7.04	10.24	2.03	2.53
	18.53	5.64	44.81	21.39	16.90	7.86
Percentage of energy and feedstock	74	16	64	8	74	11

Source: N. Dabdab and B. Mohuddin, Oil-based and Non-oil-based Industrial Development in the Arab Gulf Region (Doha, Gulf Organization for Industrial Consulting, 1982), p. 11.

advantage to countries with lower raw material costs in the export of mature petrochemical products. It is also true that world trade is largest in those commodities, and thus the possibility of building a large, economically efficient plant is high. The latter consideration is critical to prospective investor countries; it is important to ensure that the higher fixed costs associated with capital in third world countries do not wipe out the competitive advantage due to lower average variable costs associated with lower raw material costs.

Equally important to the investment decision is the consideration of products that are least vulnerable to technological obsolescence. Western countries, witnessing the erosion of their competitive edge in petrochemicals as raw material costs have risen and as capital costs have been declining, are expected to capitalize on technical change and technological advances to offset the effects of higher raw material costs.* This suggests that new producers from developing countries should begin with mature standardized commodities, but must also plan and implement massive research programmes. Teaming with transnational corporations may not be sufficient, as those corporations are not generally known to sell newly developed technologies. They do sell established technologies, and these need to be purchased and improved upon. For oil-rich countries with large financial surpluses, research and development in petrochemical technologies may be a productive use of those surpluses.

Marketing considerations are also important and need to be examined carefully. Local markets could be developed, particularly as chains and sequences of production are exploited. Regional demands need to be identified and plans made to take advantage of geographical and cultural proximities at the earlier stages of production. Marketing partnerships with transnational corporations need to be complemented with regional partnerships and with a detailed South-South co-operation effort. There are already several examples of such co-operation and instances in which producers from developing countries have invested in complementary downstream operations in other third world countries. Those activities may have to be expanded and enriched to present a credible marketing strategy.**

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*For example, a major chemical manufacturer has recently announced the development of a new ethylene production process, referred to as partial combustion cracking, in which ethylene can be produced directly from crude oil, in one step, or by using other feedstocks such as residual oil, gas oil or naphta. See [4], pp. 78-81.

**There are today a number of joint venture projects in which Arab countries are teaming with other third world countries to produce petrochemicals. Kuwait owns 40 per cent of the Turkish Mediterranean Petrochemical Company. The Kuwait Fund is financing

continued

The emphasis on large-size petrochemical plants stems in part from the need to capture economies of scale, thereby reducing the capital component of cost. It is equally important to emphasize the need to present a credible strategy to persuade competitors of the seriousness of the new producers to occupy a substantial world niche in downstream industries, commensurate with their share in world oil production. The largar the committed volume of capital, the more credible is the prospect of their competitiveness, not only on account of the efficiency of their operations, but also because of the belief that they are likely to be willing to absorb substantial operating losses before allowing their huge fixed investment to go down the drain.

Thus credibility grows with size and size depends upon close co-operation. The credibility of new petrochemical producers will be eroded if each oil-producing country sets up a small-scale plant producing the same range of products that its neighbours are producing. There is a definite and serious need for co-ordination of investment which allocates specialization on a regional basis. Joint ventures are needed to avoid duplication.

Co-operation among petrochemical producers may take a number of forms. Joint ventures are only one such form of co-operation. Equally important are joint marketing strategies, joint bargaining with transnational corporations and the joint development of technology. Subgeographical groupings may be formed as initial mechanisms of co-ordination, but the eventual articulation of a larger co-operative strategy remains critically needed to maintain the growth of the world market for third world petrochemical products. Thus, for example, while the co-operation now shown among the countries of the Gulf Co-operation Council (GCC) is a useful first step, co-operation on wider levels, involving Arab countries, the Organization of Petroleum Exporting Countries or other third world groupings, may be desirable and even necessary for the budding industries to thrive in the third world.

Oil-producing countries embarking on building massive petrochemical complexes are also major importers from developed countries. This is an important factor which could be used to induce developed countries to open their markets to petrochemicals produced in developing countries. The interdependent nature of trade relationships is a fact that the petrochemical producers could use to their collective advantage. The recent experience of GCC petrochemical exports to countries of the European Economic Community is a case in point.

(continued) a urea and ammonia complex in Sri Lanka. Saudi Arabia has a joint petrochemical venture with Pakistan and another is contemplated in India. The countries belonging to the Association of South-East Asian Nations are already committed to an ammonia-urea plant and are contemplating the establishment of petrochemical complexes. The same trend is apparent in Latin America, one example being the Venezuela-Colombia Ammonia Project.

C. The Arab petrochemical industry: the historical lessons

Although the Arab petrochemical industry is not exclusively tied to the geographical locations of Arab oil and gas, it is heavily concentrated in those countries. That is logical, given the strong technical affinity of the industry to its raw materials and the huge capital outlays required for its efficient production, which only oil-exporting countries in the region can afford.*

Oil was first exploited in the Arab region in the early 1930s, on a small scale at first, and then on a massive scale in the 1940s and 1950s. However, the Arab petrochemical industry is of recent origin. The Arab world will be divided into two geographical areas to highlight the development of Arab petrochemicals - Arab North Africa and Arab Western Asia.

1. The petrochemical industry in Arab Western Asia

Petrochemical production in Arab Western Asia dates back to the mid-1960s with the establishment of an ammonia plant at Shuaiba in Kuwait in 1966. The early 1970s saw the erection of a number of basic fertilizer plants. The Syrian Arab Republic established an ammonia-producing facility at Homs in 1970. Saudi Arabia started production of urea at Dammam in the same year. Iraq commenced production of urea and ammonium sulphate in 1971, while Qatar began production of ammonia from its first plant at Umm Said in 1973. From 1975 onwards, the area witnessed a major proliferation of fertilizer-producing plants (see table 2).

Petrochemical products other than fertilizers were not produced in the region until 1975, and then only on a limited basis in terms of both production scale and output variety. The delay in starting the industry in the region, despite its cost advantages, was primarily due to the low price of oil and high percentage of foreign ownership in the oil industry. Together, those two factors resulted in low revenues for the producing Governments, a feature which impaired their ability to engage in heavy investments in the petrochemical industry.

Iraq and Qatar were the first two countries in the region to venture into the production of basic petrochemicals, particularly basic products such as ethylene. The first complex was built at Umm Said, with the help of C.D.F. Chimie Française, to produce 280,000 tonnes per year of ethylene and 140,000 tonnes of low-density polyethylene (LDPE). The Iraqi complex was completed in 1976 at Khor Al-Zubair to produce 130,000 tonnes per year of

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*Petrochemical plants are capital-intensive and the minimum efficient scale is often very large. For example, at 1979 prices, it takes an investment of $1,700 to produce one tonne per year of ethylene, $1,000 to produce one tonne per year of propylene and $600 to produce one tonne per year of butadiene. The minimum efficient scale of ethylene production is currently 450,000 tonnes per year, 200,000 tonnes per year for propylene, and 100,000 tonnes per year for polypropylene.

Table 2. Ammonia projects in the Arab world: existing and planned capacities
(Thousands of tonnes per year)

Country	Existing as of 31 December 1981		Projects under construction	
	Capacity a/	Site and start-up date	Capacity a/	Site and start-up date
Algeria	660	Arzew, 1971-1979	330	Annaba, 1983
	330	Annaba, 1981		
Bahrain	--	-	330	Sitra, 1985
Democratic Yemen	--	-	--	-
Djibuti	--	-	--	-
Egypt	60	Hellwan, 1970	330	Safaga, 1986
	60	Suez, 1973		
	400	Abuqir, 1981		
	520 (2)	Talkha, 1975-1980		
	145	Aswan, 1961		
Iraq	325 (2)	Basrah, 1971-1977	50	Al Qaim, 1982
	660	Khor al Zubair, 1980	660	Khor al Zubair b/
Jordan	--	-	--	-
Kuwait	660 (2)	Shuaiba, 1966-1971	330	Shuaiba, 1984
Lebanon	--	-	--	-
Libyan Arab Jamahiriya	330	Marsa el Brega, 1971	330	Marsa el Brega, 1982
			890 (2)	Sirte, 1985
Mauritania	--	-	--	-
Morocco	--	-	90	Timahdit, 1985
Oman	--	-	20	Sahar, 1985
Qatar	590 (2)	Umm Said, 1973-1979	--	-
Saudi Arabia	180	Dammam, 1970	330	Al Jubai, 1984
Somalia	--	-	--	-
Sudan	--	-	58	Khartoum, 1983-1984
Syrian Arab Republic	50	Homs, 1970	330	Homs, 1982
Tunisia	--	-	330	Gabes, 1984
United Arab Eminates	--	-	330	Gabes, 1984
Yemen	--	-	--	-
Total	4 970		4 918	

Sources: Annual Report of the Organization of Petroleum Exporting Countries - 1981; Arab Oil and Gas Directory - 1982; Chemical Age; Chemical Engineering; European Chemical News; Middle East Economic Digest; Oil and Gas Journal; and Saudi Arabian Monetary Agency: Annual Report - 1981 and "Insight of possible marketing strategies for petrochemicals and fertilizers" (1980).

a/ Number of plants by site given in parentheses.

ethylene. The Iraqi complex is also capable of producing LDPE, high-density polyethylene (HDPE), polyvinyl chloride (PVC) and caustic soda in varying small amounts.

Saudi Arabia is entering the petrochemical field in a substantial way, with several major complexes at Al-Jubail and Yanbu. The Saudi Basic Industries Corporation (SABIC) was established in 1976 to formulate and implement a major thrust into downstream processing of the Kingdom's hydrocarbon resources. SABIC envisages the production of about 2 million tonnes per year of ethylene, 1 million tonnes per year of LDPE, and 1.3 million tonnes per year of methanol, in addition to small amounts of ethylene glycol and other intermediate and final petrochemical products.

Kuwait is moving towards producing aromatics, primarily benzene, ortho-xylene and paraxylene, and considering the production of ethylene, styrene, ethylene glycol and formaldehyde. The United Arab Emirates is also studying the feasibility of producing ethylene in the Al-Ruwaid industrial area.

It is clear from the above that Arab Western Asia is on the threshold of joining the world petrochemical industry. Saudi Arabia is emerging as the major producer in the region. Two characteristics dominate the region's petrochemical industry. First, there is a heavy emphasis on the production of basic products. Second, olefins dominate the product mix. There is a conspicuous dearth of plans to produce aromatics.

The concentration on olefins is rooted in the current experience of flaring associated gas: the ratio of flared gas in the region varied from an insignificant 13 per cent in Bahrain in 1980 to over 72 per cent in Saudi Arabia in the same year [5]. Thus, the opportunity cost of using flared gas in petrochemical production is almost zero. The same is not true for oil, whose opportunity cost in petrochemical production is the going export price per barrel of crude.

2. The petrochemical industry in Arab North Africa

Egypt was the first country in Arab North Africa to undertake the production of petrochemicals. It was producing ammonia as far back as 1961 at Aswan, by 1970 at Hellwan, and by 1973 at Suez. The heavy utilization of fertilizers in Egyptian land-scarce agriculture provided a major outlet for Egyptian fertilizer production. In 1986, the country had a rated capacity of 1,185 million tonnes per year of ammonia, and an additional plant with a rated capacity of 330,000 tonnes per year was being constructed at Safaga. The latter plant became operational in 1987. Algeria and the Libyan Arab Jamahiriya are the two other Arab North African countries with sizeable ammonia production. Algeria started production of ammonia in 1971 at Arzew; the plant was expanded in 1979 from 330,000 to 660,000 tonnes per year. In 1981, the Annaba complex came on stream with a rated capacity of 330,000 tonnes per year, and by the end of 1983, another 330,000-tonnes-per-year facility was operational at Annaba.

The Libyan Arab Jamahiriya, which had an ammonia plant at Marsa Al Brega with a rated capacity of 330,000 tonnes per year in 1978, already extended that facility by another 330,000 tonnes per year in 1983, and by 1985 two new facilities with a rated capacity of 890,000 tonnes per year were operational at Sirte.

Tunisia and Morocco both began to produce ammonia by 1985. Tunisia built a plant with a capacity of 330,000 tonnes per year, whereas Morocco built a smaller facility with a capacity to produce 90,000 tonnes per year.

In terms of basic petrochemical products, Arab North Africa is not much different from Arab Western Asia. Both regions are late entrants into the field, and both produce or plan to produce primarily mature products on a limited scale.

Algeria already has the capacity to produce ethylene (120,000 tonnes per year) and vinyl chloride monomer (40,000 tonnes per year) at Skikda. Since 1976 it has had a methanol-producing facility at Arzew with a rated capacity of 100,000 tonnes per year. Algeria has also constructed an aromatic production facility with a rated capacity to produce 95,000 tonnes per year of benzene, 50,000 tonnes per year paraxylene and 107 tonnes per year onthoxylene.

The Libyan Arab Jamahiriya, which has been producing about 330,000 tonnes per year of methanol, is moving fast and in a decisive manner into the production of ethylene, styrene, ethylene glycol and vinyl chloride monomer. However, neither the Libyan Arab Jamahiriya nor Algeria is contemplating the production of any significant amounts of final petrochemical products.

3. Arab petrochemical capacity, 1987

Although Arab production of petrochemicals was limited in the 1970s and early 1980s, it expanded greatly in the mid-1980s. By 1987, the total Arab ammonia production capacity was expected to exceed 9.8 million tonnes per year. In the same year, Arab capacity was almost 2.3 million tonnes per year of methanol, over 2.4 million tonnes of ethylene, 900,000 tonnes of styrene, 705,000 tonnes of ethylene glycol, 454,000 tonnes of styrene, 454,000 tonnes of ethylene dichloride, 406,000 tonnes of benzene and a host of small amounts of other basic and intermediate petrochemicals. The largest components of final petrochemicals produced in the Arab area in 1987 included 800,000 tonnes per year of LDPE, 490,000 tonnes of HDPE, 240,000 tonnes of PVC and 95,000 tonnes of polystyrene.

Those capacities are large when compared to current or past production rates of the products, but they represent a small fraction of the corresponding world production and are certainly within the bounds of even Arab domestic demand for most of the products.

D. Conclusions

Petrochemical production is the dominant industrialization option for oil-rich developing countries, most of which have little else to develop. They generally have a strong comparative cost advantage, since feedstock prices account for a large share of production costs and their big financial surpluses enable them to invest in large efficient complexes with a relatively low capital cost per unit.

There are compelling reasons why third world petrochemical producers should choose a restricted basket of products, including products at the mature phase of the product cycle with limited vulnerability to technological obsolescence and those that are highly sensitive to price competition and feedstock prices. However, since efficiency and credibility are sensitive to size, third world producers ought to start big and pursue co-operative strategies both among themselves and with producers in developed countries.

References

1. UNIDO, "Second world-wide study on the petrochemical industry: process of restructuring" (ID/WG.336/3).

2. Petrochemical Industries in the Arabian Gulf Countries, (Doha, Qatar, Gulf Organization for Industrial Consulting, 1980).

3. L'industrie chimique (Paris, Organisation for Economic Co-operation and Development, 1972).

4. Chemical Engineering Progress, vol. 79, No. 2 (February 1983).

5. Organization of Petroleum Exporting Countries, Annual Statistical Bulletin 1980 (Vienna, 1980).

SEMI-INPUT-OUTPUT ANALYSIS TO ESTIMATE NATIONAL ECONOMIC PARAMETERS: AN APPLICATION TO BOTSWANA

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Introduction

If it is accepted that the prevailing prices on goods and factor markets in developing countries generally do not reflect the economic value of resources traded on those markets, then national economic parameters that revalue resources on the basis of their economic opportunity costs expressed in efficiency prices are a crucial link between economic planning at the national level and the appraisal of individual investment proposals.

Of the various methodologies designed to appraise investment projects within a cost-benefit analysis framework, the most widely applied is that developed by Little and Mirrlees ([1] and [2]) and modified by Squire and van der Tak [3], referred to as the LM/SVT method. It uses a world price numeraire to express all costs and benefits of a project in terms of foreign exchange equivalent values,** and is particularly suitable for open economies such as that of Botswana, where most goods are open to international trade and therefore have easily identifiable opportunity costs.

Different approaches have been used in recent studies to estimate national economic parameters on the basis of the LM/SVT method.*** The semi-input-output (SIO) approach, first developed by Tinbergen [5] and then applied by Kuyvenhoven [6] and by Powers [7], is the most advanced. It permits, in particular, the most accurate treatment of two major theoretical problems, that of interdependence in the estimation of key parameters and that of valuation of non-traded sectors.

While the theoretical foundations of the SIO approach are well-documented, its practical applications cannot be standardized. Such applications must take into account country-specific characteristics as well as the existing data. Therefore, after a brief summary of the SIO approach, this article concentrates on a practical approach [4] to deriving a comprehensive set of national

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**"Uncommitted public income measured in convertible foreign exchange" is the unit of account in the LM/SVT method. See [3], p. 57.

***See Weiss [4] for a comparison of three different approaches adopted in recent studies on Jamaica, Nepal and Ethiopia.

economic parameters for Botswana. The results should be of particular interest for planners in developing countries and those involved in the estima- tion and application of accounting prices.

<u>The semi-input-output approach</u>

In order to convert all items of a project's cost and benefit stream from market into economic accounting prices, a set of accounting price ratios (APRs), which are ratios of accounting prices to domestic market prices, has to be estimated, covering all goods and services produced (benefits) or used (costs) in the economy.

As accounting prices for traded goods in the LM/SVT method are determined by world prices, expressed in domestic currency, the general formula for APRs is as follows:

$$APR_i = \frac{WP_i \times OER}{DP_i} \qquad (1)$$

where WP_i is the world price for good i in foreign exchange
OER is the official exchange rate
DP_i is the domestic price for good i

Clearly the estimation of APRs for every individual good or service is not feasible; however, in order to provide a comprehensive set of APRs for the economy, all goods and services produced or consumed have to be combined under clearly defined productive sectors, each representing a single good or service or a homogeneous group of goods and services that can easily be distinguished from the others.

Estimation of the divergence between domestic and world prices of sectoral output is based on the sectoral cost structure. Depending on a sector's trade status, the economic opportunity cost of supplying an additional unit of sectoral output differs between internationally traded and non-traded, as well as between import and export, sectors.

If sectoral output is internationally traded at the margin, the opportunity costs are represented by foreign exchange used to buy imports or forgone if exports are diverted to the domestic market, to which the following are added: tariffs and subsidies applicable for imports and exports; and domestic trade and transport costs of delivering the commodities to the domestic purchaser.

Tables 1 and 2 show the general cost structure of traded sectors measured at the purchasers' price level and the method of entering each cost factor into the SIO table.

Table 1. Cost structure for import sectors a/

Cost factor	Input/SIO table	Matrix
c.i.f. import price	Foreign exchange	F-matrix
+ Import tariffs		
- Subsidies		
+ Indirect taxes at point of entry	Net transfers	F-matrix
+ Domestic transport cost	Transport	A-matrix
+ Domestic marketing cost	Trade	A-matrix

a/ Domestic price at point of delivery (purchasers' price)

Table 2. Cost structure for export sectors a/

Cost factor	Input/SIO table	Matrix
B.o.b. export price	Foreign exchange	F-matrix
- Export taxes		
+ Export subsidies	Net transfers	F-matrix
+ Domestic transport cost		
- Transport cost export	Net transport	A-matrix
+ Domestic marketing cost		
- Marketing cost export	Net trade	A-matrix

a/ Domestic price at point of delivery (purchasers' price)

In case, owing to the physical nature of the output, prohibitively high international transport costs, or deliberate government trade policy, sectoral output is not traded internationally, an increase in domestic demand for the non-traded sectors will inevitably require an expansion of domestic production, not only in the non-traded sector that supplies the final product, but also in other productive sectors that provide inputs into the non-traded sectors. In addition, inputs of such primary factors as foreign exchange or labour, the supply of which is determined outside the productive relations captured in the SIO table, must be increased.

The distinction between produced inputs provided from other productive sectors and primary factor inputs provided from outside the productive system forms the basis for the general structure of the SIO table. Each productive sector in the SIO table is represented by a column, with all direct inputs from other producing sectors being recorded along the rows for each productive sector. Hence the top part of the SIO table is a square matrix called the A-matrix of n productive sectors and giving the intersectoral input structure. Direct primary factor inputs into productive sectors are recorded in a rectangular matrix called the F-matrix, which consists of k primary factors recording primary factor inputs into the n productive sectors.

The general structure of an SIO table is shown below.

<u>General structure SIO table, direct coefficients</u>

$$\begin{bmatrix} a_{11}, & a_{21}, & \cdots, & a_{1n} \\ a_{21}, & a_{22}, & \cdots, & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1}, & a_{m2}, & \cdots, & a_{nn} \end{bmatrix} \qquad \begin{matrix} \text{A-matrix} \\ (n \times n) \end{matrix}$$

$$\begin{bmatrix} f_{11}, & f_{21}, & \cdots, & f_{1n} \\ f_{21}, & f_{22}, & \cdots, & f_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ f_{k1}, & f_{k2}, & \cdots, & f_{kn} \end{bmatrix} \qquad \begin{matrix} \text{F-matrix} \\ (k \times n) \end{matrix}$$

Hence, the first step in estimating APRs by the SIO approach is the construction of a direct coefficient matrix that gives the relative cost structure for the n productive sectors for which APRs are to be estimated.

In less sophisticated studies based on foreign trade data, it is commonly assumed that the divergence between world and domestic prices for traded sectors is determined solely by tariffs and subsidies applicable to imports and exports, and that the divergence between world and domestic prices for non-traded sectors may be equal to the average difference between world and domestic prices for all traded sectors, which is expressed by a standard conversion factor.*

In contrast, the SIO approach not only takes domestic trade and transport costs into account when estimating APRs for traded sectors, but more importantly estimates specific "world price

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*See, for example, Linn [8] and Adhikari [9] for such partial studies.

equivalent values" for each non-traded sector on the basis of the primary factor inputs that directly or indirectly (as primary factor inputs into produced inputs from other sectors) enter into the cost structure of those sectors. Therefore, the APR for a specific sector is estimated as the weighted average of the APRs of the primary factors that are directly or indirectly used to produce one extra unit of sectoral output.

In matrix algebra, the general formula for obtaining a full set of APRs for all productive sectors on the basis of their respective cost structures - a distinction being made between produced and primary factors - is:

$$P = PA + PfF \qquad (2)$$

where P is the vector of APRs for all productive sectors
A is the direct coefficient matrix at market prices for produced inputs from other productive sectors
F is the direct coefficient matrix at market prices for primary factor inputs
Pf is the vector of APRs for all primary factors

To express the produced inputs in terms of primary factor inputs and obtain the total, global primary factor requirements, the F-matrix has to be post-multiplied by the Leontief inverse of the A-matrix. Hence,

$$M = F\,(1-A)^{-1} \qquad (3)$$

where M is the global primary factor requirement matrix
$(1-A)^{-1}$ is the Leontief inverse of the A-matrix

Finally, to obtain the vector of APRs for all productive sectors P, the global primary factor requirements matrix has to be expressed in terms of world prices, which is done by multiplying it by the vector of the APRs for the primary factors Pf:

$$P = Pf(M) \qquad (4)$$

Here the problem of interdependence arises because, although the supply of primary factor inputs into productive sectors is determined outside the productive relations expressed in the SIO table, the APRs of some of the primary factors are partly or entirely determined by some APRs of productive sectors.*

The interdependence between P and Pf is taken care of in the computation by initially using seed values in the Pf that in subsequent rounds of computation are replaced by new values obtained

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*For example, the APR for the primary factor "rural unskilled labour" may depend on the APR for the productive sector "agriculture". In that case, the opportunity cost of rural unskilled labour is determined by the output forgone in its sector of origin (agriculture), output that has then to be converted from market into world prices by the sectoral APR for agriculture.

from the results of the previous round of calculation. The iterative process is continued until convergence in the values is achieved. Algebraically,

$$P^1 = Pf^0M$$

$$P^2 = Pf^1M$$

$$\vdots \qquad \vdots$$

$$P^n = Pf^{n-1}M$$

with convergence being reached when $P^n = Pf^{n-1}$ and $Pf^{n-1} = Pf^{n-2}$.

B. A semi-input-output table for Botswana

While in principle the sectoral structure of the SIO table should be determined by the requirements for APRs in the appraisal of development projects in a specific country, the availability of data sets a practical limit to that choice.

1. Traded sectors

On the basis of foreign trade statistics, internationally traded sectors may be identified and, depending on the marginal source of supply for domestic demand, classified as import or export sectors. For Botswana, 20 import, three export and one partially traded sectors were included in the SIO table (see table 3).

In theory, foreign trade statistics will provide the c.i.f. import and f.o.b. export prices, as well as different tariff and subsidy values applicable on imports and exports, while marketing and transport studies will provide data concerning domestic costs of moving imports and exports between the border, producers and domestic consumers.

Botswana, being a member of the Southern African Customs Union (SACU), is in international trade statistics generally only recorded together with the other SACU member countries, namely Lesotho, South Africa and Swaziland, as one area, while Botswana's own external trade statistics only show duty-inclusive values.

Hence, for the 20 import sectors of the SIO table, c.i.f. import prices representing foreign exchange inputs, and import tariffs representing transfer payments, were estimated on the basis of internal statistics provided by the Department of Customs and Excise that show duty-inclusive imports by commodity group and country of origin. On the basis of 61 commodity groups representing the 20 import sectors in the SIO table and accounting for approximately 40 per cent of total imports, imports in each commodity group were grouped into the following three different categories according to the country of origin:

(a) Imports from within SACU, for which no tariffs apply;

Table 3. Cost structure for traded sectors
(Percentage)

Sector	Trade status a/	Cost structure: Primary factor inputs: Foreign exchange	Primary factor inputs: Tariffs	Produced inputs: Trade	Produced inputs: Transport: Rail	Transport: Road	Transport: Others	Total
Maize	M	74.3	2.3	21.2	0.8	1.4	0.1	100
Wheat	M	76.9	4.4	17.1	0.5	1.0	0.1	100
Rice	M	62.1	0.0	34.1	1.3	2.3	0.2	100
Sugar	M	56.6	5.7	34.0	1.3	2.2	0.2	100
Other food	M	86.7	1.4	10.8	0.4	0.6	0.1	100
Spirits and beverages	M	89.6	0.2	9.2	0.4	0.6	0.0	100
Cement	M	81.1	2.9	14.4	0.5	1.0	0.1	100
Coal	M	80.6	0.7	17.1	0.5	1.0	0.1	100
Petroleum	M	73.6	0.0	24.5	0.7	1.1	0.1	100
Industrial chemicals	M	80.2	0.4	17.6	0.6	1.1	0.1	100
Chemical consumer goods	M	80.5	0.7	16.9	0.7	1.1	0.1	100
Wood	M	79.9	1.4	17.1	0.5	1.0	0.1	100
Textiles	M	79.0	2.4	16.9	0.6	1.0	0.1	100
Footwear	M	80.8	0.6	16.7	0.7	1.1	0.1	100
Iron and steel	M	77.2	3.5	17.6	0.6	1.0	0.1	100
Aluminium	M	81.1	2.2	17.1	0.5	1.0	0.1	100
Machinery	M	81.4	1.7	15.3	0.5	1.0	0.1	100
Consumer durables	M	71.1	2.8	23.5	0.9	1.5	0.2	100
Automobiles	M	84.8	0.7	13.1	0.5	0.8	0.1	100
Commercial vehicles	M	76.9	4.4	17.1	0.5	1.0	0.1	100
Diamonds	X	100.0	0.0	0.0	0.0	0.0	0.0	100
Copper-nickel matte	X	100.0	0.0	0.0	0.0	0.0	0.0	100
Beef	X	100.0	0.0	0.0	0.0	0.0	0.0	100
Electricity	NT/M	77.0	0.0	21.0	0.0	0.0	2.0	100

a/ M = imported at the margin; X = exported at the margin; NT/M = partially traded, with marginal supply coming from domestic production and from imports.

(b) Imports from Zimbabwe, for which basically a 10 per cent surcharge applies;

(c) Imports from other countries, which face various import and excise duties, ad valorem taxes and surcharges.*

On the basis of the tariffs given in the tariff handbook for Botswana, tariffs and c.i.f. import values were then estimated for all 20 import sectors.

In the absence of any detailed marketing and transport studies that could be used to determine trade and transport margins for the import sectors, the three different approaches described below were used to obtain those margins, depending on the data availability and the level of homogeneity of the commodities included in each sector:

(a) For homogeneous sectors represented by a single commodity (rice, cement etc.), the difference between retail prices in Gaborone and the estimated duty-inclusive border price represents the trade and transport margin. That was then decomposed into trade (90 per cent) and transport (10 per cent) components based on the average long-term shares of those sectors in GDP, and the transport component then further decomposed into the different subsectors based on the average long-term shares of each subsector in total value added in the transport sector;

(b) For sectors comprising several similar commodities, and where no import prices on a single product basis could be estimated, different products that are representative of their respective sectors were identified, and the difference in retail prices between Johannesburg and Gaborone was assumed to reflect trade and transport margins that were then decomposed following the same procedure as given above;**

(c) For rather heterogeneous sectors without representative products, trade and transport margins were assumed to be equivalent to the national average defined by the respective shares of trade and transport in GDP.

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*Few exceptions from these generally applicable tariffs were considered in the actual study.

**This approach is based on the fact that most of the imports, particularly in the commodity groups for which this approach was used, come from South Africa. The relevant import price would be the wholesale price ex Botswana border charged by South African suppliers. By using retail prices in Johannesburg instead, it is assumed that retail margins in South Africa may roughly be equal to additional costs that South African wholesalers would charge for transport and marketing if those goods were delivered to the Botswana border rather than the centrally located Johannesburg market.

Following those procedures, table 3 includes the relative cost structure for the 20 import sectors. With respect to Botswana's export sectors, the three included in the SIO table, namely diamonds, copper-nickel and beef, in 1986 accounted for 94.5 per cent of total exports. All exports from those sectors are de facto free of export tariffs.

In the absence of any domestic demand for diamonds and copper-nickel matte, no data on trade and transport margins for domestic sales were available. If it is assumed that potential domestic purchasers of those two commodities and of beef, the third export commodity, are located as close to the point of production as are Botswana's points of exit for exports - an assumption that is justified by the close proximity of both the production of those commodities and the most densely populated areas of Botswana to the borders to South Africa and Zimbabwe - then the opportunity costs of the export sectors are represented by forgone foreign exchange only (see table 3).

2. Non-traded and partially traded sectors

If sectoral output is not traded internationally, an increase in demand for output inevitably requires an increase in domestic production, and the marginal supply cost of domestic production represents the opportunity costs that are to be included in the SIO table for non-traded sectors.

For Botswana, a yet unpublished and preliminary version of the "Social Accounts Matrix 1983/84" has been made available,* and forms the basis for the cost structure of the 10 non-traded sectors and the domestically produced share of a partially traded sector, electricity, which are included in the SIO table. Table 4 shows the cost structure for those sectors.

With respect to electricity, Botswana at present obtains about 10 per cent of its supply from South Africa, and it is assumed that this will not change until about 1994, when the new power station at Morupule will have reached its maximum generation capacity and Botswana will have become self-sufficient in electricity supply.

In case of additional demand for electricity, it may thus be assumed that fresh supplies may be provided partly from the gradual increase of domestic production at Morupule, and partly from South Africa, with individual shares reflecting the existing situation. Table 4 thus shows the cost structure for the 90 per cent of electricity that is supplied from domestic sources, and the opportunity cost of the other 10 per cent that is imported is assumed to consist of 21 per cent of domestic trade costs, 2 per cent of domestic transmission costs and 77 per cent of foreign exchange, which is based on long-term average shares of trade and transport in gross domestic product (GDP), with the rest representing foreign exchange costs (see table 3).

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*See [10].

Table 4. Cost structure, non-traded sectors
(Percentage)

Input	Traditional agriculture	Water	Construction	Trade	Transport: Rail	Transport: Road	Transport: Others	Communi-cations	Financial services	Other services	Electricity
Maize	0.5	--	0.1	0.3	0.2	--	--	--	0.1	--	--
Other food	0.4	--	0.1	0.3	--	--	--	--	--	--	--
Cement	--	0.1	0.1	--	--	--	--	--	--	--	--
Coal	--	--	1.6	--	--	--	--	--	--	2.5	8.5
Petroleum	0.1	--	0.2	0.2	0.2	0.3	0.4	--	0.1	0.1	0.2
Industrial chemicals	--	0.1	0.1	0.2	--	0.4	--	0.1	--	--	--
Wood	0.1	--	0.2	0.2	0.2	0.3	0.4	--	0.1	0.1	--
Iron and steel	--	--	0.1	0.1	--	--	--	--	0.1	--	--
Beef	0.8	--	0.2	0.8	0.2	--	0.4	--	0.1	0.2	--
Traditional agriculture	2.4	--	--	1.1	--	--	--	--	--	0.3	--
Water	--	0.6	0.2	1.4	0.2	0.3	--	1.2	0.5	0.6	1.6
Construction	0.1	1.2	3.7	1.1	0.9	0.6	1.6	0.6	1.3	1.6	1.0
Trade	1.7	1.2	4.5	3.2	2.4	5.2	3.6	1.8	1.7	3.6	4.1
Transport, rail	0.2	--	0.2	2.6	--	--	2.0	3.5	--	0.9	3.7
Transport, road	0.1	--	1.5	5.2	0.4	0.3	1.2	--	0.3	3.3	0.2
Transport, other	0.1	1.8	1.3	1.5	1.9	1.5	4.0	0.6	1.6	0.9	0.6
Communications	0.3	2.4	1.4	1.5	2.4	5.5	1.2	1.4	0.5	0.7	--
Financial services	1.2	10.8	6.9	14.0	11.1	10.1	24.2	7.1	7.3	2.3	2.6
Other services	0.3	4.8	2.4	2.7	3.9	3.7	8.7	1.8	2.3	0.9	1.0
Electricity	--	10.8	0.2	1.9	0.4	0.3	0.4	1.2	0.6	0.8	--
Agriculture investment CF a/	1.8	--	--	--	--	--	--	--	--	--	--
Trade investment CF a/	--	--		5.3	--	--	--	--	--	--	--
Transport investment CF a/	--	--		--	3.4	9.5	2.8	--	--	--	--
Utilities investment CF a/	--	39.2	--		--		--		--		17.3
Average investment CF a/	--	--	1.7	--	--	--	--	22.5	10.1	10.5	--
Skilled labour, foreign	--	11.5	5.2	4.2	--	3.4	15.1	19.5	12.0	10.2	4.8
Skilled labour, local	--	12.7	11.3	22.6	6.2	13.1	8.3	26.6	24.9	32.2	7.3
Unskilled labour, urban	--	3.6	7.9	9.8	3.7	4.3	1.2	3.5	1.0	2.8	0.8
Unskilled labour, rural	75.3	--		--		--		--		--	--
Foreign exchange	12.1	6.6	31.4	14.9	60.0	38.5	23.4	6.5	10.8	20.6	31.3
Operating surplus	--	-7.8	11.4	2.3	--	-2.1	-6.4	1.2	22.0	1.1	9.4
Transfers	2.5	0.6	6.1	2.6	2.1	8.3	2.8	1.2	1.6	4.0	4.9
Total	100	100	100	100	100	100	100	100	100	100	100

a/ Depreciation expenditures are recorded under the respective sectoral or national investment conversion factors (CF)

3. Aggregate conversion factors

Although specific APRs should ideally be calculated for each individual cost and benefit item of a potential development project, that is generally not feasible owing to the lack of manpower or funds or to other constraints. Therefore, on the basis of national averages rather than project-specific data, sectoral APRs are estimated for homogeneous groups of goods and services generally produced or consumed in the economy and are applied to corresponding items in a project's cost-benefit stream. For less specific, minor cost or benefit items, no specific sectoral APR may be available. In that case, aggregate APRs may be used.

Within the framework of a SIO analysis, such aggregate conversion factors are the weighted averages of specific sectoral APRs. Technically, they are integrated into the SIO table by adding an additional row and column for each aggregate conversion factor in the A-matrix, with the rows recording expenditures made by other sectors on items covered by the aggregate conversion factor, and the column entries recording the weights that specific sectoral APRs carry in defining the aggregate conversion factor.

Table 5 shows the columns for the 15 aggregate conversion factors estimated for Botswana. Weights for the six sectoral investment conversion factors as well as for the economy-wide average investment conversion factor are based on the shares of machinery, transport equipment (commercial vehicles) and building (construction) in total sectoral or national stock of fixed assets. The three aggregate consumption conversion factors are based on the different weights that 152 goods and services included in Botswana's cost-of-living indices carry in the baskets for urban high-income, rural and total consumption. Four aggregate sectoral conversion factors are included for the major sectors of agriculture, mining, manufacturing and transport and communications, and the weights are determined by the respective input or output values of the six agricultural sectors included in the SIO table for agriculture, by total sales values of the three mining sectors for mining, by import and export values of the 15 manufacturing sectors for manufacturing, and by value-added values for the four transport and communications sectors. An economy-wide average conversion factor is included on the basis of the average shares of all sectors in GDP from 1980/81 to 1985/86.

C. Derivation of accounting price ratios for Botswana

The estimation of APRs for all economic activities in Botswana follows the general procedure outlined earlier. On the basis of the relative cost structure of traded, non-traded and partially traded sectors and aggregate conversion factors as given in tables 3, 4 and 5, a direct coefficient matrix of 49 independent columns and 56 rows was constructed, consisting of an A-matrix (49 x 49) and an F-matrix (7 x 49).

By post-multiplying the F-matrix by the Leontief inverse of the A-matrix as shown in formula (3), the global primary factor requirements matrix is obtained. As the M-matrix so obtained is

Table 5. Structure of aggregate conversion factors
(Percentage)

Item	Agriculture investment CF	Mining investment CF	Manufacturing investment CF	Trade investment CF	Transport investment CF	Utilities investment CF	Average investment CF	Urban high-income consumption CF	Rural consumption CF	Average consumption CF	Agriculture conversion factor	Mining conversion factor	Manufacturing conversion factor	Transport and communications CF	Average CF
Maize	-	-	-	-	-	-	-	0.5	16.7	9.4	14.0	-	-	-	-
Wheat	-	-	-	-	-	-	-	1.5	4.9	3.7	5.4	-	-	-	-
Rice	-	-	-	-	-	-	-	0.8	1.1	1.4	5.4	-	-	-	-
Sugar	-	-	-	-	-	-	-	0.5	9.6	5.2	9.4	-	-	-	-
Other food	-	-	-	-	-	-	-	11.8	15.5	15.0	17.4	-	-	-	-
Spirits and beverages	-	-	-	-	-	-	-	3.4	2.6	3.5	-	-	1.0	-	-
Cement	-	-	-	-	-	-	-	0.3	1.5	0.9	-	-	2.8	-	-
Coal	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-
Petroleum	-	-	-	-	-	-	-	4.0	2.7	3.1	-	-	15.6	-	-
Industrial chemicals	-	-	-	-	-	-	-	-	-	-	-	-	1.6	-	-
Chemical consumer goods	-	-	-	-	-	-	-	4.0	6.7	6.2	-	-	6.7	-	-
Wood	-	-	-	-	-	-	-	-	-	-	-	-	2.1	-	-
Textiles	-	-	-	-	-	-	-	7.5	14.4	12.0	-	-	6.9	-	-
Footwear	-	-	-	-	-	-	-	1.0	3.3	2.5	-	-	2.7	-	-
Iron and steel	-	-	-	-	-	-	-	0.5	3.2	2.0	-	-	8.0	-	-
Aluminium	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-
Machinery	27.8	62.2	47.6	28.1	5.33	59.5	25.2	-	-	-	-	-	4.8	-	-
Consumer durables	-	-	-	-	-	-	-	11.5	6.3	7.7	-	-	1.2	-	-
Automobiles	-	-	-	-	-	-	-	6.3	0.8	2.9	-	-	8.4	-	-
Commercial vehicles	23.9	1.0	7.0	10.2	34.7	0.1	6.4	-	-	-	-	-	13.5	-	-
Diamonds	-	-	-	-	-	-	-	-	-	-	-	76.9	-	-	-
Copper-nickel matte	-	-	-	-	-	-	-	-	-	-	-	22.0	-	-	-
Beef	-	-	-	-	-	-	-	4.0	3.6	5.5	-	-	24.1	-	-

continued

Table 5 (continued)

Item	Agriculture investment CF	Mining investment CF	Manufacturing investment CF	Trade investment CF	Transport investment CF	Utilities investment CF	Average investment CF	Urban high-income consumption CF	Rural consumption CF	Average consumption CF	Agriculture conversion factor	Mining conversion factor	Manufacturing conversion factor	Transport and communications CF	Average CF
Traded agriculture	-	-	-	-	-	-	-	-	-	-	51.3	-	-	-	-
Water	-	-	-	-	-	-	-	2.0	0.5	0.9	-	-	-	-	1.2
Construction	48.3	36.8	45.4	61.7	12.0	40.4	68.4	15.8	0.2	6.3	-	-	-	-	4.5
Trade	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.8
Transport, rail	-	-	-	-	-	-	-	0.4	-	0.2	-	-	-	25.1	-
Transport, road	-	-	-	-	-	-	-	4.4	5.0	4.4	-	-	-	42.6	-
Transport, others	-	-	-	-	-	-	-	1.0	-	0.3	-	-	-	4.4	-
Communications	-	-	-	-	-	-	-	1.1	-	0.4	-	-	-	27.9	-
Financial services	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.5
Other services	-	-	-	-	-	-	-	13.0	1.4	5.1	-	-	-	-	19.0
Electricity	-	-	-	-	-	-	-	4.7	-	1.4	-	-	-	-	1.2
Agricultural CF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.4
Mining CF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.2
Manufacturing CF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8
Transport and communications CF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.4
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

<u>Note</u>: CF = conversion factor.
- = not applicable.

still expressed in terms of market prices, it has to be converted into world prices by multiplying it by a vector Pf of APRs for the seven primary factors of the SIO table to obtain the final set of 49 APRs for Botswana's main economic activities.

Here the problem of interdependence arises. As table 6 shows, only the APRs for, on the one hand, the foreign-exchange primary factor, which is the numeraire in the LM/SVT system and therefore does not require a conversion, and, on the other hand, transfers, which do not represent any claim on real resources and therefore are eliminated from the economic analysis by an APR of zero, are defined independently from any APR for a productive sector or aggregate conversion factor.

Table 6. Definition of primary factor APRs

Primary factor	Definition of APR
Skilled labour, foreign	0.326 + (0.674 x UHICCF) a/
Skilled labour, local	Average conversion factor
Unskilled labour, urban	0.35 x APR traditional agriculture
Unskilled labour, rural	APR traditional agriculture
Foreign exchange	1.0
Transfers	0
Operating surplus	0.3 x average conversion factor

a/ UHICCF = urban high-income consumption conversion factor.

The APRs for the four different types of labour and for operating surplus are partly determined by coefficients and constant values, the estimation of which, being outside the relationships of the SIO table, is explained in detail in the next section. Those APRs are however also determined partly by the APRs for the traditional agriculture sector, and by the aggregate conversion factors, specifically the urban high-income consumption conversion factor and the average conversion factor. On the basis of formula (4), initial seed values of 0.8 were used for all Pfs in the first round of computation. They were in consecutive rounds of computation replaced by the results obtained from the previous rounds.

The procedure was followed iteratively until convergence in the values was reached after the eleventh round of computation. The final results are given in table 7.

Table 7. Accounting price ratios for Botswana

Sector	Status	APR	Sector	Status	APR
Maize	M	0.92	Communications	NT	0.81
Wheat	M	0.91	Financial services	NT	0.71
Rice	M	0.91	Other services	NT	0.82
Sugar	M	0.86	Electricity	NT/M	0.80
Other food	M	0.96	Agriculture investment CF	ACF	0.83
Spirits and beverages	M	0.97	Mining investment CF	ACF	0.86
Cement	M	0.93	Manufacturing investment CF	ACF	0.84
Coal	M	0.95	Trade investment CF	ACF	0.80
Petroleum	M	0.94	Transport investment CF	ACF	0.91
Industrial chemicals	M	0.95	Utilities investment CF	ACF	0.85
Chemical consumer goods	M	0.95	Average investment CF	ACF	0.79
Wood	M	0.94	Urban high-income consumption CF	ACF	0.86
Textiles	M	0.93	Rural consumption CF	ACF	0.92
Footwear	M	0.95	Average consumption CF	ACF	0.91
Iron and steel	M	0.92	Agriculture CF	ACF	0.87
Aluminium	M	0.95	Mining CF	ACF	1.00
Machinery	M	0.94	Manufacturing CF	ACF	0.95
Consumer durables	M	0.91	Transport and communication CF	ACF	0.83
Automobiles	M	0.96	Average CF	ACF	0.86
Commercial vehicles	M	0.91	Skilled labour, foreign	Pf	0.92
Diamonds	X	1.00	Skilled labour, local	Pf	0.86
Copper-nickel matte	X	1.00	Unskilled labour, urban	Pf	0.29
Beef	X	1.00	Unskilled labour, rural	Pf	0.83
Traditional agriculture	NT	0.83	Foreign exchange	Pf	1.00
Water	NT	0.87	Transfers	Pf	0.00
Construction	NT	0.72	Operating surplus	Pf	0.26
Trade	NT	0.76			
Transport, rail	NT	0.88			
Transport, road	NT	0.81			
Transport, other	NT	0.86			

<u>Key</u>: M = Productive sector, imported at the margin
X = Productive sector, exported at the margin
NT = Productive sector, non-traded at the margin
NT/M = Productive sector, partially traded with marginal supply coming from domestic production and from imports
ACF = Aggregate conversion factor
Pf = Primary factor

1. APRs for labour

In general terms, the APR for labour is defined as the ratio of labour's shadow wage rate (SWR) over its market wage rate (MWR), with the SWR being defined as the opportunity cost of labour expressed by the value of output forgone in its alternative use, measured at world prices.

Algebraically:

$$APR_l = \frac{m_i \times APR_i}{MWR}$$

where m_i is the output forgone in activity i
APR_i is the accounting price ratio for output of activity i

In case of perfect labour markets, the MWR reflects economic opportunity costs and therefore equals m_i.

In Botswana the case for skilled labour, generally in short supply, is supported by the following considerations. As demand rather than wage legislation or trade union bargaining strength* determines the MWR for skilled labour, that MWR may be assumed to reflect opportunity costs. As skilled labour in Botswana is mobile on a national scale, the economy-wide average conversion factor has to be used to convert opportunity cost from market into world prices.

With respect to skilled foreign labour, a different approach has to be adopted, as the economic opportunity cost for that type of labour consists of the following two components: the proportion of the MWR that is repatriated, representing a loss in foreign exchange to the economy; and the proportion of MWR that is consumed locally, representing a loss in consumer goods and services. As foreign exchange is the numeraire, its APR is unity; but the domestically consumed proportion of earnings has to be converted into world prices by an appropriate APR that is the weighted average of the APRs for all goods and services consumed locally by foreign labour. For Botswana it was estimated that on average 32.6 per cent of expatriate earnings are repatriated, while the other 67.4 per cent is consumed within Botswana. A special aggregate conversion factor for urban high-income consumption was integrated into the SIO table to convert that 67.4 per cent of earnings from market into world prices.

With respect to unskilled labour, generally in abundant supply in developing countries, two different labour markets have to be distinguished. In the urban formal sector, market wages are generally determined by government minimum-wage legislation or other forms of market intervention, and market wage rates cannot be assumed to reflect opportunity costs of unskilled labour on those markets. In the rural informal sector, distorting labour-market

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*See Kitchen and Weiss [11] for a general discussion of market distortions on labour markets and other factor markets in developing countries.

legislation usually does not apply, and a relatively large number of potential employers and employees who are reasonably well-informed about prevailing market conditions guarantees that MWRs broadly reflect labour productivity and thus equal opportunity cost in terms of output forgone in rural production measured at market prices.

With respect to Botswana those conditions hold true, and an analysis of its population and labour force structure reveals that the traditional agricultural sector is the ultimate source of unskilled labour. Migration studies show strong rural-to-urban migration flows that are however matched by almost equally strong counterflows from urban to rural areas. It may thus be assumed that output forgone in traditional agriculture if one person leaves the sector represents the opportunity cost of unskilled labour in Botswana. Table 8 shows the average net household income in traditional agriculture from major sources and for different regions, which forms the basis for estimating the average output forgone* in traditional agriculture per working person as given in table 9.

Table 8. Average net farm income from traditional agriculture in Botswana (Pula) a/

Region	Crops b/	Cattle	Goats	Sheep	Total
Southern	26.83	825.60	59.34	72.24	994.01
Gaborone	25.53	1 191.96	85.14	74.82	1 377.45
Central	29.24	1 443.94	107.50	136.74	1 717.42
Francistown	35.12	839.36	40.42	82.56	917.09
Maun	15.38	994.16	86.86	157.38	1 253.78
Western	0.00	829.04	93.74	777.44	1 700.22
Average	33.47	1 162.72	82.56	153.08	1 431.83

a/ Botswana currency unit.

b/ Based on the production of sorghum, maize, millet, beans and pulses.

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*In theory, the marginal rather than average output forgone reflects the opportunity cost of unskilled labour. The results may therefore overestimate the value of rural output forgone; but since those migrating to the urban areas are mainly young male workers who contribute most to rural production, average values may still provide acceptable orders of magnitude of the opportunity cost of unskilled labour.

Table 9. Average rural net income from traditional agriculture in Botswana (Pula) a/

Region	Annual household income b/	Average household size	Working members per household	Annual income per worker	Daily income per worker 1985	Daily income per worker 1988
Southern	994.01	5.93	3.67	270.85	1.13	1.34
Gaborone	1 377.45	5.75	3.56	386.92	1.61	1.91
Central	1 717.42	5.95	3.69	465.43	1.94	2.30
Francistown	917.09	5.90	3.66	250.57	1.04	1.24
Maun	1 253.78	4.92	3.05	411.08	1.71	2.03
Western	1 700.22	5.76	3.57	476.25	1.98	2.35

a/ Botswana currency unit.

b/ Based on the production of sorghum, maize, millet, beans and pulses.

While the opportunity cost of unskilled labour from traditional agriculture has been estimated on the basis of regional as well as national production figures, the SIO table constructed to estimate national economic parameters only considers the national weighted average of labour costs for unskilled labour, consisting of unskilled labour to be employed in the urban formal sector and that employed in the rural informal sector.*

For unskilled rural labour it can be assumed that the MWR will equal its opportunity cost of 1.98 pula (P) per day. That is not the case for unskilled urban labour because government minimum wage legislation has fixed its MWR at P 5.60 per day. Hence, for unskilled rural labour the APR is determined directly by the APR for traditional agriculture that is required to convert the output forgone of P 1.98 from market into world prices to obtain the SWR.

The APR for unskilled urban labour is determined by the output forgone (P 1.98) in its supply sector (traditional agriculture), revalued by the APR for that sector, the result being divided by the MWR of P 5.60 - in other words, it is determined by the coefficient 0.35 (1.98/5.60) multiplied by the APR for traditional agriculture.

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*In addition to the national parameter, the main study also estimates regional conversion factors for unskilled rural labour on the basis of the output forgone in the six different regions into which Botswana was subdivided.

D. Operating surplus

Operating surplus as part of the cost structure of non-traded sectors in the SIO table is dealt with in two ways. Either it is converted into economic accounting prices by an APR of zero if it is the residual value after all payments for real resources used in the production of sectoral output have been made, operating surplus therefore representing only excess profit with no economic value. Or it has to be revalued by an APR that is the weighted average of the APRs for factor inputs not specifically recorded but lumped together under operating surplus. Possible factor payments are returns to self-employed entrepreneurs or family labour not entered under labour costs or returns to capital in the cost structure.

The exact definition of operating surplus in [10], on which the cost structures of the non-traded sectors in the SIO are based, is not known. Depreciation and payments to self-employed labour are however included under the aggregate investment conversion factors and under labour, and there is limited scope for operating surplus to include further payments for real resources that have any economic value.

A sensitivity analysis has revealed that the APRs for such non-traded sectors as financial services, construction or trade, which feature high levels of operating surplus in their cost structure, are highly sensitive to a change in definition of the primary factor. For example, the APR for financial services changes from 0.98 if the APR for operating surplus is assumed to be zero, to 0.64 if the APR for operating surplus is assumed to be equal to the average conversion factor, which is the case if operating surplus represents unspecified returns to real resources that may have been provided from any factor and any sector in the economy.

Given that most possible payments to real resources are already covered under specific input categories, it was assumed that operating surplus consists of 70 per cent of excess profits and 30 per cent of returns to unspecified primary factors that are converted into the numeraire by the average conversion factor (see table 6).

E. Discount rates

The final national economic parameter determined independently from all other parameters is the discount rate that represents the opportunity cost of capital in Botswana. It is required in project appraisal for two reasons: to convert costs and benefits realized at various points in time to the common basis of the present; and to establish a minimum acceptable rate of return for potential projects when allocating funds. The value of the opportunity cost of capital depends on the marginal source of supply of investment funds.

Although it is often assumed that investment funds for public sector projects in developing countries are generally fixed, so that the ultimate source of funds for new projects are other projects that are denied investment funds.* Governments in developing countries are however likely to have some scope for drawing upon domestic or foreign savings to finance additional projects. In that case, the supply cost of marginal funds, measured in real economic terms, determine the opportunity cost of capital.

For countries like Botswana that have access to international capital markets, capital becomes a traded commodity, and the real cost of international borrowing from the least attractive source - generally assumed to be the international commercial capital market where the cost of borrowing is determined by the London Inter-Bank Offered Rate (LIBOR) plus a spread that covers the country risk premium and various other charges - determines the opportunity cost of capital.

Botswana, primarily owing to the rapid expansion of its diamond mining sector, has recently accumulated substantial capital reserves.** By the end of 1987 it held foreign exchange reserves of $1.8 billion, which covers approximately 28 months' worth of imports. Botswana can therefore be treated as a capital surplus country, and it is most likely that the marginal source of supply of investment funds for development projects are funds previously lent abroad.

For Botswana, the opportunity cost of capital is represented by the real rate of return from the least attractive foreign investment. As foreign investments are generally made in foreign exchange rather than the domestic pula, nominal rates of return are already expressed in terms of the numeraire and only have to be inflation-adjusted to be expressed in real terms. The appropriate price index is a combined index of the international price movements for Botswana's import and export commodities, with weights being determined by the respective shares of each commodity in the total value of foreign trade.

According to the Bank of Botswana, returns from foreign lendings at the end of 1987 ranged between 3 per cent and 10 per cent per annum, depending on the currency of investment, with an average nominal rate of interest of 7.5 per cent. Theoretically, the lowest interest rate of 3 per cent would represent the opportunity cost of capital. As the difference in nominal interest rates however reflects the difference in currency risk, lendings yielding above-average nominal rates of interest may be at risk of currency depreciation resulting in reduced overall yields, while for lendings with below-average nominal interest rates the opposite may be assumed.

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*See, for example, Powers [7], p. 46. In this case, the internal rate of return of the least acceptable project would represent the opportunity cost of capital and determine the discount rate.

**In addition, Botswana in 1983 received about nine times the average per capita development assistance for all developing countries (see United Nations [12], Commonwealth Secretariat [13] and World Bank [14] for data).

If the difference in nominal interest rates correctly reflects currency risks, the average nominal interest rate of 7.5 per cent is the appropriate rate that reflects returns from international lendings. The nominal rate has to be inflation-adjusted by a foreign trade deflator. On the basis of the import price index published by the Bank of Botswana and the price movements on the international markets for Botswana's major export commodities, in particular diamonds, copper nickel and beef, an average foreign trade deflator of 2.38 per cent per annum was estimated for Botswana.

By deflating the average nominal interest rate of 7.5 per cent by the deflator, a real rate of return from international lending of 5.12 per cent per annum is derived, which represents the opportunity cost of capital for Botswana and should be used as discount rate in the economic appraisal of project proposals.

F. Conclusions

At the theoretical level, project appraisal techniques that use a cost-benefit analysis framework to establish the net economic contribution to national income of potential development projects are now well established and offer various methodologies to estimate comprehensive sets of national economic parameters. At the practical level, however, the adaptation of those techniques to select projects that use scarce resources most efficiently has been slow and sporadic.

The slow pace of adaptation may have been partly caused by concerns about the underlying theoretical foundations of the appraisal techniques,* but certainly also by the expected difficulties in actually estimating meaningful sets of APRs that cover all economic activities within an economy and are at the same time specific enough to be applied to corresponding cost and benefit items of a project's cash flow. Most of the theoretical issues having been dealt with, the complexity of the estimation procedure may now be regarded as the major obstacle to a wider application of the appraisal techniques against the background of a limited data base in many developing countries.

Focusing on the practical procedures applied in a recent study on Botswana, this paper has tried to show that, by adopting the semi input-output approach, detailed and economically meaningful parameters can be estimated on the basis of data generally available in developing countries. While crude assumptions have to be made when reliable, detailed data are not available, the establishment, within the central planning organization of a developing country, of a permanent unit designed to refine and update the estimates could help to minimize the problem of limited data.

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*This is borne out, for example, by the well-documented, intense debate during the late 1970s and early 1980s about the assumed free-trade bias of the LM/SVT method.

Finally, it should be stressed that the results of an economic appraisal of potential development projects should form only the quantitative basis for a project selection process that also takes broader and less quantifiable social, cultural and political objectives into account.

References

1. I.M.D. Little and J. Mirrlees, Manual of Industrial Project Analysis in Developing Countries (Paris, Organization for Economic Co-operation and Development, 1969), vol. 2.

2. I.M.D. Little and J. Mirrlees, Project Appraisal and Planning in Developing Countries (London, Heinemann, 1974).

3. L. Squire and H. van der Tak, Economic Analysis of Projects (Baltimore, Johns Hopkins University Press, 1975).

4. J. Weiss, "Approaches to estimating national economic parameters: Jamaica, Nepal and Ethiopia", Project Appraisal 1987, vol. 2, No. 1, pp. 21-30.

5. J. Tinbergen, Development Planning (London, World University Library, 1967).

6. A. Kuyvenhoven, Planning with the Semi Input-output Method - with Empirical Reference to Nigeria (Leiden, Martinus Nijhoff, 1978).

7. T. Powers, ed., Estimating Accounting Prices for Project Appraisal (Washington, D.C., Inter-American Development Bank, 1981).

8. J. F. Linn, Economic and Social Analysis of Projects: A Case Study of the Ivory Coast, World Bank Staff Working Paper No. 253 (Washington, D.C., World Bank, 1977).

9. R. Adhikari, National Economic Parameters for Nepal, Project Planning Centre Occasional Paper No. 9 (Bradford, United Kingdom, Unversity of Bradford).

10. Botswana Ministry of Finance and Development Planning "Botswana social accounts matrix 1983/84", preliminary version (Gaborone, 1987).

11. R. Kitchen and J. Weiss, "Prices and government intervention in developing countries", Industry and Development, No. 20 (UNIDO publication, Sales No. E.86.II.B.7), pp. 51-99.

12. Statistical Yearbook 1983/84, United Nations publication, Sales No. E/F.85.XVII.1).

13. Commonwealth Secretariat, Basic Statistical Data on Selected Countries (London, 1985).

14. World Bank, World Development Report 1985 (New York, Oxford University Press, 1985).

IMPROVEMENT OF THE SMALL-SCALE FOOD INDUSTRY IN DEVELOPING COUNTRIES*

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Introduction

The development of small-scale food enterprises in developing countries is limited by the lack of technological research oriented towards their needs. In this paper it is suggested that integration of current industrial extension services (mainly dealing with management and credit components) with technological research in local institutions could make significant improvements and encourage development of the industry. Experiences of the International Development Research Centre (Canada) and a case-study conducted in Thailand are reviewed to illustrate possible approaches toward those objectives.

The development of small enterprises has in recent years become an important component of industrial development strategies in the third world. The characteristics of small enterprises fit well with the objectives of poor countries; they are labour-intensive, employment-generating, less capital-demanding and adapted to operation in rural areas. This is in contrast to large-scale enterprises which tend to be centralized and capital-intensive, and which until recently have been in favour [1].

Third world countries are seeking to find appropriate development strategies that promote food production and distribution, increased employment and income generation within their particular constraints of capital availability, culture and infrastructure. Indigenous small- and medium-scale food-processing industries can play an important role.

Indigenous industries have evolved through the determination and skills of local entrepreneurs in providing goods for local consumers, often at low prices. The majority of those industries operate as family businesses at household or small-scale level, in both urban and rural areas. There is evidence that a proportion of the businesses successfully grow to become medium and large-scale enterprises with expanding employment [2].

There is considerable difficulty in assessing the important role of small-scale industries in developing countries, because most

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small plants are not registered and size classifications are problematic and not standardized across countries. However, recently compiled data (see table 1) confirm that household, small- and medium-scale enterprises dominate industry in developing countries, contributing more than 60 per cent of employment in most cases. Those plants generally provide more jobs per unit of capital invested when compared with large-scale plants [3].

Table 1. Share of employment in industry by size category, selected countries and areas
(Percentages)

Country or area		Cottage, 3 workers	Small- and medium-scale, 3-99 workers	Large-scale, over 100 workers
Colombia	1978	43	29	28
	1964	51	26	24
Ghana	1970	78	7	15
India	1973	60	18	22
Indonesia	1975	76	12	12
Kenya	1969	49	10	41
Mexico	1974	84		16
	1970	83		17
Nigeria	1972	59	15	26
Pakistan	1976/77	86	13	1
Philippines	1975	64	9	26
	1967	78	7	15
Taiwan Province	1971	3	33	64
	1940	25	75	
	1920	61	39	
United Republic of Tanzania	1967	55	8	37

Sources: S. Nanjundan, "Small and medium enterprises - some basic development issues" (UNIDO/PC.137) (original references cited therein); J. Gutierrez Estrada, "La pequeña y mediana industria: situación problemática y perspectivas", (Mexico City, Universidad Nacional Autónoma de México, 1975) (thesis) (small- and medium-scale plants defined by capital assets of from 25,000 to 25,000,000 pesos); Federal Bureau of Statistics, Survey of Small and Household Manufacturing Industries 1976/77 (Karachi, Government of Pakistan, 1982) (survey of 80,000 small plants with fixed assets of less than 2 million rupees; data referring only to samples).

The food industry is typically one of the most important industries in developing countries (see table 2). Small-scale and household plants dominate, with typically over 80 per cent of food plants in developing countries in those categories (see tables 3 and 4). A number of country surveys of small-scale industry have been made ([4], [5] and [6]). However, more standardized and comprehensive surveys of small-scale industry in more developing countries are necessary in order to provide data bases comparable to those available for large-scale industry and capable of serving as a basis for development strategies.

Table 2. Contribution of food industry to total manufacturing industry
(Percentage) a/

Country group	Number of employees	Number 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)			
Average	22	23	26
Philippines	21	35	24
Guatemala	27	26	34
Zimbabwe	15	..	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
Developed countries			
Canada	11	12	15

Source: Yearbook of Industrial Statistics 1981, vol. I (United Nations publication, Sales No. E.83.XVII.5).

a/ Most recent year.

Table 3. Scale of food industry in selected developing countries

Item	Percentage of establishments and number of employees by 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
Employees	1-4	5-25	26-100	100
Chile b/	50.5	44.8	4.6	
Bakery products	25.6	27.4	0.5	
Employees	1-4	5-49	>49	
Philippines b/	79.0	18.8	1.5	0.6
Employees	1-4	5-19	20-99	>100
Indonesia c/	91.2	8.4	0.4	
Employees	1-4	5-19	20+	

a/ Data presented by the Centro de Investigaciones en Tecnología de Alimentos, San José, Costa Rica, at the Latin American Seminar on Development of Rural Food Agro-industry, held at San José, Costa Rica, 1985.

b/ Adapted from W. Edwardson and C. W. McCormac, eds., Improving Small-scale Food Industry in Developing Countries (Ottawa, International Development Research Centre, 1984).

c/ Adapted from Small-scale Industry Statistics, 1979 (Jakarta, Government of Indonesia).

Table 4. Peninsular Malaysia: a/ Number of employees by industry type (Percentage)

Industry	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/ Adapted from W. Edwardson and C. W. McCormac, eds., Improving Small-scale Food Industry in Developing Countries, (Ottawa, International Development Research Centre, 1984).

A. Technological development of the food industry in developing countries

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

Such plants are typically family-operated businesses, utilizing local raw materials. They provide local employment, often informally, in the production of popular processed foods that are marketed in the immediate area of the nearest city, usually at prices affordable to the majority of the population. Thus millions of customers are supplied with soy sauce, noodles, fish paste, steamed and 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. That does not mean that those foods are provided only by small plants, for there usually exists a local larger-scale plant that also produces such popular products, but they are often higher-priced and targeted at the more affluent consumer who will pay for the perceived higher quality and more expensive packaging and marketing associated with those companies.

The large-scale plants were established either during colonial times for the primary processing, with imported technology, of raw materials such as sugar, fats and oils for shipment to European industry; or since the end of the Second World War, when decision-makers in third world countries, who had been trained in Western countries, understandably implemented large-scale, capital-intensive projects dependent on imports of equipment, technology and know-how from developed countries where the technologies and products had proven successful [7]. Thus were established the flour-milling complexes, the massive export canneries for pineapples, the prawn-freezing plants, the breweries and soft-drinks plants etc.

The foods produced were again mainly for export or for the urban high-income consumer, and have been important new sources of employment. Such developments have usually been fostered by transnational corporations that provided all the management and technical know-how. In more recent times, there has been considerable persuasion and success in using a joint-venture approach, in which local developing country finance and personnel are combined with contributions, usually involving technology transfer, from the developed country partner, perhaps under a licensing agreement. Such ventures again provide mainly developed country products for the local high-income consumer 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 the newer activities create significant employment in proportion to the capital invested. The contribution to food availability for the low-income majority is insignificant, if not negative, owing to heavy advertising, based on health and status factors, that motivates the consumers to spend some of their limited cash on products such as dried milk and fruit-drink mixes, thus depriving them of the opportunity to purchase cheaper, typically fresh, but more perishable products.

It may 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, usually large-scale, separate and divorced from the traditional food industry, which continues to survive. There has been little, if any, internal transfer of technology to the traditional sector.

Against such a background, development strategies have concentrated on the establishment of new processing industries, both large-scale and small-scale, based on the agro-industry model, the large-scale to encourage export of processed commodities (crude vegetable oils, fruit pulps and juices, seafood), and the small-scale to provide income-generating opportunities for farmers and fishermen to stabilize their surplus and provide products for nearby domestic markets.

The experience of many such projects has been described, including the failure to meet expectations owing to the inappropriate nature of the undertaking [7]. While substantial investments, often with a high foreign exchange component, have been committed to large-scale plants, the peculiarities of the food industry and the distinct environments of developing countries have limited the success of large-scale plants, many of which are standing unused or operated at low capacity. In many developing countries the equipment and operating environments are not appropriate to the projects undertaken, and the required high volumes and consistent supplies of raw material and accessibility to water, energy and financial resources are not sustainable. Together with poorly developed operator skills, distribution and marketing infrastructure, such conditions result in a less controllable environment which critically affects the viability of large-scale ventures.

Another limiting constraint is the deficiency of management, since large-scale plants require a number of specialized managers for each function in the business. Trained managers in developing countries are very scarce, particularly in specialist areas.

Harper [3] suggests that small enterprises are less management-intensive than large ones, and that they should be promoted for that reason.

At the smaller-scale level, many of the above-mentioned factors do not interact so critically. There is considerably more flexibility at lower capacity, provided technology of the appropriate scale is employed. Managers need not be so specialized, and are inherently much more involved with the manifold aspects of management. However, in the development of new small-scale agro-industries, success has been jeopardized by the insufficient attention given to managerial competence and motivation, enterprise structure and the relationship with suppliers and markets. Despite major advances in research and testing of technology in projects that have evolved more and more towards technical and economic integration within target communities, even the best designed and most viable programmes cannot be imposed on groups of poor farmers, fishermen or the unemployed. The entrepreneur has to be identified, exposed to opportunities and supported by technical and economic studies in his attempts to establish and operate the new enterprises. Such a strategy has rarely been considered in agro-industry development projects.

Hitherto, agro-industry projects have neglected the existence of a large number of small-scale food-processing enterprises that continue to operate within the particular procurement, production, management and marketing conditions of the country. Investment in developing opportunities for thos enterprises could offer a less risky approach, be implemented faster and make a greater impact on the food system. Improvements would need to be tailored to entrepreneurs' aspirations, industrial conditions and consumer market constraints. Yet the promotion of such opportunities has received little attention in development strategies.

Attempts to improve the situation have been essentially targeted at industrial extension services, by encouraging their establishment or training staff and expanding services [8]. However, extension services generally treat all small-scale enterprises as a homogeneous mass of manufacturers, to which are targeted various support services, including feasibility studies, access to credit and training in management tools such as book-keeping. Rarely are technical services provided, since here the real heterogeneity of the sector is exposed.

Since industrial extension resources are typically limited and severely stretched to cover many individual small enterprises, consideration of the detailed technical problems or needs of individual enterprises becomes unfeasible. In the case of the food-processing industry, the general services offered are less applicable than in, for example, shoemaking or metalworking, since food-processing cannot be treated as homogeneous or standardized, owing to the great variety of raw materials and products, their perishability, the range of processing operations and the various constraints imposed by hygiene and health standards in each case. Industrial extension services as typically organized are incapable of providing technical assistance. At best, some pamphlets on general principles for each manufacturing industry are distributed. Rarely can entrepreneurs apply the information to the reality of their particular small plants [3].

In addition, technological research carried out in institutes and universities in developing countries is aimed at finding a general process that requires standardized equipment (often imported) and appears financially viable under the ideal assumptions made concerning potential market demand and prices. Rarely is such work targeted to the specific conditions of local small enterprises, since researchers are unfamiliar with those conditions and, more seriously, small enterprises cannot contribute to the costs of the research. Researchers are often more interested in creating new processes for large-scale production (perhaps with support from local large-scale business), since that appears more technically stimulating ([9] and [10]).

Thus little attention is given in development strategies to the needs of small food enterprises where the technical, managerial and infrastructural factors are so intimately integrated. Attention to one or more of those factors in a piecemeal form or in isolation from the others can bring little improvement.

It is essential to encourage strong interaction between extension services and technical research institutions. The former have the facilities for communication with small enterprises and the capability of providing management and credit advice. They need to develop appropriate technical services with linkages to, and influence on, research and development in their local technical institutions. The latter need to become more aware of the reality of small food enterprises and sensitive to the criteria of the entrepreneur in deciding on priorities and improvements to be undertaken. Their research will thereby offer realistic options for improvement of the indigenous food industry. Co-operation on those two fronts will also build local capacity to provide more effective support to the development needs of more risky, new enterprises, where, as mentioned earlier, most donor support is focused, without much success to date.

B. Experiences in the improvement of indigenous small-scale food enterprises

Since 1979 the International Development Research Centre of Canada has been supporting projects in several developing countries aimed at improving the productivity and profitability of small food enterprises, through the encouragement of applied research in the factory and with the involvement of management and operators. Researchers have come generally from food and economics sections of national science or technology institutes, although such institutions typically have no mandate for extension activities or technology transfer. In most cases technical researchers have responded to government encouragement of development of small-scale industry when deciding to enter such activities. On the other hand, as already noted, industrial extension agencies, where they exist, have moved to promote entrepreneurial development and credit programmes, in isolation from technical development.

Technical researchers in the projects have had to develop their own ways of forming relationships and generating credibility with the entrepreneur, so as to develop sufficient confidence to allow exploration of improvement options and the execution of in-plant research and testing as required. A systematic methodology is thus evolving which provides a flexible array of skills to guide researchers quickly and effectively, taking into account the entrepreneurs' goal of fostering development of indigenous small food industries.

A series of workshops have been held to develop the methodology and promote research projects, details of which have been published [9]. Projects have been carried out in the soy sauce industry in Singapore and in starch noodle enterprises in Thailand, and are currently under way in fish-cracker (Keropok) processing plants in Malaysia, in fish sauce (patis) enterprises in the Philippines, in rural coffee-processing co-operatives in Guatemala, in small bakeries co-operating with the local bakers association in Chile, and in rural traditional cheese plants in Ecuador. In all cases project teams adopt the following general approach:

(a) Initial visits to plants to discuss the entrepreneur's problems, his interest in improvements and general plant conditions. Often it is important for researchers to suggest a small improvement that can be immediately implemented, thus helping to develop credibility during the early visits;

(b) Detailed description of enterprise, including process flows, cost estimates and external linkages;

(c) Analysis of bottlenecks, key operations and critical problems, with attempts at priority-setting and estimates of costs and benefits of proposed improvements;

(d) Discussions with the entrepreneur to set priorities and agree on research strategy;

(e) In-plant experimentation to carry out improvements and measure benefits achieved, with laboratory support work;

(f) Testing of improvements (for example, equipment modification), measuring benefits achieved as compared with conditions described above in step (b), and assessing adequacy of improvements;

(g) Implementation of improvements.

The projects provide opportunities for the research group to work in a number of plants producing the same product, building on the experience gained in each and thus becoming more efficient, while at the same time appreciating the differences between enterprises and entrepreneurs despite their use of basically similar processes. Thus an overall awareness of how technology operates under the variety of conditions typical of small enterprises is developed in technical workers. This, together with the accumulation of experiences, contributes to the development of a valuable technical resource adapted to local enterprise realities. It is to be expected that where such experience accumulates, small-industry research activities may be incorporated into institutional services in developing countries.

Associated with the essentially technical improvement work, aspects of production management, cost and quality control are often addressed. However, the researchers are unable to deal with the external factor of access to capital, marketing management and more specific problems of cash flow management, employee relations etc., which certainly impinge on enterprise performance.

There is a persistent problem of financing the costs of the expensive, manpower-intensive approach for enterprises that typically have limited disposable income to invest in research or technical assistance. If the approach is beneficial and effective, it is even more imperative that integration with credit, management and other extension services should occur. It has been suggested that rapid access to credit, even at higher than normal interest rates, would be acceptable to small-scale entrepreneurs ([11] and [12]). That could generate sufficient capital to cover costs of consultancy [11]. Perhaps it would also be sufficient to cover technical research into those services, which traditionally are heavily constrained through lack of funds in public sector budgets.

In conclusion, it is essential that means be found for bringing the technical and management improvement programmes into tandem and ensuring that such an integrated approach is generated for all future enterprise development programmes. Experience with the inherently more complex technical and managerial issues associated with food processing should provide a good basis for similar improvements in other less heterogeneous manufacturing branches.

C. Case-study: Improvements in noodle-processing industry in Thailand

The project undertaken at the Thailand Institute of Scientific and Technological Research (TISTR) involved the setting-up of a project management team of engineers, food technologists and economists. It was found useful to have such a range of skills in the team to ensure a comprehensive approach to problem-solving.

Initial contacts were established by the management of the company and the staff of the working team through the following series of steps:

(a) Information on factories was derived from literature, local knowledge etc.;

(b) A number of factories were selected and contacted through a personal visit, letter, phone call or other appropriate means;

(c) Each factory was visited to obtain general information that could be used to isolate problem areas and to inform the management of benefits that co-operative work with the institute could bring;

(d) The general information was then compiled and evaluated by the team, to identify factories with potential for improvement and collaboration;

(e) Time was also allowed for the factories to approach the Institute, and a prompt response was given to any such approach.

A second visit was made by Institute staff to those factories which responded to initial contact attempts. The approach had to be careful and sensitive in order to determine whether the manager was motivated towards change.

Once agreement to collaborate was established, a plan was formulated with a schedule for the improvement work, possibly requiring more visits to the factory. A series of forms were developed to aid in gathering and recording information in an orderly fashion from rapid observations and meetings during factory visits [9]. After the factory visits, the working team compiled the information collected and drew up a process flow chart [9] and schedule. That baseline information was used for reference in subsequent studies. Economic estimates could be made from the recorded information, since often management was unwilling to discuss financial matters until they developed some confidence and trust in the research team.

Each member of the team was responsible for collecting information on different parts of the process and operations in the plant. Several visits were often necessary to fully document the business and its processing activities. Adequate time was taken to evaluate the information compiled by the technical group so that the entire process, bottlenecks and problems could be completely understood. Extensive group discussions were necessary among members of the research team in order to identify a list of improvement opportunities.

Screening the alternatives was done by a process of scoring or ranking, determined by consensus of the team members. Establishing an order of priority for the various improvement ideas was then done by seeking the opinion of management. It was good to start with an improvement in an area that management had a specific interest in or that promised to bring an obvious and dramatic change in a short period of time, since that established credibility and confidence in the research team. That being accomplished, it was much easier to work on other, less rapidly achievable improvements with the manager.

Quantitative methods of evaluation can be used in determining the area in which to concentrate. For example, in one transparent noodle factory, the freezing operation was chosen as an area for improvement because it was identified as being the most energy-intensive operation after an evaluation of energy consumption throughout the process (it was estimated that freezing consumed 68 per cent of the total energy).

The target improvement area chosen, the working team discussed the planning of necessary activities, which could include designed experiments, factory trials, laboratory experiments, determining methods of analysis and preparation of instruments, apparatus and equipment, with assignment of schedules and responsibilities for each member of the team. During the in-factory work, the team has to encourage and maintain a good relationship and the active involvement of the factory owner, so as to gain his or her confidence. All particulars of the research investigation must be held in confidence by the members of the research team, and methods used in other similar factories must not be discussed. At the implementation stage, the working team introduced the improved method in the plant and demonstrated it to the manager personally, by taking him or her through the activities where adjustments or changes had been made, to ensure that the manager understood them thoroughly. For example, in one noodle factory, the working team drew up a chart illustrating the improved process compared with the existing method, in a simplified format for implementation and transfer in the factory. Once improvements in a process were made in one factory, it was found that other factories in the same business were more approachable as word of the improvements spread. The team in Thailand successfully implemented improvements in three transparent noodle plants as follows:

(a) Factory A. Increased yield of separated mung-bean starch prior to noodle-making, through incorporation of a second wash of the bean residue;

(b) Factory B. Reduced energy requirement for the freezing stage in noodle manufacture, through adoption of temperature and time control and redesign of stacking rails in freezing chambers;

(c) Factory C. Solved critical quality problem of dry noodle shattering, which was leading to loss of markets and bankruptcy. Control of freezing and sulphur-dioxide fumigation stages led to consistent production of good-quality product. The company was saved from bankruptcy and has since expanded to incorporate another noodle production line, with an increase in the number of employees.

Considerable difficulties were encountered by the team in Thailand (as well as all other groups involved in such projects), particularly in generating sufficient credibility and confidence with entrepreneurs to make possible the initial sharing of necessary data, while ensuring the security of their industrial secrets. Nevertheless, word of the team's activities soon circulated around the industry. When they arranged a workshop to explain their progress in an attempt to stimulate wider industry interest, they were surprised to find that 23 noodle plants were represented at the meeting. This was the first time the manufacturers had met together as a group. The meeting provided an opportunity to highlight their common interests and to learn that they were all facing similar problems. A set of technical priorities was developed by the industrial group at the meeting, which served as a research agenda for the team in its future activities. Thus improvements of interest to the whole industry could be worked on by the team, which had gained credibility and developed practical knowledge of the realities of that traditional industry. Such an approach should considerably enhance the prospects for change in both the noodle and other traditional food industries in the future. As a result of the project, the Ministry of Industry of Thailand has requested TISTR to provide technical inputs to its programmes for the promotion of the food industry.

References

1. M. Carr, Developing Small-scale Industries in India (London, Intermediate Technology Publications, 1981).

2. D. Anderson, Small Industry in Developing Countries, World Bank Staff Working Papers, No. 518 (Washington, D.C., World Bank, 1982).

3. M. Harper, Small Business in the Third World (Chichester, John Wiley, 1984).

4. O. Dans and others, Small-scale Non-farm Enterprises in Jamaica, Working Paper No. 8, Rural Development Series (East Lansing, Michigan State University, 1979).

5. Central Statistical Office, Small Business Survey 1976 (Port of Spain, Trinidad and Tobago, 1980).

6. Statistics Division, Small-scale Industry Survey Report 1977 (Ilorin, Kwara State, Nigeria).

7. D. H. Bruinsma, W. W. Witensburg and W. Wuderman, Selection of Technology for Food Processing in Developing Countries (Wageningen, Netherlands, Centre for Agricultural Publishing and Documentation, 1983).

8. N. Molenaar, M.S.S. El-Namaki and M. P. van Dijk, Small-scale Industry Promotion in Developing Countries, Conference on Small-scale Industry Problems and Prospects, Delft, 19-20 September 1983 (Delft, Netherlands, Research Institute for Management Science, 1984).

9. W. Edwardson and C. W. McCormac, eds., Improving Small-scale Food Industry in Developing Countries (Ottawa, International Development Research Centre, 1984).

10. W. Edwardson, "Food engineering, technology transfer: and the Third World lessons and challenges", Impact of Science on Society, No. 142, 1986, p. 187.

11. M. Harper, personal communication.

12. A. J. Young, "Small business development constraints", in Molenaar, El-Namaki and van Dijk, Small-scale Industry Promotion ..., pp. 50-65.

SOMMAIRE

L'industrie agro-alimentaire en Amérique latine

Teresa Salazar de Buckle, William Holaday et Guillermo Castella

Le présent article a pour objet de montrer que pour analyser l'industrie agro-alimentaire, mesurer la demande potentielle de produits alimentaires et évaluer le rôle potentiel et les possibilités de développement de ce secteur conformément au concept élargi de sécurité alimentaire, il faut utiliser une approche systémique intégrée. Dans cette analyse, on peut utiliser les instruments méthodologiques mis au point et disponibles à l'ONUDI (en particulier les méthodes d'évaluation et de programmation de systèmes industriels). L'avantage de cette méthodologie est qu'elle peut être appliquée sur micro-ordinateur à l'aide d'un modèle comptable pour simuler les effets de différentes options techniques et pour obtenir des résultats quantitatifs qui permettent de choisir les meilleures solutions pour former une stratégie de développement intégré du système.

Dans cet article, les auteurs proposent un cadre de référence pour l'action à mener sous forme d'une stratégie de développement agriculture/emploi/technologie, fondée sur un concept initialement proposé par J.W. Mellor. Une telle stratégie devrait permettre de s'attaquer simultanément à tous les secteurs critiques du système en faisant appel aux techniques, politiques et investissements nécessaires pour parvenir à un développement intégré (tel qu'il est défini dans l'article) qui réponde aux besoins d'un programme élargi de sécurité alimentaire de l'offre et de la demande. En outre, les auteurs estiment que la coopération internationale, surtout aux niveaux sous-régional et régional, peut jouer un rôle important dans une stratégie de développement de ce genre.

Les raisons économiques qui expliquent l'apparition de nouveaux producteurs de produits pétrochimiques dans les pays en développement riches en hydrocarbures

P. Abou-Ezze, D.W. Butterfield et A.A. Kubursi

Les auteurs font valoir que pour les pays en développement riches en pétrole, dont la plupart n'ont guère d'autres ressources à mettre en valeur, la production pétrochimique est l'option la plus favorable à l'industrialisation. S'agissant des coûts, ces pays bénéficient généralement d'un très net avantage comparatif, étant donné que le prix des matières brutes représente une forte part des coûts de production et que l'abondance de leurs excédents financiers leur permet d'investir dans de grands complexes industriels performants avec un investissement initial relativement faible par unité de production. Il faut choisir une gamme restreinte de produits pétrochimiques, notamment des produits à la phase de maturité du cycle du produit et peu sujets à l'obsolescence technologique, ainsi que des produits extrêmement sensibles à la concurrence par les prix et aux prix des matières brutes. Les auteurs donnent une description de l'industrie dans les pays arabes.

Analyse des semi-entrées-sorties pour estimer les paramètres économiques nationaux : application au Botswana

Rainer Saerbeck

Aux fins de cette analyse, un tableau type des entrées-sorties est ventilé en secteurs fabriquant des produits entrant dans le commerce international et en secteurs non marchands. Combinée avec une analyse coûts-avantages telle que celle de Little et Mirrlees, cette méthode permet de calculer sur une base systématique, en tenant compte des relations interindustrielles, les prix comptables de biens non marchands et de facteurs primaires tels que le travail. La série de prix ainsi calculés peut fournir la base d'évaluation de projets et de programmation sectorielle. Dans cet article, l'auteur expose cette théorie et donne l'estimation d'une série de rapports de prix comptables pour le Botswana.

Amélioration de la petite industrie alimentaire dans les pays en développement

William Edwardson

La petite et moyenne industrie alimentaire nationale peut jouer un rôle très utile dans le développement. Pour l'auteur, une intégration plus poussée des services de promotion industrielle, notamment pour la gestion et le financement, la recherche technologique étant effectuée dans des établissements nationaux, permettrait d'aboutir à des améliorations non négligeables et de stimuler le progrès de ces activités. L'auteur examine l'expérience du Centre de recherches pour le développement international (Canada) et une étude de cas menée en Thaïlande, qui met en évidence l'interaction entre les entrepreneurs et les organismes d'assistance, pour illustrer les approches qui permettraient d'atteindre ces objectifs.

EXTRACTO

La industria agroalimentaria en América Latina

Teresa Salazar de Buckle, William Holaday y Guillermo Castella

El propósito de este trabajo es demostrar la necesidad de utilizar un sistema integrado como método para analizar la industria agroalimentaria, determinar la demanda potencial de alimentos y evaluar la función que puede desempeñar la industria, así como sus posibilidades de expansión, en el marco de un concepto amplio de la seguridad alimentaria. Ese análisis se puede llevar a cabo utilizando instrumentos metodológicos ya existentes, de los que dispone la ONUDI (en particular la metodología para evaluar y programar sistemas industriales). Las ventajas que presenta esa metodología se aprecian en el hecho de que se puede aplicar, empleando un modelo contable en una microcomputadora, para simular las consecuencias de la aplicación de las diversas opciones técnicas y producir resultados cuantitativos, que servirían de base para seleccionar las mejores opciones, a fin de establecer una estrategia para el desarrollo integrado del sistema.

En este trabajo también se propone un marco para la adopción de medidas, consistente en una "estrategia para el desarrollo que abarque la agricultura, el empleo y la tecnología", basada en un concepto propuesto originalmente por J.W. Mellor. La finalidad de esa estrategia consistiría en hacer frente simultáneamente a todas las esferas que suscitan problemas en el sistema, adoptando las tecnologías, políticas e inversiones necesarias para lograr un desarrollo integrado (concepto que se define en el texto) que pueda satisfacer las necesidades de la demanda y de la oferta en un programa amplio de seguridad alimentaria. Se sostiene asimismo que la cooperación internacional, en particular en los planos subregional y regional, puede desempeñar una función importante en esa estrategia de desarrollo.

Las ventajas económicas del establecimiento de nuevas empresas de productos petroquímicos en los países en desarrollo que poseen hidrocarburos en abundancia

P. Abou-Ezze, D.W. Butterfield y A.A. Kubursi

Se sostiene en este trabajo que la producción petroquímica es la posibilidad de industrialización más importante de que disponen los países en desarrollo que poseen petróleo en abundancia, la mayoría de los cuales cuentan con escasos recursos aparte de éste. Por lo general, tienen una importante ventaja comparativa en materia de costos, ya que una considerable proporción de los gastos de producción corresponden a los costos de las materias primas y sus grandes excedentes financieros les permiten hacer inversiones en complejos eficientes y en gran escala, con gastos de capital por unidad relativamente bajos. Se debería escoger un conjunto limitado de productos petroquímicos, incluidos los que se hallen en una fase de eficacia comprobada de su ciclo de desarrollo y tengan una vulnerabilidad limitada con respecto a la obsolescencia tecnológica, así como los productos que sean muy sensibles ante la competencia de precios y los precios de las materias primas. Se describe la industria de los países árabes.

Análisis semi-insumo-producto para estimar los parámetros económicos nacionales: su aplicación a Botswana

Rainer Saerbeck

Mediante el análisis semi-insumo-producto se desglosa un cuadro "insumo-producto" en sect s que se pueden comercializar o no internacionalmente. En combinación con una metodología de costos-beneficios, como la elaborada por Little y Mirrlees, los precios contables correspondientes a los bienes no comercializados y los factores primarios -como la mano de obra- pueden calcularse de modo sistemático, teniendo en cuenta los vínculos de concatenación. El conjunto de precios determinado de este modo puede servir de base para la evaluación de proyectos y la programación sectorial. En este artículo se presenta la teoría y se calcula un conjunto de proporciones de precios contables en el caso de Botswana.

Mejoramiento de la industria alimentaria en pequeña escala en los países en desarrollo

William Edwardson

La industria nacional de elaboración de alimentos en pequeña y mediana escala puede desempeñar una función importante en el desarrollo. Se sostiene en este artículo que la mayor integración en las instituciones locales de los servicios de extensión industrial -como los relacionados con la gestión y las finanzas- con la investigación tecnológica puede dar lugar a un mejoramiento considerable y alentar el desarrollo de esa industria. Se examinan las experiencias del Centro Internacional de Investigaciones sobre el Desarrollo (Canadá) y un estudio monográfico llevado a cabo en Tailandia, que hacen hincapié en las acciones recíprocas entre empresarios y organizaciones que prestan asistencia, a fin de ilustrar posibles enfoques encaminados al logro de esos objetivos.

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